VOLUME I

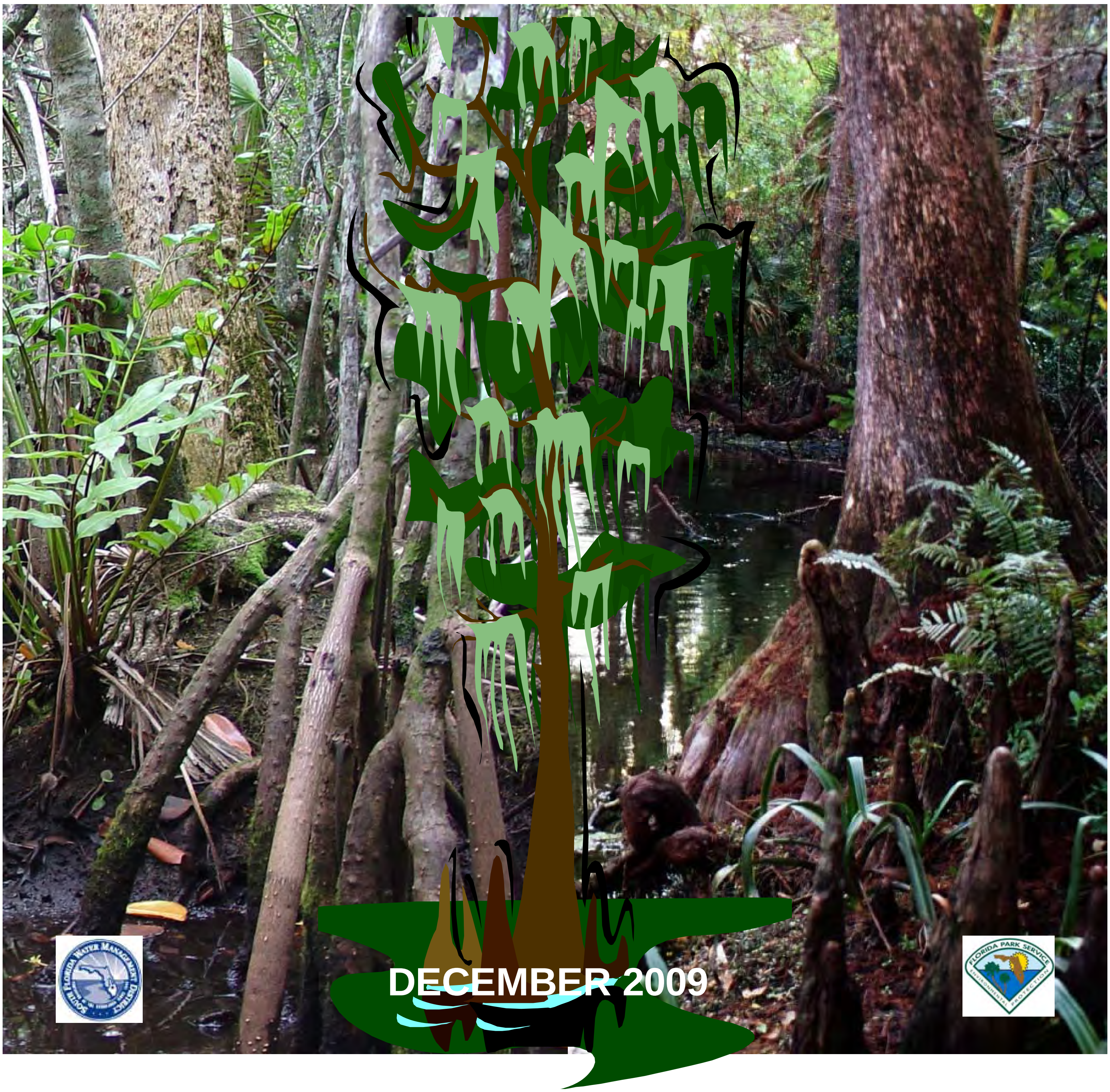
RIVERINE AND TIDAL FLOODPLAIN VEGETATION OF THE LOXAHATCHEE RIVER AND ITS MAJOR TRIBUTARIES

South Florida Water Management District

Coastal Ecosystem Division

Florida Department of Environmental Protection

Florida Park Service, District 5



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GLOSSARY

Basal area is the cross-sectional area of a trunk (in m^2), which is calculated from dbh (in cm) 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 and Rblh3) 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 (Wharton et al., 1982).

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 m 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 USGS 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 which 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 Upland. 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 (2003). 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 sub canopy 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.

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 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 RM 0 at the mouth of the river (Jupiter Inlet).

Riverine reach (R) (Rsw1, Rsw2, Rblh1, Rblh2, Rblh3 and Rmix) Primary freshwater canopy forest that is generally unaffected by salinity. It extends from just north of the G-92 structure (RM16) downstream to RM 9.5.

Sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD29), 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 dbh of 10 cm or more and a height of 3 m 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 on 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 deepwater habitats by the Florida Natural Areas Inventory (FNAI) (See oak/pine upland forest).

Upper tidal reach (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 RM 9.5 to RM 8.13 at the mouth of Kitching Creek in addition to the North Fork of the Loxahatchee 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 U.S. 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.

A Complete List of Vegetative Species by Scientific and Common Names

Scientific Name	Common Name
Abrus precatorius	Rosary pea
Acer rubrum	Red maple
Acrostichum danaefolium	Leather fern
Alternanthera philoxeroides	Alligator weed
Alternanthera sessilia	Joyweed
Amorpha fruticosa	False indigo
Annona glabra	Pond apple
Apios americana	Ground nut
Ardisia elliptica	Shoe button
Ardisia escallonioides	Marlberry
Baccharis glomeruliflora	Groundsel
Baccharis halimifolia	Salt bush
Bacopa monnieri	Water hyssop
Bejaria racemosa	Tar flower
Bidens alba	Beggar ticks
Bischofia javanica	Bishop wood
Blechnum serrulatum	Swamp fern
Boehmeria cylindrica	False nettle
Callicarpa americana	Beautyberry
Canna flaccida	Golden canna
Carex lupuliformis	Hop sedge
Carya aquatica	Water hickory
Celtis laevigata	Hackberry*
Cephalanthus occidentalis	Buttonbush
Chamaecrista fasciculata	Partridge pea
Chromolaena odorata	Jack-in-the-bush
Chrysobalanus icaco	Coco plum
Citrus sp.	
Cladium jamaicense	Sawgrass
Colocasia esculenta	Wild taro
Commelina diffusa	Dayflower
Cornus foemina	Swamp dogwood*
Crinum americanum	Swamp lily
Cynoglossum zeylanicum	now *Mitreola petiolata*
Cyperus haspan	Flat sedge

Cyperus ligularis	False saw grass
Cyperus retrorsus	Flat sedge
Cyperus virens	Green flat sedge
Dalbergia ecastaphyllam	Coin vine
Desmodium incanum	Zarzabacoa
Desmodium triflorum	Three flower beggar weed
Dichanthelium commutatum	Witch grass
Eichhornia crassipes	Water hyacinith
Eleocharis baldwinii	Road grass
Epipremnum pinnatum	Golden pothos
Erechitites hieracifolia	now *E.hieracilfolius,*fireweed
Eupatorium mikanioides	now *Cromolaena odorata*
Ficus aurea	Strangler ficus
Ficus microcarpa	Indian laurel ficus
Fraxinus caroliniana	Pop ash
Galactia spp	Milkpea
Gomphrena serrata	Globe amaranth
Hydrilla verticillata	Water thyme
Hydrocotyle spp	Pennywort
Hygrophila polysperma	E. Indian swamp weed
Hypericum spp	St. John's wort
Hyptis alata	Musky mint
Ilex cassine	Dahoon holly
Ilex glabra	Ink berry
Ipomoea indica	Blue morning glory
Itea virginica	Virginia willow
Laguncularia racemosa	White mangrove
Liguidambar styraciflua	Sweet gum**
Limnophilia sessiliflora	Marsh weed
Ludwigia octivalvus	Primrose willow
Ludwigia peruviana	Primrose willow
Ludwigia repens	Creeping primrose willow
Lygodium microphyllum	Old World climbing fern
Lyonia fruiticosa	Staggerbush
Lyonia lucida	Fetterbush
Magnolia virginiana	Sweet bay*
Melaleuca quinquenervia	Punk tree
Melanthera nivea	Square stem
Micranthemum glomeratum	Baby tears/mudflower
Mikania scandens	Hempvine
Mimosa quadrivalvis	Sensitive brier
Mitreola petiolata	Lax hornpod
Momordica charantia	Wild balsum apple

Morus rubra	Mulberry
Myrica cerifera	Wax myrtle
Nephrolepis cordifolia	Tuberous sword fern
Nephrolepis exaltata	Wild Boston fern
Nephrolepis multiflora	Boston fern
Osmunda cinnamomea	Cinnamon fern
Osmunda regalis	Royal fern
Panicum abscissum	Cut throat grass
Panicum maximum	Guinea grass
Panicum rigidulum	Redtop Panicum
Panicum virgatum	Switch grass
Parthenocissus quinquefolia	Virginia creeper
Persea borbonia	Red bay
Persea palustris	Swamp bay
Pinus elliottii	Slash pine
Pleopeltis polypodioides	Resurrection fern
Pluchea odorata	Sweet scent
Polygonum hydropiperoides	Swamp smart weed
Polygonum punctatum	Dotted smart weed
Pontederia cordata	Pickerel weed
Pouzolzia zeylania	Pouzoulz's bush
Psidium cattleianum	Strawberry guava
Psidium guajava	Guava
Psilotum nudum	Whisk-fern
Psychotria nervosa	Wild coffee
Psychotria sulzneri	Wild coffee
Ptychosperma macarthurii	MacArthur palm
Quercus laurifolia	Laurel oak
Quercus myrtifolia	Myrtle oak
Quercus virginiana	Live oak
Rapenea punctata	Myrsine
Rhabdadenia biflora	Rubber vine
Rhizophora mangle	Red mangrove
Rhynchospora corniculata	Beak sedge*
Rhynchospora inundata	Beak sedge
Rhynchospora rariflora	Beak sedge
Roystonea regia	Royal palm
Rubus trivialis	Blackberry
Sabal palmetto	Cabbage palm
Sagittaria lancifolia	Arrow head
Sagittaria latifolia	Broadleaf arrow head
Salix caroliniana	Carolina willow
Salvinia minina	Water spangles

Samolus valerardi	Pineland pimpernel
Sarcostemma clausum	White vine
Saururus cernuus	Lizard's tail
Schinus terebinthifolius	Brazilian pepper
Senna pendula	Climbing Cassia
Serenoa repens	Saw palmetto
Sida acuta	Wire weed
Smilax auriculata	Earleaf greenbrier
Smilax bona-nox	Greenbrier
Smilax laurifolia	Bamboo vine
Spartina sp.	Cordgrass
Sphagneticola (Wedelia) trilobata	Creeping oxeye
Syngonium podophyllum	Nephthytes
Syzygium cumini	Java plum
Syzygium jambos	Rose apple
Taxodium distichum	Bald cypress
Thelypteris dentata	Downy shield fern
Thelypteris interrupta	Tri-veined fern
Thelypteris palustris	Marsh fern
Thelypteris serrata	Meniscium fern
Tillandria fasciculata	Cardinal airplant
Tillandria setacea	Needle leaf airplant
Toxicodendron radicans	Poison ivy
Tripsacum dactyloides	Gamma grass
Typha spp.	Cattail
Unidentfied Cyperaceae	
Unidentified Poaceae	
Unidentified Xyris	
Urena lobata	Caesar weed
Urochloa mutica	paragrass
Vitis rotundifolia	Muscadine grape vine
Xanthosoma sagittifolium	now *Colocasia esuenta*

*Not found on transects but found in JDP inventory list.

**Found by Davis (1943) but not found in JDP inventory list.

EXECUTIVE SUMMARY

As Florida's first National Wild and Scenic River, the Loxahatchee River and its major tributaries deserve the intensive attention received from federal government, state and local agencies, local residents, and tourists. The most impressive feature of the Loxahatchee River and floodplain system is the sub-tropical cypress swamp and mixed hardwood forest that is found within the river's floodplain. This swamp contains bald cypress trees that are 300 or more years old, and is one of the last remaining bald cypress swamps in southeast Florida. The Loxahatchee River is also south Florida's last free-flowing river system. Additionally, the tidal floodplains and estuary of the Loxahatchee River are valuable ecological resources within the Loxahatchee River watershed.

Despite an impressive list of enduring natural resources, problems still abound in "Paradise". The Loxahatchee watershed is now permanently altered by the stabilization of Jupiter Inlet, which heightens the effects of tidal amplitude and salt-water intrusion; and the construction and operation of drainage canal systems which alter the natural pattern of freshwater flow and inundation of the floodplain. *The Restoration Plan for the Northwest Fork of the Loxahatchee River* (SFWMD, 2006) chronicles these problems and provides ecological target species, performance measures, and monitoring requirements needed to track the success of restoration goals and provide guidance to future adaptive management and operational practices.

The major concern for floodplain communities in the riverine reach is inadequate hydroperiods (depth and duration) which: (1) resulted in the loss of canopy trees between 1985 and 2003; (2) encouraged the intrusion of transitional, upland, and exotics plant species; (3) resulted in the alteration of forest type communities; and, (4) may be insufficient for aquatic organisms to fully utilize the floodplain communities. The major concerns for the floodplain communities in the tidal reaches are increased salinity in surface waters and soils and the increase in tidal inundation since stabilization of Jupiter Inlet. The emphasis on restoration in the Loxahatchee River will be on reducing salinities to below 2 parts per thousand (ppt) at the mouth of Kitching Creek (RM8.13) for tidal reaches and to improve hydroperiods on the riverine floodplain, which should in turn improve habitat quality for freshwater seed production, germination, and eventually reforestation throughout the river system. Continued vegetation, and surface water and soil monitoring of the floodplain will be necessary to ensure that the hydrologic conditions necessary for the long term health of these vegetative communities are maintained.

In 2003, the staff of South Florida Water Management District (SFWMD) and Florida Park Service (FPS) District 5, sampled vegetation on 10 transects on the Northwest Fork and its major tributaries to investigate floodplain community composition, structure and health. Seven of the 10 transects were previously investigated from 1967 to 1985. Three new transects were created to investigate additional sites. Guidelines were created to identify forests by reach (riverine, and upper and lower tidal) and forest type. The major forest type categories were swamp, bottomland hardwoods, hydric and mesic hammocks, and uplands. Forests on sampled transects were identified to forest type by applying rules based on relative basal area of species present. On the transects, elevation was one of the major factors correlated with forest composition. Other factors that influenced forest composition included salinity, storm events, logging, fire history, soil types, the presence or absence of exotics, the presence of hummocks, light, and nutrients.

Species richness, density (abundance), biomass (relative basal area), and frequency of occurrence were examined within the 138 vegetative plots within ten transects. Forest plots sampled on transects were 58% swamp, 13% bottomland hardwood, 13% hammock, 12% mixed hardwood, 3% upland, and 1% freshwater marsh types. Canopy species included 26 trees and one large woody vine. The shrub-layer contained 49 species, and the groundcover layer contained 118 species. Transects that had been disturbed had higher species richness than undisturbed transects. The five most abundant canopy species sampled on transects were white mangrove 22.5%, red mangrove, 14.2%, pond apple 13%, cabbage palm 12.4% and bald cypress 9%. The two species with the highest relative basal area on all transects combined were bald cypress (40.6%) and cabbage palm (22.7%). With regard to an overall importance value based on abundance, basal area, and frequency of occurrence cabbage palm ranked the highest followed by bald cypress, white mangrove, pond apple, red mangrove, pop ash, red maple, wax myrtle, water hickory and Carolina willow.

During the 2004 hurricane season, Florida was hit by an unprecedented 5 hurricanes (Charley, Frances, Ivan, Jeanne, and Charley). The floodplain forest of the Loxahatchee River was impacted by both Hurricanes Frances and Jeanne. Hurricane Frances made landfall on September 5, 2004 near Sewall's Point, Florida, with maximum sustained winds of 105 mph (91 kts, Category 2). Three weeks after Hurricane Frances, Hurricane Jeanne made landfall at Stuart, Florida, on September 26, 2004, as a category 3 storm with winds of 120 mph (105 kts).

Canopy trees were re-examined along the 10 belt transects in the summer and fall of 2005 to assess hurricane damage on the floodplains. Comparisons were made between the 2003 survey of the canopy trees and the remaining canopy. In the tidal floodplains near RM 6.46 (Transect 9), tall white mangrove were heavily impacted in the form of tip-overs (wind thrown, 47 percent) and broken branches (49 percent) while shorter red mangrove were only marginally impacted by broken branches (72 percent) and defoliation. In the riverine floodplains, the heaviest damage occurred within bottomland hardwood communities. Large red maple and water hickory trees have shallow root systems and were frequently tipped over (23.5 percent and 25 percent tip-over rate, respectively). Few bald cypress were tipped over (0.008 percent); however, major branches were lost on most trees (86.3 percent), resulting in greater levels of light penetration on the floor of the floodplains. Most trees recovered quickly by sending out new branches. Of the 1,694 canopy trees sampled, a 2.5 percent mortality rate occurred as a result of the storms. There is a concern that the storms may provide an opportunity for the expansion of exotics within the floodplain with a shift from shade tolerant species to more light obligate plant species. Future research is needed to measure long term impacts of the hurricanes.

In 2006, all ten transects were re-examined for species occurrence in the canopy, shrub-layer, and groundcover. On Transects 1 through 6, observations of species richness made in 2006 were similar to those made during the 1995 study. Changes in species richness are probably a direct result of a combination of factors including hurricane impacts, changes in light availability, invasion of upland and exotic species, and changes in hydrology and salinity within the floodplain. Looking at dbh size class frequencies of several of the major canopy species, there was very little recruitment occurring in the riverine reach and there was a loss of trees over a three decade period (1985, 1995 and 2003). Losses of bald cypress, cabbage palm, red maple, water hickory and popash were observed.

The proposed restoration target flows for wet and dry season established by the Restoration Plan in 2006 should enhance the native freshwater communities in the riverine and upper tidal floodplain of the Loxahatchee River by slowing the loss of trees, increasing the hydroperiod, providing additional nutrients to the floodplain, and discouraging the invasion of upland, transitional and exotic species. With an improved freshwater environment in the tidal floodplain, freshwater tree species (primarily bald cypress, pop ash, and pond apple) would be expected to increase in importance while saltwater tree species would have decreased importance except in the lower tidal reach where the limiting factor may be sea level rise and tidal amplitude. The determination of flow levels needed to maintain floodplain communities will provide the SFWMD Operations Department with a scientific basis for regulation of water deliveries from the C-18 Canal through the G-92 structure on a seasonal basis.

INTRODUCTION

The Loxahatchee River and Estuary are located along the lower East Coast of Florida (**Figures 1 and 2**). The watershed drains an area that was historically 240 square miles within northern Palm Beach and southern Martin Counties and connects to the Atlantic Ocean via the Jupiter Inlet, in Jupiter, Florida (**Figure 3**). Just west of the inlet, the river opens into a central embayment area, which formed at the confluence of three major branches, the Northwest Fork, North Fork and the Southwest Fork (**Figure 4**). The Northwest Fork is the largest branch with two major tributaries (Cypress Creek and Kitching Creek). Wilson, Moonshine, and Ketter Creeks are three minor streams that can also be found along the tidal portion of the Northwest Fork of the Loxahatchee River. Other features on the Northwest Fork include Lainhart and Masten Dams, which were constructed in the 1930s at RM 14.78 and RM 13.50, respectively.

During the past 100 years, the natural hydrologic regime of the Loxahatchee Watershed (**Figure 4**) has been altered by drainage activities associated with urban and agricultural development, and stabilization of the inlet. A year by year time line of the changes is given in **Appendix A**. Most of the watershed was historically drained by the Northwest Fork. Headwaters of the river originated in the Loxahatchee and Hungryland Sloughs (**Figure 3**). Today much of the watershed has been impacted by the construction of canals and levees for drainage and flood protection. McPherson and Halley (1996) in their publication, *The South Florida Environment: A Region Under Stress,* documented the encroachment of mangroves, along with the overall reductions in freshwater flows, maintenance of lower groundwater levels, short-duration high-volume freshwater flows devised for flood protection from 5 & 6 and G-92 structure, and changes in the quality of runoff. Environmental studies are continuing to be conducted today to document hydrological, chemical, and biological factors associated with the health of the floodplain area.

The floodplain of the Loxahatchee River supports a tropical and temperate riparian forest. Species richness in the understory is increased by the overlapping of tropical and temperate vegetation communities. Hydrologic conditions within the floodplains vary from dry to flooded as the river and its tributaries react to local rainfall events. Major plant community types in the floodplain include hammocks, bottomland hardwood, and swamps. Hydric hammocks are generally defined as “tree islands” that usually occur on higher elevations within the floodplain and often contain species that are found in the uplands as well as in the floodplain. On the

Loxahatchee River, hydric hammocks are dominated by cabbage palm. Bottomland hardwood communities contain diverse vegetation that varies along gradients of topography and flooding frequency. They are usually considered to be more productive than the adjacent uplands due to the periodic inflow of nutrients, especially when flooding is seasonal rather than continuous (Mitsch and Gosselink, 1993). Swamps are defined as woody wetlands that have standing water for most, if not all, of the growing season. On the floodplain of the Loxahatchee River, they consist primarily of bald cypress, red and white mangrove and, pond apple and pop ash. The Loxahatchee River contains some of the last pristine subtropical cypress swamps in Southeast Florida. The more mature bald cypress trees range from 300-500 years old (Florida Department of Natural Resources, 1985). In May of 1985, 7.5 miles of the Northwest Fork of the Loxahatchee River was federally designated as Florida's first National Wild and Scenic River (outlined in red on Figure 4). Other unique resources of the river and estuary include the designated Aquatic Preserve and Outstanding Florida Waters, and the Jonathan Dickinson State Park (**Figures 2 and 3**). The Loxahatchee River-Lake Worth Creek Aquatic Preserve consist of Lake Worth Creek, North Fork, Southwest Fork and Northwest Fork up to RM 15 (Indiantown Road), which is designated as an urban preserve while the remaining upper Northwest Fork is designated a wilderness preserve. All of the waters within Jonathan Dickinson State Park are designated as Outstanding Florida Waters.

Figure 1. South Florida – Martin and Palm Beach Counties, Jonathan Dickinson State Park, and Jupiter Inlet highlighted.

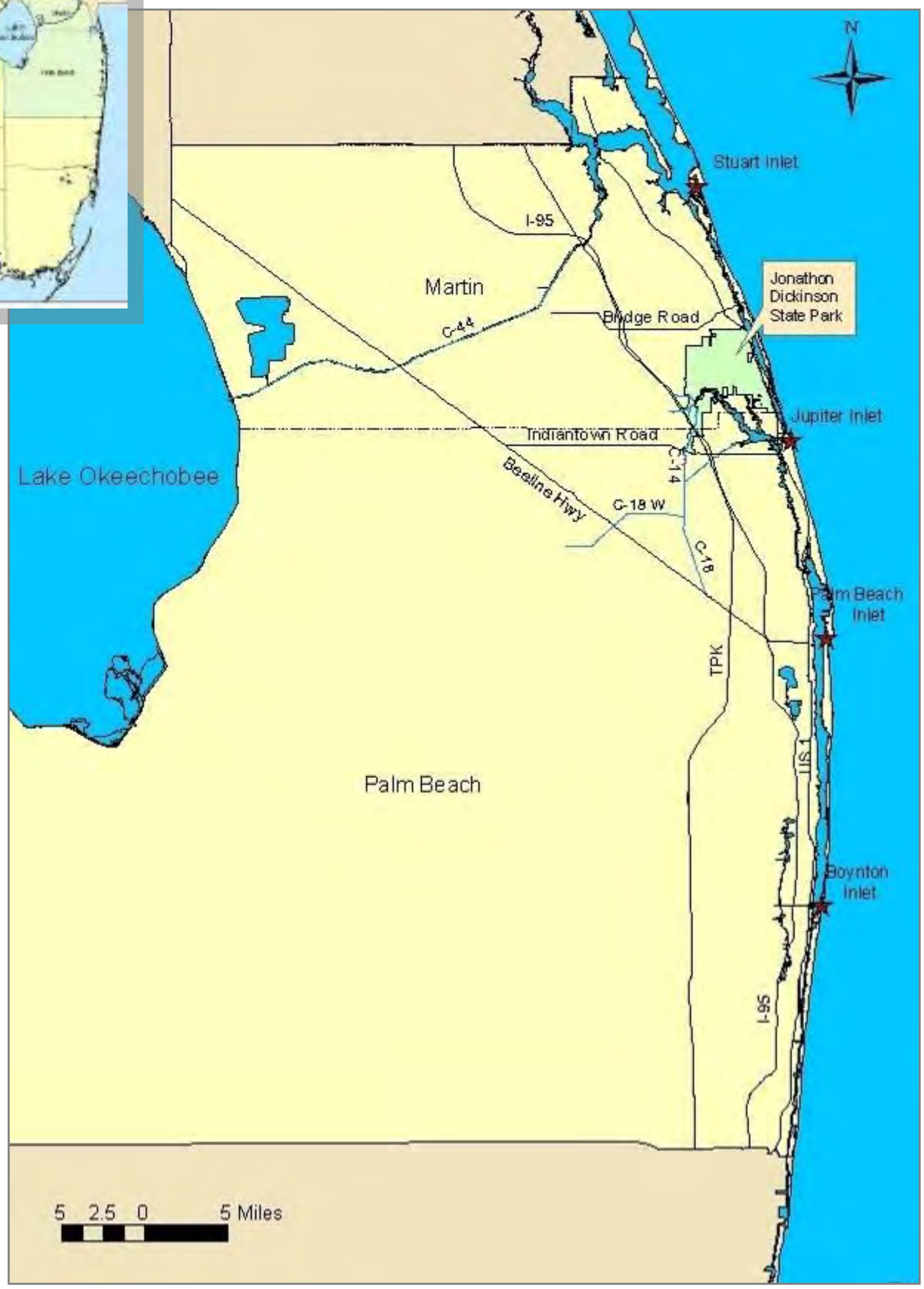


Figure 2. Detail – Martin and Palm Beach Counties, Jonathan Dickinson State Park, and Jupiter Inlet in South Florida.

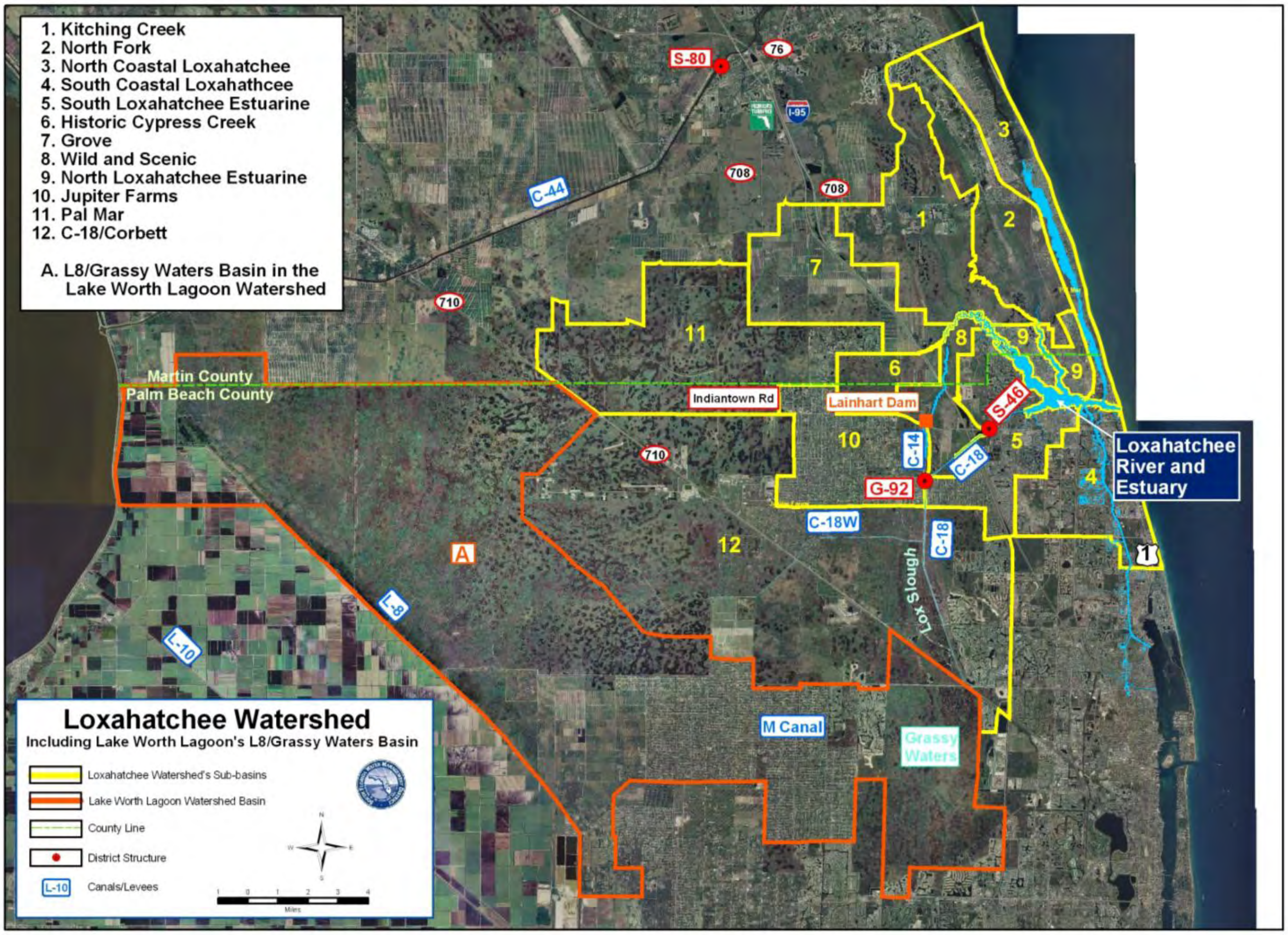


Figure 3. SFWMD map of the Loxahatchee River Watershed. Note: Hungryland Slough is just south of the C-18W Canal.

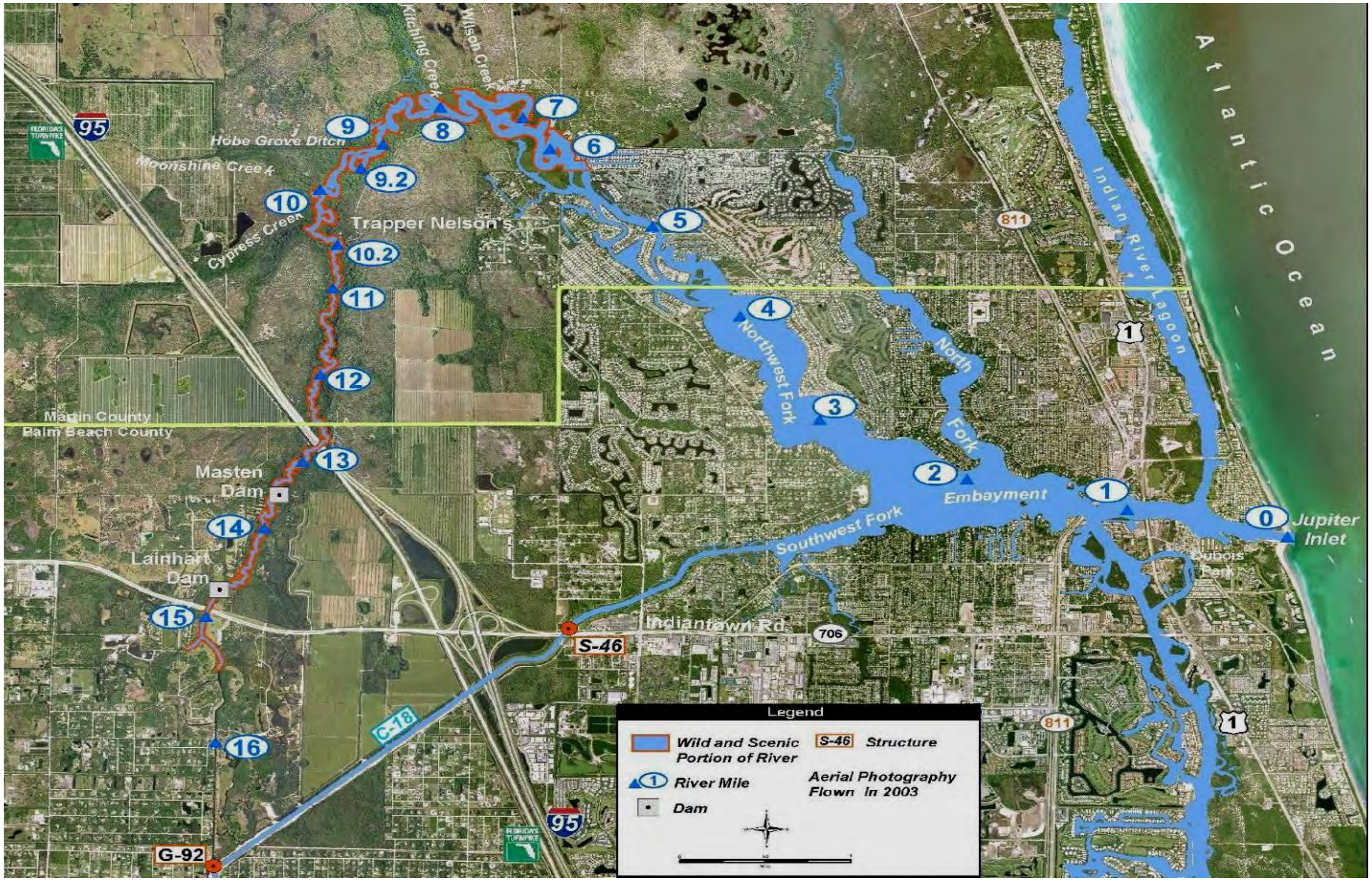


Figure 4. The Loxahatchee River and its major tributaries and water control structures. The boundaries of the Wild and Scenic River are outlined in red. Note: the mouth of Ketter Creek is approximately RM. 5.8 and Ornamental Garden is on the south side at RM 8.4. The river miles depicted on this map are based on 2003 GPS and GIS analysis.

PURPOSE AND SCOPE

With the development of the 2000 National Wild and Scenic River Management Plan, 2002 Comprehensive Water Management Plan for Northern Palm Beach County, 2003 Minimum Flow and Level Rule, 2006 Restoration Plan, and the 2007 Regional Water Availability Rule along with the North Palm Beach County CERP Project-Part 1, it became imperative to establish a floodplain vegetation monitoring program for canopy, shrub-layer, and ground-cover communities. The objectives of the monitoring program will be: (1) to determine the composition and structure of floodplain plant communities and their associated hydrological characteristics; (2) to identify indicator forest type communities and species; (3) to identify key soil types that are indicative of the various forest types; (4) to examine the impact of exotic plants on this system; (5) to verify the success or failure of established restoration performance measures for Valued Ecosystem Components; and, (6) to provide adaptive management considerations to Operational managers for the river.

The purpose of this study was to establish methods of data collection and analysis to be used in the long term monitoring program for plant community composition and structure and to compare historic and present plant communities on the floodplain of the Loxahatchee River. This study was conducted jointly by staff from South Florida Water Management District (SFWMD) and Florida Department of Environmental Protection's FPS, District 5.

This report presents the methods and results of sampling vegetation in 2003 and summaries of data from previous vegetation studies. Six historical vegetation transects were utilized in 2003 and four new transects were established in additional areas of concern**.** Groundwater quality on the transects was examined; however, this data will be detailed later in separate reports.

Sampling will continue in the future with the monitoring of canopy communities every six years and of the shrub and ground-cover layers every three years. The CERP process is expected to result in additional freshwater flows to the river in the future. These hydrological modifications are expected to enhance existing native flora and fauna.

BACKGROUND

Blackwater Floodplain Forests

Freshwater swamps occur throughout the Southeast and may be classified by their dominant vegetation, such as cypress/gum swamps, or by their hydrologic features and primary water source, such as whitewater or blackwater swamps (Wunderlin and Hansen, 2003). The flowing portions of the upper and middle reaches of the Northwest Fork of the river and its tributaries are considered a blackwater stream system. The name “blackwater” is derived from the tea-colored waters of these streams, which are laden with tannins, particulates and other dissolved organics derived from the drainage through swamps, wet prairies and marshes (Roberts et al. 2006). The dark-colored water reduces light penetration and inhibits photosynthesis and the growth of submerged aquatic plants (FNAI and DNR 1990). Myers and Ewel (1990) described several characteristics of blackwater stream communities. These include:

- Underlying sandy soils contribute few nutrients to runoff that supplies the river
- Flooding is closely related to local rainfall events and water levels rise and fall rapidly
- Impermeable soil layers may be present that allow for horizontal movement of groundwater to the river and contribute to standing water in the floodplains
- Plant diversity is generally lower than whitewater or alluvial rivers
- Some forest type zones are narrow or absent
- One canopy species may dominate such as cypress because of historical hydroperiod and flow rates

The Loxahatchee River and its floodplain communities fit most of Myers and Ewel’s characteristics of a blackwater stream system. Flow and stage level data since the 1970s showed that rises in stage level and inundation of the floodplain are correlated with local rainfall events and are generally of short duration. Hydrological data was not available on flow and stage levels prior to human manipulation of flows in the Loxahatchee River basin. A USGS study (Orem et al., 2006) showed that groundwater does make a contribution to freshwater flow on the Loxahatchee River although the level of contribution appears to change by river mile and the location of major tributaries. Between September 2005 and July 2006, Loxahatchee River Environmental Control District noted the color of water in the embayment area averaged 53

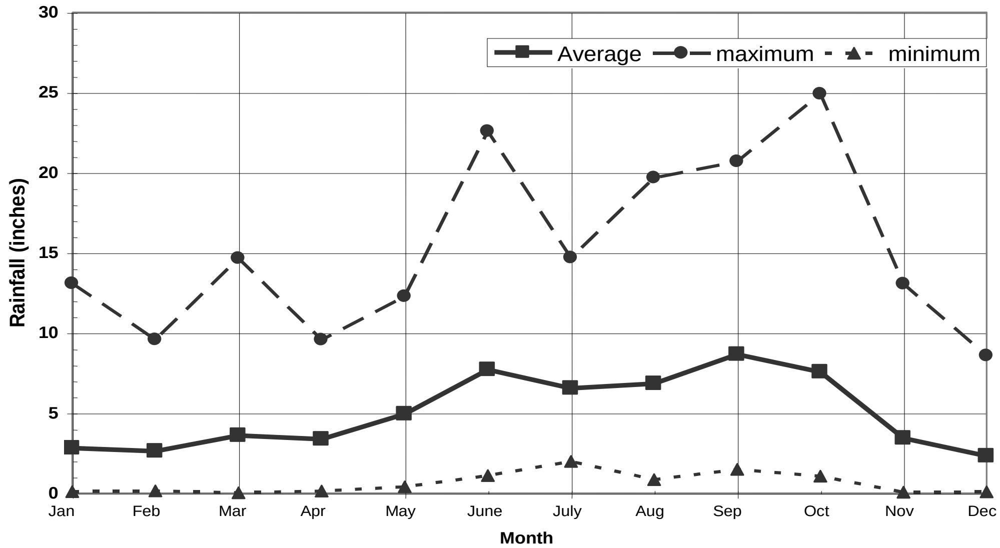
Platinum Cobalt units (PCU) with a range of 5 and 240 PCU/units in upper Kitching Creek (fig. 4). The dark-colored waters may partially explain the absence of freshwater submerged aquatic vegetation (SAV) with the exception of small patches of the exotics *Limnophila* and *Hydrilla* in the freshwater segments of the river. The other major reason for the absence of SAV would be the low levels of light in some of the braided channels due to the thickness of the canopy. Results of the USGS study in 2006 indicated that primary production in the Loxahatchee River may be limited by nitrogen rather than phosphorus. Canopy diversity is generally low consisting of primarily bald cypress in the riverine reach and mangroves in the tidal reaches. One would assume that it was historical flow rates and hydroperiods that created these bald cypress riparian communities along the river. Bald cypress trees on the Loxahatchee River have been estimated as 300 to 500 years old (FDNR and SFWMD, 1985). The dominant floodplain forest types on the Loxahatchee River appear to be swamp and hammock; however, the width of the hammock areas was variable or can be absent or intermixed with swamp or bottomland hardwood communities.

Climate, Rainfall, and Hydrology

Climate in the vicinity of the Loxahatchee River is subtropical with daily temperatures ranging from an average of 82˚F in summer to an average of 66˚ in winter. Winters are mild with warm days and moderately cool nights. August is the warmest month, usually having more than 29 days with temperatures above 90˚F. Even in the coldest winters, temperatures at or below freezing are rare. The average annual temperature is 75˚F (Breedlove, 1982).

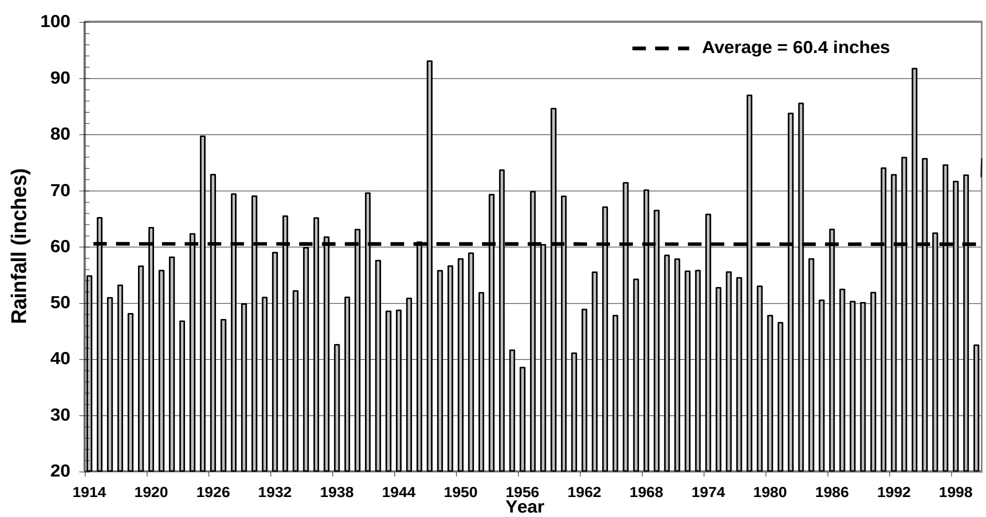
Rainfall within the Loxahatchee River Watershed averages about 61 inches annually (Breedlove, 1982; Dent 1997) with a median value of about 57 inches. Heaviest precipitation occurs during the wet season from late spring to early fall (May through October). Dent (1997) reports that since the early 1960s, about two-thirds of the total yearly precipitation (40.63 inches) occurs during the wet season, while the remaining one-third (20.42 inches) falls during the dry season (November–April). These data agree with rainfall data generated from the South Florida Water Management Model (SFWMM) (SFWMD, 2000) for a longer period of record (1914–2000) for northern Palm Beach and southern Martin Counties (**Figure 5**).

The highest monthly average rainfall of 8.7 inches/ month occurs during September, while the lowest average values are 2.3–2.8 inches/month for the months of December, January and February (**Figure 6**). May and November are transitional months and sometimes represent key months for either prolonging or relieving a drought or flood condition (Dent, 1997). In some years there are long periods of little or no rainfall during the winter and early spring, resulting in a regional drought condition. In contrast, tropical storms or hurricanes over the area can produce as much as 6 to 10 inches of rainfall in one day. Total annual rainfall has been as much as 93 inches and as low as 38 inches.



Source: Model results from the South Florida Water Mangement Model (SFWMM)

Figure 5. Average, minimum, maximum monthly rainfall values.



Source: South Florida Water Mangement Model
Data obtained from the following grid cells representing northern Palm Beach and southern Martin counities: Row 65 columns 32-38, Row 64 columns 63 columns 30-38, Row 62 columns 30-38, Row 61 columns 30-37, Row 60 columns 31-37, Row 59 columns 32-37, Row 58 columns 33-37.

Figure 6. Long-term annual rainfall for northern Palm Beach and southern Martin Counties (1914–2000).

Figure 6 provides a summary of annual rainfall amounts received within northern Palm Beach and southern Martin counties from 1914–2000 (data from SFWMM, version 9.7). Mean annual rainfall for the full 86 year period of record was 60.4 inches with a median of 57.7 inches. The maximum amount of rainfall recorded was 92.9 (1947) and 91.6 inches (1994). Minimum rainfall values occurred in 1956 (38.4 inches) and 1961 (41 inches). Review of the distribution of annual rainfall data over time showed that a variance of about 10 percent of the mean (±6 inches) occurs about once every three years on average. Extreme dry and wet periods can be defined as a variance of more than 20 percent of the mean (± 12 inches). Based on this definition, the long-term record shows that an extremely dry period occurs within the basin about once every 8.6 years, while extremely wet periods occur about once every 5.7 years.

Several studies were conducted on the vegetative transects during the course of our investigation. The 2003 vegetative transect data was collected between the period of July through November 2003. The canopy at all ten transects was reexamined between June and September 2005 to assess damages from Hurricanes Frances and Jeanne, which came through the area during September 2004 (Appendix E). Hurricane Wilma came through the area in October 2005. The transects were not re-assessed for damage after this event. Conditions were very dry during the winter and spring of 2006; therefore, additional observations were made on all ten transects in June 2006.

Rainfall data (inches) for the study periods was obtained from the JDWX weather station located at the northern end of JDSP near Jenkins Ditch. Leading up to the 2003 study that was conducted from July through November 2003, mean monthly rainfall values from January to March 2003 at the JDWX weather station were an inch or less (**Figure 7**). The rains came in spring with about 13 inches between April and June. July was again dry for wet season with only about 3 inches of rain. The late wet season began in August with all most 10 inches. The 2004 dry season began in December 2003 and was very dry up until May 2004, which received 4 inches of rain.

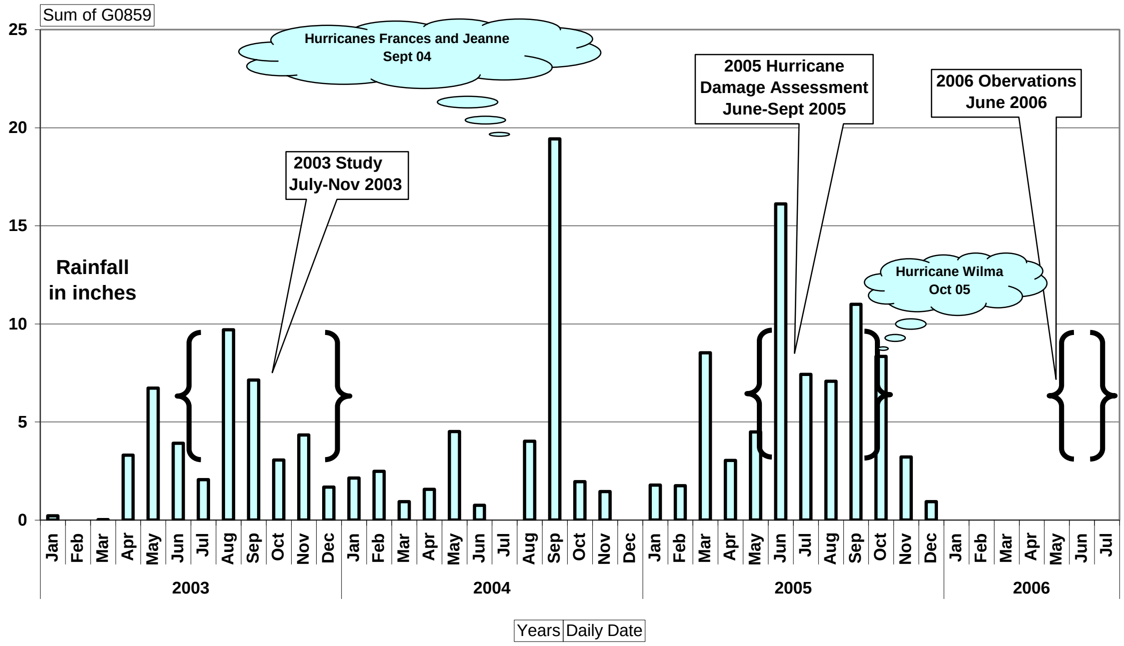


Figure 7. Rainfall amounts at JDWX during the study period January 2003 – July 2006. The rainfall gage was out for most of 2006.

This was followed by a very dry (less than 2 inches) June and July 2004 with slight increases in rainfall in August (4 inches). Total rainfall for September 2004 was 19 inches as a result of Hurricanes Frances and Jeanne, and the remnants of Hurricane Ivan. This was once again followed by a "very dry" dry season in 2005. Substantial rain was not seen again until March 2005, when 8 inches of rain was followed by a very wet June 2005 (over 15 inches). Hurricane Wilma came along in early October 2005 and October rainfall totaled 8 inches.

Dry and wet seasonal patterns can be seen in the mean monthly flows in cubic feet per second (cfs) over Lainhart Dam (**Table 1**) for 1965 to 2003. No flow or stage data were available before 1965 at the Lainhart Dam; as a result the flows shown do not include pre-development levels of freshwater input to the Loxahatchee River. Recent data shows that flows of 90 cfs are sufficient to fill the main channel of the Northwest Fork to the top of the bank near Lainhart Dam (at Transect 1). There is inundation of the swamp community at Transect 1 when flows are over 110 cfs while inundation of the top edge of the floodplain is at 476 cfs.

The number of days per month (1965-2003) that the 20-day rolling average flow at the Lainhart Dam was greater than 110 cfs is shown in **Table 2**. In **Table 2,** months shown in green had more than 20 days with rolling average flows greater than 110 cfs. The total number of days with a rolling average flow greater than 110 cfs in 1983 and 1984 were 272 and 139 days, respectively. Both 1994 and 1995 had over 200 days (222 and 218 days) and were considered wet years. In 1995, Tropical Storm Irene dropped about 17 inches of rain on central Palm Beach County. In 2003, only 3 months had more than 20 days and the total was 96 days. The 1983/84 SFWMD Study (Worth, unpublished) and the 1993/94 Ward and Roberts Study (unpublished) appear to have been conducted during much wetter years (i.e. higher flows) than our 2003 study.

Table 1. Mean monthly flow at Lainhart Dam (cfs) from 1965 - 2003.

Dry Season	
<	35
<	65
>= 65 & <=90	
>	90

Wet Season	
<	35
<	65
>=	65

LNHRT-Base

	Date												
Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1965	39	35	14	2	1	14	29	45	10	136	71	10	34
1966	90	76	34	22	53	211	220	127	88	203	63	37	102
1967	22	40	37	18	5	52	89	114	67	193	79	26	62
1968	14	13	7	2	19	302	173	136	197	274	147	62	112
1969	71	45	116	35	154	120	79	131	135	269	173	86	119
1970	113	104	208	237	97	155	112	64	56	71	29	18	105
1971	16	18	12	3	47	19	38	46	136	79	194	73	57
1972	44	39	21	41	191	204	85	50	33	33	68	28	70
1973	28	36	14	9	13	80	66	124	134	168	41	39	63
1974	150	39	45	14	8	131	151	156	54	134	57	63	84
1975	27	30	20	7	33	104	141	31	85	108	39	15	54
1976	9	20	27	5	106	114	30	67	182	72	72	28	61
1977	60	19	10	2	25	33	11	24	271	42	24	139	55
1978	72	30	32	6	14	145	140	145	88	168	263	190	108
1979	193	79	56	47	61	51	31	19	161	146	113	66	85
1980	47	58	39	20	33	29	86	34	32	80	26	17	42
1981	7	9	3	1	2	6	6	152	176	46	53	9	39
1982	12	26	150	200	166	241	124	93	110	145	302	182	146
1983	143	200	172	108	76	141	77	135	268	342	198	157	168
1984	123	86	127	84	102	124	65	48	179	120	196	150	117
1985	72	43	28	61	21	25	65	40	144	110	53	71	61
1986	125	42	102	82	14	93	112	72	76	80	92	99	83
1987	112	36	69	25	15	24	43	30	39	137	234	34	67
1988	57	47	42	14	29	91	116	184	75	18	14	7	58
1989	4	2	17	8	7	8	30	85	25	79	14	15	25
1990	11	6	7	10	7	15	17	77	93	151	22	16	36
1991	142	118	53	141	119	160	128	86	134	192	92	83	121
1992	49	117	66	56	20	122	125	188	217	164	198	95	118
1993	231	204	200	122	92	104	87	85	164	281	149	89	150
1994	96	142	84	82	70	143	114	223	273	209	278	285	166
1995	140	96	98	85	69	101	131	288	186	352	271	153	165
1996	82	73	156	116	137	140	176	96	128	163	123	78	123
1997	81	104	84	121	93	214	109	200	222	105	83	149	130
1998	148	204	161	88	106	53	84	66	208	133	289	102	136
1999	227	89	70	39	30	172	122	109	198	335	206	109	142
2000	81	74	62	91	34	19	40	18	52	174	29	23	58
2001	16	9	46	24	8	43	197	260	254	236	145	78	110
2002	69	125	60	44	15	116	185	57	40	51	43	36	70
2003	22	14	62	46	119	137	48	149	90	73	146	75	82
Average	78	65	67	54	57	104	94	104	130	151	120	77	92

SFWMD Dewey Worth 1983/84

Ward & Roberts Study 1993/94

2003 Study

Table 2. Inundation analysis* during the study periods (circled).

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Grand Total
1965	0	0	0	0	0	0	0	0	0	12	16	0	28
1966	4	0	8	0	0	23	31	27	0	22	11	0	126
1967	0	0	0	0	0	0	18	15	0	24	18	0	75
1968	0	0	0	0	0	25	31	27	18	31	30	1	163
1969	0	0	18	0	22	21	11	16	17	31	30	5	171
1970	14	23	19	30	9	30	20	0	0	0	0	0	145
1971	0	0	0	0	0	0	0	0	18	2	29	1	50
1972	0	0	0	0	18	30	11	0	0	0	0	0	59
1973	0	0	0	0	0	2	0	26	28	29	5	0	90
1974	15	8	0	0	0	13	31	31	1	21	0	0	120
1975	0	0	0	0	0	11	24	9	1	19	0	0	64
1976	0	0	0	0	4	21	0	0	26	7	0	0	58
1977	0	0	0	0	0	0	0	0	26	13	0	16	55
1978	5	0	0	0	0	6	31	26	0	20	30	31	149
1979	31	13	0	0	0	0	0	0	14	31	22	3	114
1980	0	0	0	0	0	0	0	0	0	4	0	0	4
1981	0	0	0	0	0	0	0	11	30	14	0	0	55
1982	0	0	16	30	25	30	26	0	3	27	29	31	217
1983	31	28	31	28	1	21	1	9	30	31	30	31	272
1984	23	0	8	14	1	23	0	0	10	24	8	28	139
1985	0	0	0	0	0	0	0	0	10	19	0	0	29
1986	20	0	3	19	0	5	16	12	0	0	9	1	85
1987	23	0	0	0	0	0	0	0	0	17	30	7	77
1988	0	0	0	0	0	10	15	16	18	0	0	0	59
1989	0	0	0	0	0	0	0	5	0	2	0	0	7
1990	0	0	0	0	0	0	0	0	1	30	0	0	31
1991	13	23	0	15	15	30	31	5	21	31	5	6	195
1992	0	7	14	0	0	3	24	22	30	31	20	18	169
1993	27	28	31	25	0	0	0	0	25	31	30	16	213
1994	0	26	10	0	0	19	14	31	30	31	30	31	222
1995	31	5	0	0	0	3	26	31	30	31	30	31	218
1996	2	0	19	23	7	30	31	3	18	25	26	0	184
1997	0	5	7	14	6	29	28	29	30	21	0	17	186
1998	15	28	31	10	20	0	0	0	14	31	30	17	196
1999	29	13	0	0	0	14	22	7	30	31	30	22	198
2000	6	0	0	4	3	0	0	0	0	26	0	0	39
2001	0	0	0	0	0	0	21	31	30	31	28	0	141
2002	0	15	5	0	0	8	31	4	0	0	0	0	63
2003	0	0	0	0	4	30	0	21	18	0	23	0	96

* Number of days in a month with 20-Day Moving Average Flows Greater than 110 cfs at Lainhart Dam.

Fire and Logging History on the Loxahatchee River

Fires and logging activities have influenced forest composition and species distribution of the Loxahatchee River floodplain. Fire occurrence on the river floodplain is generally low, primarily because the soils are saturated most of the year. Additionally, dry live and dead fuel in the floodplain is sparse, decomposition rate is rapid, and frequent flood events tend to clear away combustible material. Bald cypress and mixed hardwood forests thrive in both fire-free habitats and occasionally in burned areas (see Gunderson 1984, Ewel 1990a). If a local seed source is available, bald cypress has been found to re-colonize after fire (Gunderson 1984).

Most of the bald cypress in southern Florida was harvested by the lumber industry by the 1940s, leaving only isolated strands of cypress that were too difficult for loggers to reach. Bessie Wilson DuBois wrote in her book, "The History of the Loxahatchee River" (1981), that logging leases in two townships on the Loxahatchee Watershed were purchased by the Hunt brothers from Green Cove Springs in 1891. B. K. Hunt eventually built a saw mill on the river. Over the years, the loggers cut pine from the uplands and cypress from the river's edge. Later, a man by the name of Arbuthnot established another logging operation using a gas tramway to transport the pine and cypress logs across land to his sawmill. Before logging a portion of their property in the 1940s, local pioneers, John and Bessie DuBois, purposely saved 27 large cypress trees on Kitching Creek. This was the last recorded logging operation on the river. The cypress on the upper Northwest Fork near Indiantown Road remains largely intact, and along this reach of the river range from 300 to 500 years in age (FDEP and SFWMD, 2000).

Logging was verified on most of the vegetative transects sampled in 2003 by the presence of tree stumps without fallen trunks. Logging evidence was more prevalent in the upper tidal portions of the river where the logs could be removed to the uplands side or floated down the wide river channel. Occasionally, we observed logs that had obviously been cut but never been removed (**Figure 8**).

Figure 8. Logging evidence on Transect 6 where the tree was cut but the log was left.

Previous Studies of the Loxahatchee River and Floodplain

Early accounts of vegetation and soil conditions in south Florida were reported by United States soldiers during the Seminole Wars as they traveled between military posts. Maps of the Loxahatchee watershed were produced by Mackay and Blake in 1839 and Lieut. J.C. Ives in 1856. Hohner (1994) wrote an excellent summary of these maps and their interpretation for a Florida Atlantic University Master's Thesis. A 1860s military drawing of the Northwest Fork of the Loxahatchee River showed only a floodplain with a small "canoeable" creek just upstream of the mouth of Kitching Creek. Today this part of the river is navigable by boat for an additional

2.2 miles. In the Second Seminole War, it was probably not coincidence that the U.S. Army utilized the Southwest Fork rather that the Northwest Fork to engage the Seminoles in the first skirmishes of the 1838 Battle of the Loxahatchee River. It was thought that in this time period, canoe travel along the Northwest Fork was extremely difficult (Pepe and Steele, 1997).

The first comprehensive study of pre–drainage hydrology and plant distributions of South Florida was published by the Florida Geological Survey in a 300-page study, The Natural Features of Southern Florida (Davis, 1943). G.G. Parker and others of the Miami Geological Society produced a similar report in 1955 (Water Resources of Southeastern Florida) and in 1974 on pre-drainage hydrology and historic ecology of the region entitled Hydrology of the Pre-Drainage System of the Everglades in Southern Florida. Davis's 1943 map (**Figure. 9**) showed the vegetative connection between the Loxahatchee River Watershed and the Everglades. In his text on the Eastern Flatlands, Davis describes the Loxahatchee Slough, the main three branches of the Jupiter River (actually the Loxahatchee River) and the South Fork of the St. Lucie River as the eastern boundary of the Allapattah Marsh. Davis based his map on soils and aerial photography of the vegetation (**Figure 9**). He described the floodplains in the watershed as freshwater marsh with hammock forest, and cypress sloughs. The map illustrates how waters from Loxahatchee Slough diverged into both the Northern Everglades and the Loxahatchee River. This is further described in Hohner's 1994 thesis. Davis identified over 850 species of plants as indigenous to the south Florida region. Over 90 species of plants were woody plants (trees, shrubs, and woody vines) which Davis considered to be a high number of species. Davis stated "Except for the pines, cypresses, and mangroves, the trees do not form large area forests of pure or nearly pure trees and many of the forests cover only small areas and have a great variety of trees." He further stated that it is the small trees and shrubs that give character to vegetative communities. He concluded that South Florida has nothing corresponding to the large alluvial swamps of muddy rivers further north but has swamps that narrowly border streams and lakes or cover ponds and sloughs.

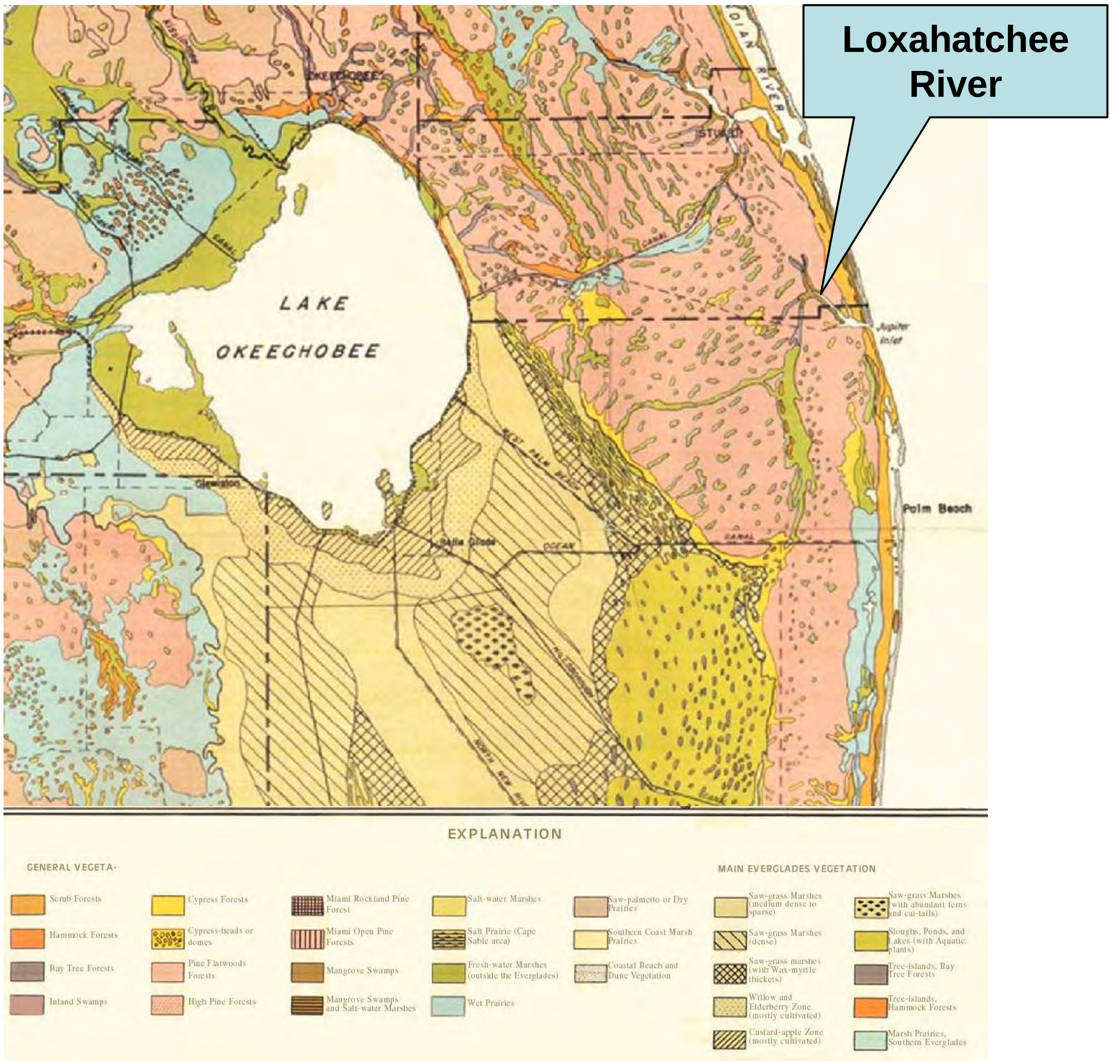


Figure 9. Davis' 1943 map of south Florida vegetation showing the historical connection between the Loxahatchee River and the Everglades.

Taylor Alexander's 1967 Bald Cypress and Mangrove Complex Study

During April 1967, Taylor Alexander established vegetation quadrants along a transect on the Northwest Fork of the Loxahatchee River near RM 6.46 and documented the alterations in plant species, also (See: **Appendix F**). Alexander considered it a rare opportunity to study temperate and tropical species in combination with salt tolerant and non-salt tolerant species growing in such a limited area. His transect contained dead, stressed but living, and healthy cypress trees. The transect was 137 m (450 feet) long with 36 randomly spaced square quadrats, 5 m long on either side of the transect. Species occurrence and density were examined for each plot. Water and soil samples taken on the transect were analyzed for pH, electrical conductivity, and chloride content. Alexander's raw transect data was examined as a part of this study, and his 1967 transect was included as Transect 9 of this study.

Alexander and Crook 1975 South Florida Ecological Studies

Alexander and Crook (1975) utilized aerial photographs and ground-truthing to examine plant communities along the Northwest Fork (**Figure 9**) of the Loxahatchee River and Kitching Creek. Plant species lists were compiled for 3 sites on the Northwest Fork and one site on Kitching Creek. After identifying the signature of the most abundant community types in the field, they used photo-interpretation to identify major vegetative communities from a 1940 aerial photograph. Areas of dead and living cypress canopy within a mangrove understory were noted in 1970.

Figure 10. Dead bald cypress trees in the tidal floodplains of the Northwest Fork (ca. 1970s).

Alexander and Crook (1975) concluded that since 1940, wet prairie and swamp hardwoods have been converted to pineland and mangrove communities due to a lowering of the groundwater table and the invasion of saltwater between RMs 6 and 8. They were able to identify areas of past logging by groundtruthing, which could explain the loss of mature trees within portions of the floodplain. Based on additional information, they further concluded that there was no evidence that cypress forest had extended much further downstream than about RM 6. This is illustrated in a 1968 aerial photograph taken from the mid-Northwest Fork at approximately RM 6 looking westward upstream (**Figure 11**). Bald cypresses were clearly the tallest canopy trees present in the floodplain of the lower tidal swamp at this time. It is hard to assess whether the cypress are dead or alive in this photograph. Mcpherson (1967 unpublished) had collected freshwater peat at a depth of 24 inches below the surface and concluded that bald cypress forest never extended further than about RM5.69. Also, Alexander and Crook mentioned the impact of fire, hurricanes and heavy frost on the major plant communities. Finally, they predicted that the mangrove invasion would accelerate if anthropogenic activities in the upper floodplain of the river further reduced the freshwater head. With regards to saltwater marshes, aerial photographs have been used to identify several spots in the mid-Northwest Fork that were formerly saltwater marsh (probably cordgrass, *Spartina* sp.) before its succession to mangrove communities. As part of Alexander' 1974 study, he noted that mangroves had filled in nearly all of the salt marshes since 1940 (written communication to Richard Roberts, 1974). **Figure 12** is a photograph taken by local resident Bill Lund in 1971. It pictures a rather large saltwater marsh in the vicinity of the power lines that cross the Northwest Fork near Rivermile 6.5. Today this site is completely covered with mangroves.

Figure 11. A 1968 Bill Lund aerial photograph of the Northwest Fork of the Loxahatchee River showing bald cypress (circled) and mangrove distributions.

Figure 12. Former saltwater marsh under power lines at RM 6.5 that has since converted to mangroves on the Northwest Fork of the Loxahatchee River (Bill Lund photograph from 1971).

SFWMD (Dewey Worth) 1983-1984 Loxahatchee Vegetation Transects

Dewey Worth established and examined six vegetation transects (10 m wide) from January to June 1984 along the Northwest Fork of the Loxahatchee River as a part of the SFWMD earlier Loxahatchee River Restoration Plan (See: **Appendix G**). His transects were surveyed and ground and surface water elevations were recorded along with heights and elevations of cypress knees. In addition, several shallow water groundwater monitoring wells were established during his study period. His six transects were re-examined as a part of this study.

FDEP (Ward and Roberts) 1993-1994 Vegetation Analysis of the Loxahatchee River Corridor

Between October 1993 and January 1994, Ward and Roberts (Ward and Roberts, written communication, 1996) re-examined Dewey Worth's six vegetative transects on the Northwest Fork of the Loxahatchee River between Indiantown Road (SR 706) and the mouth of Kitching Creek (RM 8.0) (See: **Appendix H**). Each belt transect was 10 m wide and partitioned into 10 m^2 plots. Within each 10 m^2 plot all trees greater than 10 cm (3.94 inches) diameters at breast height (dbh) were identified by species and the dbh measured. Shrub-layer vegetation was defined as plants with a height greater than 1 m and with a dbh of less than 10 cm. Shrub-layer plants were counted by line intercept within each 10 m^2. The groundcover was defined of all herbaceous plants and woody plants under 1 m (3 feet) in height. Cover and stem counts of groundcover plants were recorded in three 1 x 1 meter subplots nested within each 10 x 10 plot. A total of 79 10 m^2 plots were surveyed during the study. Generally the density (stems/hectare) of bald cypress increased from downstream (Transect 6, RM 8.4) near Kitching Creek to upstream (Transect 1, upstream of RM 14.5 just north of SR 706). A noticeable drop in cypress density occurred at Transect 3 (upstream of RM 12.1 and just north of Interstate 95), which was heavily populated with pop ash, red maple and cabbage palm.

2002 Minimum Flows and Levels and Related Projects

In an examination of historical aerial photographs taken from 1940 to 1995, major vegetative communities were identified along the floodplains of the Northwest Fork of the Loxahatchee River (SFWMD, 2002). The results of the study indicated that floodplain vegetation had reduced due to the stabilization of Jupiter Inlet in 1947, bulk heading of shorelines for development, and other changes from wetland vegetation types to transitional and upland forests. Aerial photographs taken in 1940 of the watershed revealed an abundance of swamps, wet prairies, inland ponds, and sloughs. Freshwater swamp hardwood and cypress communities were dominant within the floodplain portion of the Northwest Fork (RM 4.5 to 8.9), comprising about 73 percent of the vegetative coverage, while mangroves represented 22 percent. Mangroves were dominant from RM 4.5 to RM 6.0 and were present upstream to RM 7.8. By 1985, freshwater communities represented 61 percent of the coverage, while mangroves represented 25 percent of the coverage. Mangroves were dominant between RM 5.5 and 8.7 and extended up to RM 10.5. One would suspect that mangrove encroachment would appear much higher; however, there was a loss of approximately 80 acres of mangroves due to development between RMs 4.5 and 5.5. There were no major changes between cypress and mangrove floodplain coverage's between 1985 and 1995. It was concluded that most of the mangrove encroachment occurred between 1947 and 1979. This timeframe corresponds to a period in which the Jupiter Inlet was stabilized and freshwater flows were redirected by C-18 Canal from the Northwest Fork to the Southwest Fork of the river for flood control.

Semi-quantitative and quantitative vegetation surveys (species composition and abundance) were conducted along the Northwest Fork of the Loxahatchee River as a part of the Minimum Flows and Levels Technical Document (MFL) (2002). Twenty-three semi-quantitative sites were sampled in November 2000 and December 2001. Eight sites were re-investigated from the series of semi-quantitative survey sites to produce a quantitative database in 2002. Using the results of the vegetation surveys and a salinity time series generated from the 2-D hydrodynamic/salinity model, correlation analysis was used to examine vegetation trends relative to salinity event duration along the river corridor. From this data a river/vegetation/salinity model (SAVELOX) was developed using an empirical approach to extrapolate vegetative response given a set of long-term salinity conditions. Results from the 2000 semi-quantitative survey identified at least 35 species of vascular plants with distributions correlated to distance upstream from Jupiter Inlet. The results indicated that the number of species increased as a function of distance from the inlet, which is correlated to salinity. Bald cypress and cabbage palm appeared to tolerate a wider range of salinity conditions than a number of other common floodplain species while red maple, pop ash, dahoon holly, pond apple, red bay and Carolina willow appeared to be impacted within a very short segment of the river.

Concurrent with this project, the SFWMD Coastal Ecosystems Division is in the process of implementing other projects. These projects will provide information critical for understanding the impact of saltwater intrusion and fresh water flux within the river's floodplain and the feasibility of restoring freshwater vegetation among existing brackish water plant communities. Brief descriptions of these projects are given below:

LOXAHATCHEE WATERSHED HYDROLOGIC MODEL

Freshwater flows from the major tributaries of the Loxahatchee River and Estuary were simulated with a watershed (WaSh) model. The hydrologic model domain covers the entire historic watershed, including the floodplain which is represented with a fine grid system. This model was built on the new generation of hydrologic models in the SFWMD, and simulates 2-D overland flow, 3-D ground water flow, 1-D channel flow, and flow in and out of banks in an integrated manner. This model provides historic and current water levels in the floodplain and estimates of fresh water discharges into the river.

INTEGRATED LOXAHATCHEE SALINITY MODEL

Tide and salinity stations have been deployed in the Loxahatchee River since 2002 and continue to operate to monitor salinity for compliance with the MFL Rule, and to assess the benefits of supplemental dry season flows and salinity levels in the Northwest Fork and lower estuary. The MFL Rule established a minimum flow of 35 cfs over Lainhart Dam to the Northwest Fork of the Loxahatchee River during dry season. A hydrodynamic/salinity (RMA) model was developed to study the influences of freshwater flows on salinity conditions in the Loxahatchee River and Estuary. The model domain covers the entire Estuary, River and the floodplain area. The Estuary salinity model established a 3-D hydrodynamic framework. The salinity model in the floodplain is a salt transport model, and can be coupled or de-coupled with the estuary model. This integrated model predicts salt movement in the estuary, river and floodplain as influenced by tide and freshwater input from the watershed.

LOXAHATCHEE RIVER FLOODPLAIN DIGITAL ELEVATION MODEL

LIDAR data was obtained to produce a Digital Elevation Model (DEM). The DEM will provide micro-relief data that are critical for determining water inundation in the floodplain area. A low-flying helicopter was used to acquire the photographs and data needed. The hurricanes of 2004 and 2005 greatly reduced the density of the canopy cover, which improved conditions for collecting the needed photography.

LOXAHATCHEE FLOODPLAIN GROUNDWATER MONITORING NETWORK

This study is examining groundwater conductivity, temperature, and stage within the Loxahatchee floodplain. In 2003, twelve (12) groundwater wells were installed along vegetation transects 1, 3, 7, 8 and 9. Transect 1 serves as the background freshwater site whereas the remaining stations are exposed to different levels of tidal fluctuations and saltwater intrusion. These wells are 2 in. (5.1 cm.) in diameter and were installed to a depth of 5 to 15 ft (1.5 to 4.6m) below the existing ground surface. Each well contains a Troll 2900 Transducer along with a data logger.

Figure 13. Downloading groundwater data.

This project will provide critical information for model calibration and for understanding the relationship between rainfall, groundwater input, inundation/stage levels in the floodplains, and the health and recovery of the floodplain. The data were currently being analyzed, and monitoring will continue for the next several years.

GROUNDWATER FLUXES AND WATER QUALITY STUDY

Historical groundwater data were examined and groundwater discharge and recharge were estimated by the U.S. Geological (Orem et al, 2006) using the isotope technique. Samples were obtained in the wet and dry seasons during a two-year period on Transects 1, 3, 6, 7 and 9 (USGS, 2006). The distribution of dissolved organic carbon (DOC), silica, selected trace metals (Mn, Fe, Ba, Sr, Co, V) and a suite of naturally-occurring radionuclide's in the U/Th decay series (^{222}RN, $^{223, 224, 226, 228}$Ra, ^{238}U) were studied during high and low discharge conditions in the Loxahatchee River Estuary. Estimates were obtained for submarine groundwater discharge and rates of NH_4^+ and PO_4^{-3} flux to the estuary. The results of surface and pore water sampling yielded a higher ionic strength with depth compared to surface water. The results suggested that high salinity water may only be impacting the viability of freshwater vegetation along Transect 9 and portions of Transect 6. The distributions of higher levels of sulfides in soil/sediment pore water were also noted. This project provided data that was critical for model calibration (surface/groundwater interaction) and interpretation of vegetation health in the floodplain.

Figure 14. Downloading data from soil moisture probes.

FLOODPLAIN SOIL MOISTURE AND SALINITY STUDY

To characterize soil types, soil profiles were collected from each major forest type within each transect as part of an associated project with the University of Florida (UF), Institute of Food Agricultural Sciences IFAS, Tropical Research and Education Center in Homestead, Florida in 2003. Soil samples were collected within each plot along a transect and combined to create a composite sample to represent each major forest type within a transect. A soil auger was used to collect the top 20 cm of soil. In 2005, eight soil moisture and salinity stations were established on Transects 1 and 7. Three separate Hydra probes placed at deep, intermediate and shallow depths were installed in four different locations along the two transects. Soil moisture (percent saturation), soil texture, conductivity, nitrogen, potassium, phosphorus, pH, cation exchange capacity, and percent organic matter was determined for each composite sample. One UF master's thesis has been completed and currently a PhD dissertation is being prepared to summarize the soil moisture and salinity study.

SALINITY AND ALTERED HYDROLOGY ON THE SURVIVAL, GROWTH AND RESTORATION OF BALD CYPRESS

This UF study was designed to isolate the major factors that would prohibit reforestation of bald cypress. The study consisted of laboratory experiments (**Figure 15**) and field observations that would determine: (1) the influence of salinity and altered hydroperiods on the growth and survival of bald cypress seedlings grown from seeds collected from the brackish segments of the Loxahatchee River and its tributaries; and (2) bald cypress seedling/sapling growth along the floodplain noting water levels, elevation, and the salinity. The field monitoring portion of the study consisted of observing natural populations of bald cypress seedlings and saplings, then planting representatives of the laboratory stock within the saltwater impacted and riverine floodplain zones. In the laboratory study bald cypress seedlings tolerated 100 percent flooding (plant roots submerged in water) without salinity for as long as 30 days. All seedlings survived the 50 percent flooding with exposure to 2, 4, 6 and 8 ppt. All seedlings survived 50 and 100 percent flooding with 2 ppt while 25-75 percent of the seedlings died under 100 percent flooding with 4 to 8 ppt salinities. Field observations showed that seedlings started growing in February or March and reached their maximum growth rate in May. Additional studies were conducted to examine the effect of using oxygen fertilizer to improve the growth of bald cypress seedlings under field and laboratory conditions.

Figure 15. Bald cypress flooding and salinity experiment.

The impact of these related studies on the current study is diagramed in **Figure 16**. They present an integrated study approach to providing needed information for the adaptive management process for the future restoration of the Loxahatchee River. Tidal stage and salinity have been monitored under real time to support model development and other analyses and are needed to give water control operators at the West Palm Beach headquarters an overview of these parameters as they manage water control structures. Groundwater and soil monitoring are essential for documenting hydroperiods and salinity movement within the floodplains and explaining changes in floodplain vegetation. In-depth relationships would be established between soil moisture, floodplain stage, and river flow. LIDAR, survey data, and the Digital Elevation Model would provide a means of examining detailed levels of predictable inundation that could be used to predict the health of ecological communities and to evaluate floodplain vegetation performance in swamp and hammock areas as freshwater flow is restored to the system. Reassessment of floodplain vegetation abundance, basal area, and frequency of occurrence would be essential for identifying changes in vegetative community composition, plant species distribution, yearly seed production, germination, and successful seedling recruitment.

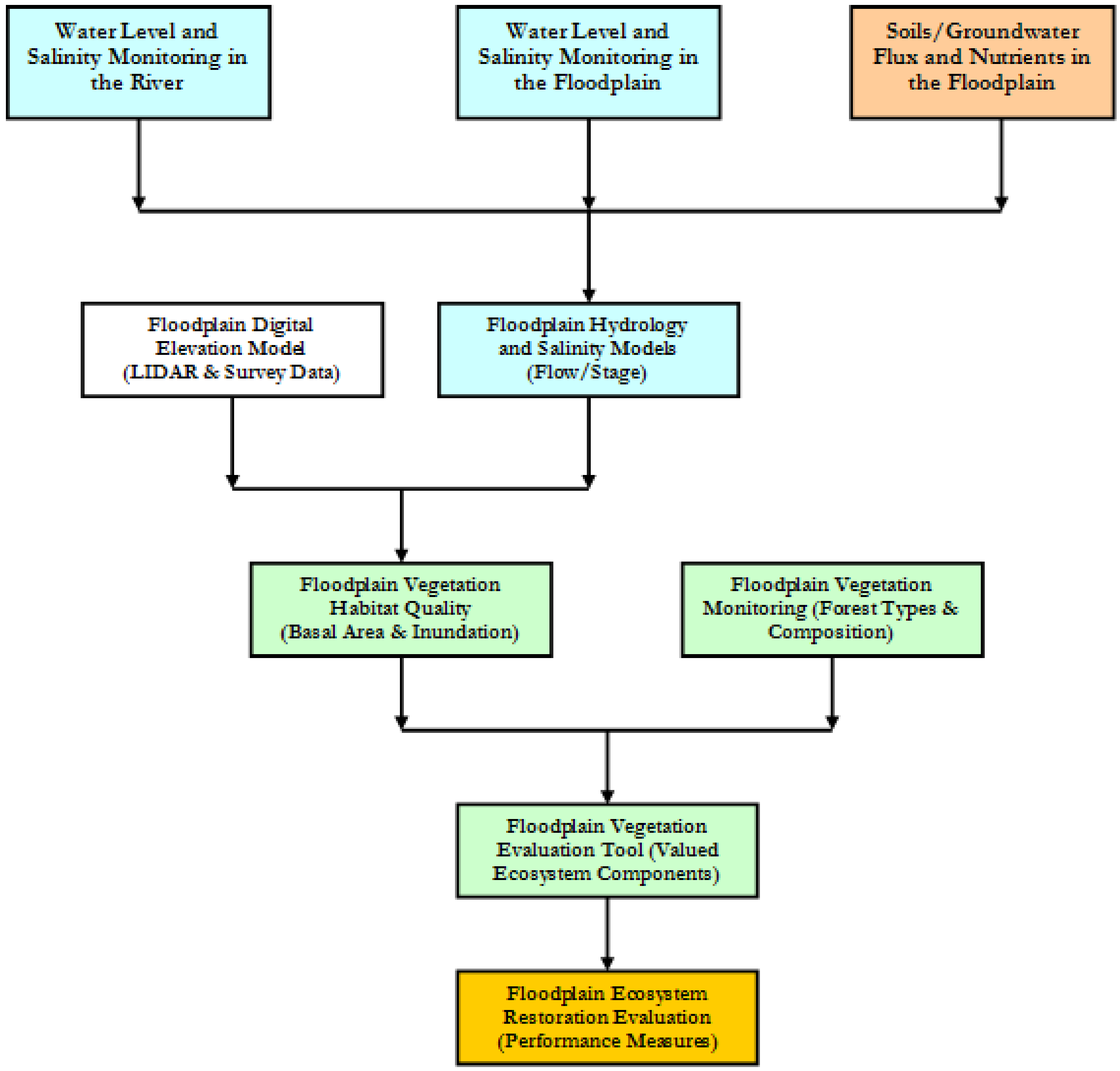


Figure 16. Interrelated projects provide information needed to evaluate floodplain plant communities

Methods

The major components of the 2003 study were floodplain vegetation sampling, forest type identification, topographic elevations, floodplain hydrology, and soil characteristics. The methods were based on those largely defined by H. Light and M. Darst (USGS) on the Suwannee River (Light et al., 2002; Darst et al., 2003).

Vegetation Sampling

Ten belt transects (Figure 17 and Table 3) were surveyed for the collection of field data on plant community composition and structure to document present and future plant community health along the floodplains of the North and Northwest Forks of the Loxahatchee River and Cypress and Kitching Creeks. Four of the belt transects are divided into sub-transects because they are either on opposite sides of the channel or because they run parallel to each other. These were intentionally created to target the study of certain particular plant communities. This study re-examined six historical vegetation transects as well as established four new transects in additional areas of concern. Transect locations were in riverine (predominantly non-impacted freshwater), upper (saltwater intruded with fresh and brackish water) and lower tidal (highly influenced by tides and salinity) areas. Seven transects were located along the middle and upper reaches of the Northwest Fork of the Loxahatchee River (T1 (T-1 and T-1-2), T2 (T2-1 and T2-2), T3 (T3-1 and T3-2), T4, T6 (T6-1 and T6-2), T7, and T9). Additional transects were established in the lower portions of Kitching (T8) and Cypress Creeks (T5) (tributaries of the Northwest Fork), and in the upper North Fork of the Loxahatchee River (T10). Transects T1, T2, T3, T5, and T6 are in the same location as the transects utilized by Dewey Worth in 1983-84 and again by Ward and Roberts in 1993-1994. T9 was surveyed previously by Taylor Alexander in 1967.

Belt transects were positioned perpendicular to the river and to the existing elevational gradient as was the orientation in similar floodplain studies in Arkansas (Smith, 1996), northern Florida (Light and others, 1993; Light and others, 2002a and b), and previous Loxahatchee River studies (Alexander, 1967, Worth, 1986, Ward and Roberts, 1996). Transects began at the upland edge of the floodplain and continued to the river's edge. The upland edge was determined by visual cues and by examining soils. Transects were surveyed and permanently marked with PVC pipe and /or flagged.

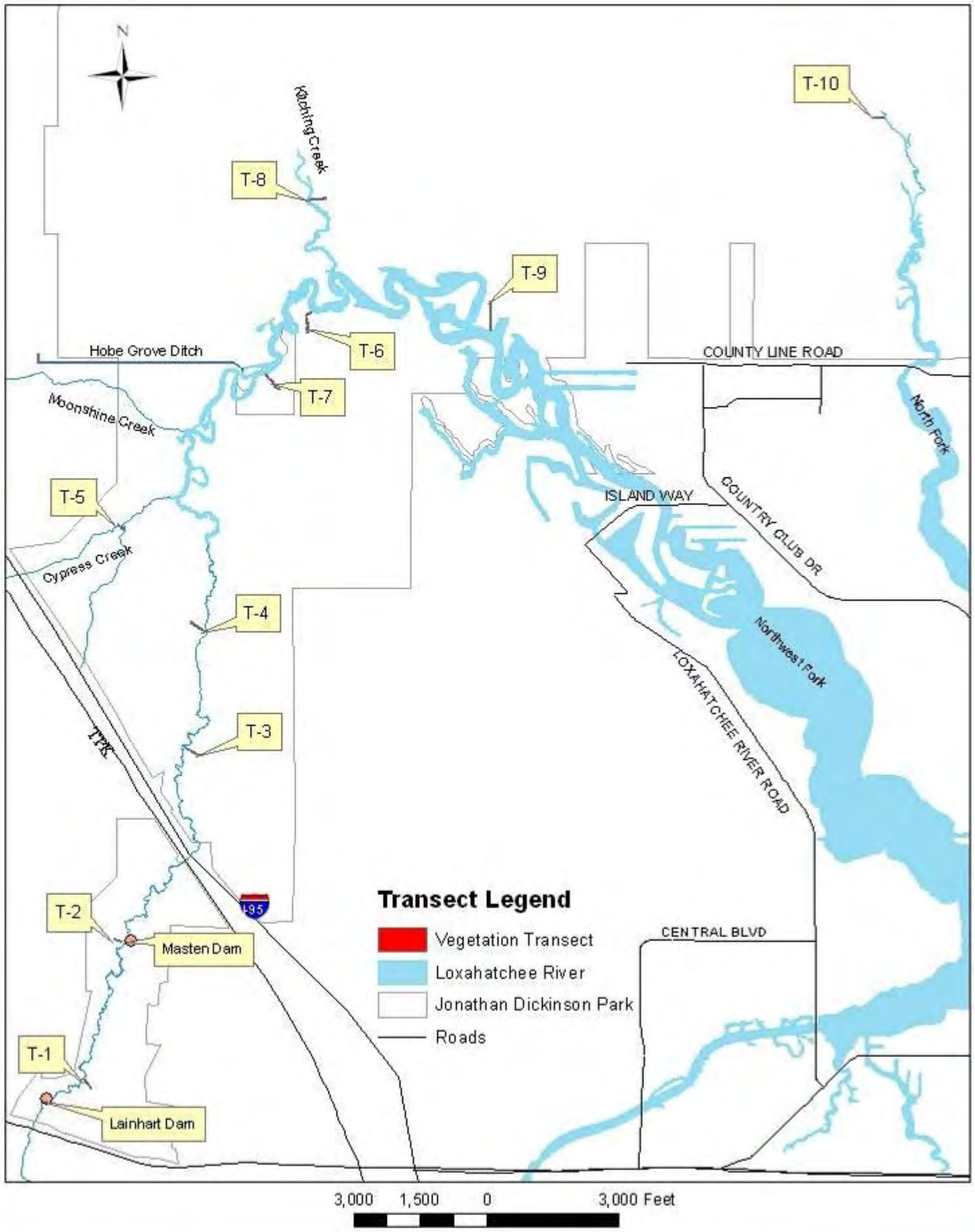


Figure 17. Ten vegetation belts transects in the Loxahatchee River Floodplain.

Table 3. Geographical information for the 2003 vegetation transect study.

Transect	Twp./Rge./Sec.	Latitude	Longitude	Length	River Mile	# of Plots
Riverine						
T-1 NW	T41S/R42E/S5	26˚56’23.552”N	80˚10’19.464”W	150m	14.5	15
T-2 NW	T40S/R42E/S32	26˚56’57.303”N	80˚10’14.107”W	130m	13.57	13
T-3 NW	T40S/R42E/S29	26˚57’39.309”N	80˚09’52.029”W	130m	13.43	13
T-4 NW	T40S/R42E/S20	26˚58’09.885”N	80˚09’53.596”W	120m	11.18	12
T-5 CC	T40S/R42E/S20	26˚58’33.248”N	80˚10’13.960”W	140m	10.33	14
Upper Tidal						
T-6 NW	T40S/R42E/S16	26˚59’15.464”N	80˚09’24.084”W	160m	8.43	16
T-7 NW	T40S/R42E/S20	26˚59’06.939”N	80˚09’35.901”W	160m	9.10	15
T-8 KC	T40S/R42E/S16	26˚59’46.271”N	80˚09’18.714”W	120m	8.13	12
Lower Tidal						
T-9 NW	T40S/R42E/S16	27˚00’09.426”N	80˚08’38.662”W	190m	6.46	20
T-10 W	T40S/R42E/S11	27˚06’59.819”N	80˚06’59.819”W	74m	2.44	8

Belt transects were 10 m wide and divided in adjacent 10 X 10 plots along the length of the transect (**Fig. 18**). Within each 10 m² plot, all trees with greater than 10 cm (3.94 inches) diameter at breast height (dbh), were identified by species and dbh measured for canopy analysis. Trees were randomly chosen for height measurement. Heights were measured using a Haglöf Vertex III Hypsometer and T3 Transponder. Shrub-layer cover was measured by examining all plant species with a height greater than 1 m (3.28 feet) and dbh less than 10 cm within a 10 m line-intercept nested within each 10 m² plot (fig. 23). Percent cover and stem counts of all herbaceous and woody plant species under 1 m were measured within three, 1 m² subplots nested within each 10 m² plot and recorded as groundcover data. Additional information, collected within each vegetation plot, included presence of hummocks, presence of cypress stumps, as well as estimates of percent open ground, percent exposed roots, percent leaf litter, and percent fallen logs. Also within each transect and vegetation plot, corresponding elevations and soil types were determined to investigate environmental factors affecting plant distribution and abundance. **Appendix E-1** presents a summary of elevations, river mile, and forest and soil types of each of the 138 vegetative plots.

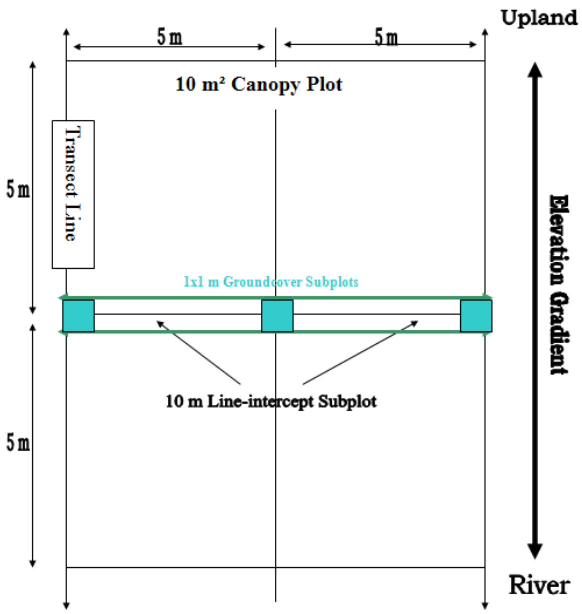


Figure 18. Schematic of transect monitoring.

The shrub-layer data is reported by percent cover and frequency of occurrence by transect and forest type and included all (plant) species that were greater than one meter in height and less than 10 cm dbh (Mueller-Dombois and Ellenberg, 1974). Frequency of occurrence was determined for each species by counting the number of plots that the species occurred in within a transect. In this case, each shrub line intercept and the three groundcover meter squares were considered a plot or sampling site. Percent cover was determined by summing the individual branch measurements of each species and dividing by the total measurement of all species along the intercept line of each plot. Additional groundcover information was collected in meter square subplots for the presence of hummocks, cypress stumps, open ground, exposed roots, percent leaf litter and percent fallen logs. At this time only stem counts, percent cover, percent open ground and percent fallen logs were evaluated (**Table E-6**). Also within each transect at the various quadrats, the elevation and soil types were also determined within each transect at the various quadrants.

PLANT AND FOREST TYPE IDENTIFICATION AND ENUMERATION

Plants were identified to the lowest possible taxonomic level. Plant identification and nomenclature followed that of Wunderlin and Hansen (2003). Species were verified according to those previously cited in "*Vascular Plants of Jonathan Dickinson State Park"* (Roberts et al, in press). A few plants that were not listed in this publication were pressed and sent to the herbarium at the University of South Florida for verification. Plant species, common names and electronic code names are listed in the **Glossary** and **Appendix C (**by vegetative layer). The terminology used for habitat preference generally follows Myers and Ewel (19900 and the Florida Natural Areas Inventory (1990).

Floodplain plant communities were divided into three distinct reaches; riverine (R), upper tidal (UT) and lower tidal (LT)**.** These reaches were distinguished based on hydrological conditions, vegetation, and soils (modified from Light et al., 2002a and b). The boundaries were based on distribution of the different canopy tree species using the 1995 aerial photography and the corresponding GIS coverage (**Figure 19 and 20**). The Northwest Fork of the Loxahatchee River contains approximately 320 hectares of riverine, 24 hectares of upper tidal and 45 hectares of lower tidal floodplain.

The riverine reach is that part of the floodplain forest having primarily freshwater canopy forest that is generally unaffected by salinity. On the Northwest Fork of the Loxahatchee River, this area ranges from just north of the G-92 Structure (**Figure 4**) downstream to RM 9.5 (**Figures 19 and 20**). Vegetative communities in this reach are dominated by bald cypress with pop ash, red maple, pond apple, water hickory and other trees present with less frequency.

The upper tidal reach is that part of the floodplain forest having a mixed freshwater/brackish canopy that has experienced some saltwater intrusion due to tidal influences and reduced freshwater flows in the dry season. On the Northwest Fork of the Loxahatchee River this area occurs between RM 9.5 and RM 8.13 (the mouth of Kitching Creek), as illustrated in **Figure 19**. Upper tidal reach communities are dominated by pond apple, red and white mangrove and cabbage palm with some communities of bald cypress present in the inner floodplain areas away from the river channels.

The lower tidal reach is that part of the Northwest Fork having primarily salt tolerant species and is highly influenced by tides and salinity in the water and soils (**Figure 19**). This area extends from approximately RM 8.13 to RM 5.5 although several smaller areas can be found around

RM 4.5 and in the embayment area. The lower tidal reach is dominated by red and white mangroves.

The identification of floodplain forest types was based on the canopy tree species that generally grow together in recognizable communities (modified from Darst et al, 2003). Tree canopy data from both the 1993-94 Ward and Roberts study (using (76) 10 m^2 plots on 6 transects) and the 2003 transect study (138) 10 m^2 plots were utilized. Prior to the creation of the forest types specific for the Loxahatchee River, Twin Span (two way indicator analysis) was used to analyze the 1993-94 Ward and Roberts canopy data. Based on the results of this analysis, indicator species were identified for the various forest types. The relative basal area (RBA) of each tree species within a plot was calculated by dividing the total basal area of a species (in m^2) by the total basal area of all species within a 10 m^2 plot. Multi-trunk trees were considered separate trees for this analysis. The most common multi-trunk trees observed were pond apple, red mangrove and bald cypress.

Rules were developed to identify the 17 forest community types by reach and community type (**Table 4**). The five major community types were identified as swamp (sw), bottomland hardwoods (blh), hydric or mesic hammocks (h), freshwater marsh (m) or uplands (u). Then, the reach and type of the forest community was determined based on species composition. Using these rules, it was possible to consistently distinguish among forest types (for example, to distinguish a riverine swamp community from an upper tidal swamp community) and it will be possible to document changes between forest types in the future.

The rules that were created specifically for the Loxahatchee River floodplain forest are presented in **Table 4.** Forest type names for freshwater swamp communities (i.e. bald cypress, pop ash and pondapple) reflect their general location in the landscape. In the tidal reaches, there is an identifiable difference between the landscape positions of red and white mangroves, and this is reflected in the forest types. Adjustments were made to a few plots where the canopy clearly did not reflect the character of the shrub and groundcover vegetation.

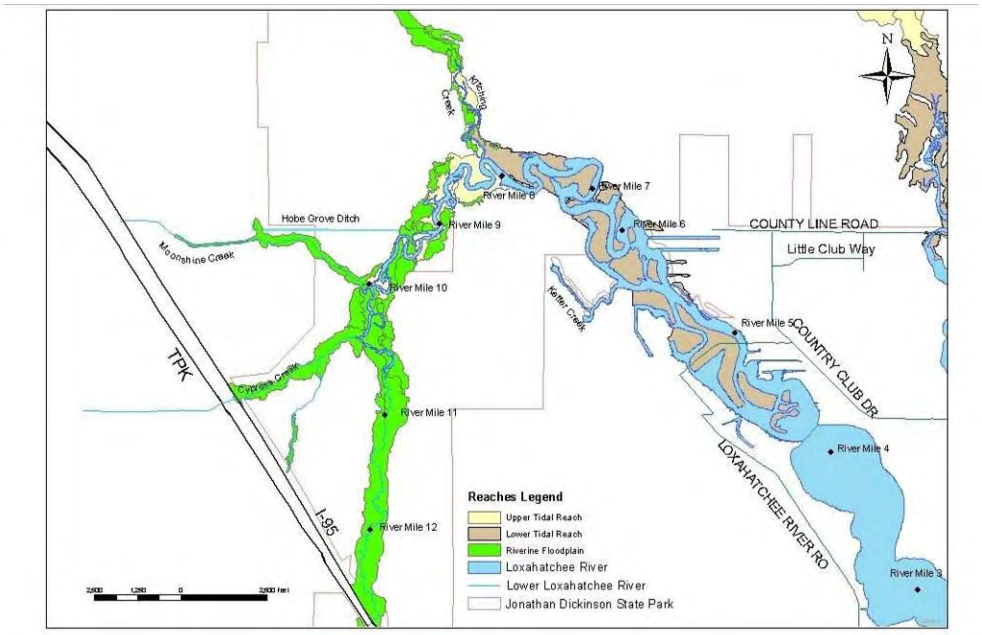


Figure 19. Designated reaches of the Northwest Fork of the Loxahatchee River – North.

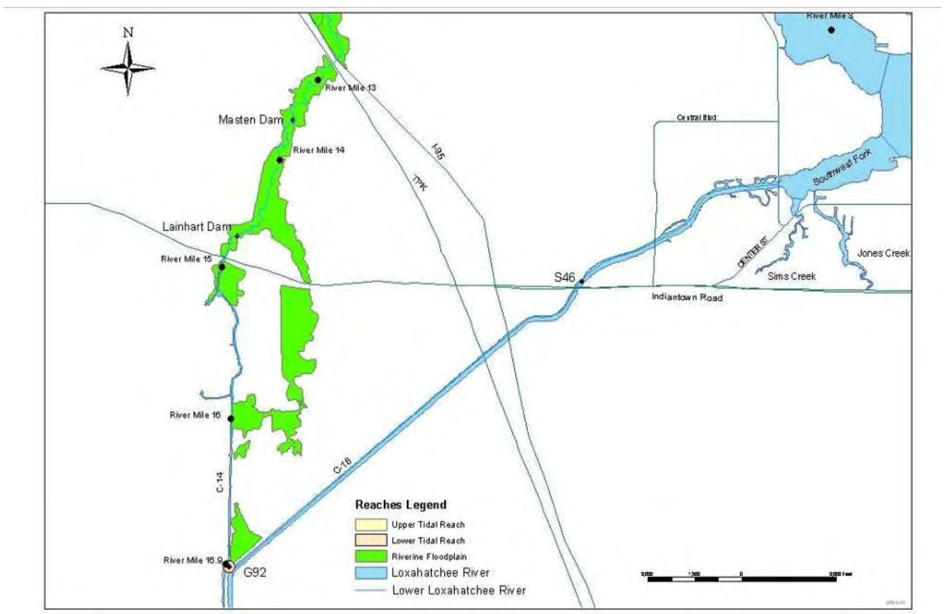


Figure 20. Designated reaches of the Northwest Fork of the Loxahatchee River – South.

Table 4. Reach and forest type determinations.

Category		Species	Determination of Reach:
Swamp	River–ine	*Fraxinus caroliniana**, Pop ash *Taxodium distichum*, Bald cypress	1. IF bald cypress +pop ash + red maple + water hickory > 80% THEN reach is **riverine**. 2. IF bald cypress+ pop ash+ red maple+ water hickory ≤ 80% and pond apple≥ 60% , Then reach is **upper tidal** 3. IF red mangrove + white mangrove + popash≥ 60%, THEN reach is **upper tidal**. 4. IF red mangrove> 80%, THEN reach is **lower tidal**. 5. IF red mangrove + white mangrove > 75%, THEN reach is **lower tidal**.
Swamp	Tidal	*Annona glabra*, pond apple *Laguncularia racemosa*, W. mangrove *Rhizophora mangle*, Red mangrove	
			Determination of Forest Types:
Bottomland Hardwood	Low	*Acer rubrum*, Red maple *Cephalanthus occidentalis*, Buttonbush *Persea palustris*, Swamp Bay *Salix caroliniana*, Carolina willow *Syzygium cumini*, Java plum	**Riverine reach forest types:** 1. IF upland ≥ 75%, THEN forest type is **upland**. 2. IF upland < 75% and hammock ≥ 50%, THEN forest type is **hammock**. 3. IF hammock < 50%, and swamp ≥ 50% THEN 4. IF bald cypress ≥ 50%, THEN forest type is **Rsw1**. 5. IF bald cypress < 50%, and pop ash ≥ 50%, THEN forest type is **Rsw2**. 6. IF bald cypress > 50% and hammock ≥ 40% THEN forest type is **Rmix.** 7. IF swamp < 50% THEN 8. IF lobh ≥ 80%, THEN forest type is **Rblh1**. 9. IF lobh < 80%, THEN 10. IF hiblh + lblh ≥ 80%, THEN forest type is **Rblh2**. 11. IF high blh + uplands OR hammock ≥ 80%, THEN forest type is **Rblh3.** 12. OR IF hiblh + lblh < 80% THEN forest type is **hammock**.
Bottomland Hardwood	High	*Carya aquatica*, Water Hickory *Chrysobalanus icaco*, Cocoplum Citrus spp. *Ilex cassine*, Dahoon holly *Psidium cattleianum*, Strawberry guava *Quercus laurifolia*, Laurel Oak *Roystonea regia*, Royal Palm	
Hammock		*Ficus microcarpa*[a], Ficus Ficus aurea[a], Strangler ficus *Myrica cerifera*, Wax myrtle *Persea borbonia*,Red Bay *Quercus virginiana*[c], Live Oak Rapanea punctata, Myrsine *Sabal palmetto*[d], Cabbage palm	**Upper tidal reach forest types:** 1. IF upland ≥ 75%, THEN forest type is **upland**. 2. IF upland < 75%, AND 3. IF hammock ≥ 50%, THEN forest type is **hammock**. 4. IF swamp[b] > 75%, AND 5. IF white mangrove ≥ 50%, THEN forest type is **UTsw3**. 6. IF white mangrove <30% and pond apple > 50%, Then forest type is **UTsw2.** 7. IF red mangrove ≥30% and pond apple > 50% THEN forest type is **UTsw1**. 8. OR IF swamp[b] <70%, THEN forest type is **UTmix.**
Upland		*Pinus elliottii*, Slash pine *Quercus myrtifolia*, Myrtle Oak *Schinus terebinthifolius*, Brazil. Pepper Serenoa repens, saw palmetto	

		Lower tidal reach forest types: 1. IF upland ≥ 75%, THEN forest type is **upland**. 2. IF upland < 75%, AND 3. IF hammock > 50%, THEN forest type is **hammock**. 4. IF hammock < 50%, AND 5. IF red mangrove > 80%, THEN forest type is **LTsw1**. 6. OR IF white mangrove > 80%, THEN forest type is **LTsw2**. 7. OR IF swamp < 50% THEN forest type is **LTMix**.

[a] Present as epiphytes at Transects #7 and #9. Species in Red Font are Exotics.

[b] Both riverine and tidal swamp species present.

[c] Dominant canopy species in Mesic Hammock.

[d] Dominant canopy species in Hydric Hammock.

Split and mixed plots occurred. Based on RBA, a split plot had two forest types (split 50 percent) on either side of the plot such as Hammock/Rsw1. A mixed plot had several forest types intermixed together within the plot. These plots were classified as Rmix, UTmix, or LTmix. The names of forest types used are given in table 6.

Canopy data was further analyzed for frequency of occurrence and species richness. Species richness was calculated as the number of species present in a sample unit (belt transect or vegetative plot). Canopy was further analyzed for abundance (density) and relative basal area (rba). Shrub-layer and groundcover data were analyzed for percent cover, density, species richness, frequency of occurrence, and distribution. Percent cover of shrub-layer species was calculated as the total length (cm) of branches intercepting the one meter high tape divided by the total length of the tape (10 m). Because of multiple layering, percent cover may exceed 100 percent. For groundcover species, percent cover was estimated visually by using a scale of 0-5, 5-25, 25-50, 50-75, and 95-100 percent. Frequency of occurrence was calculated by dividing the number of times a species occurred within a belt transect and forest type given sample size. Additional measurements of seedling/sapling counts were made and summarized.

Table 5. Major forest types used in the 2003 study.

Forest Type	Riverine (R)	Upper Tidal (UT)	Lower Tidal (LT)
Marsh (freshwater)		M	
Swamp	Rsw1 Rsw2 (FPsw1 [a])	UTsw1 UTsw2 (FPsw1[a]) UTsw3 (LRsw3[b])	LTsw1 (RMsw1[c]) LTsw2
Low Bottomland Hardwood High Bottomland Hardwood	Rblh1 Rmix Rblh2 Rblh3	UTmix	LTmix
Hammock	H (Mesic and Hydric)	H (Hydric only)	H (Hydric only)
Upland	U	U	U

[a] Another name for *Fraxinus caroliniana* swamp.

[b] Another name for *Laguncularia racemosa* swamp.

[c] Another name for *Rhizophora mangle* swamp.

Riverine reach information is generally presented in this report with a green background color. Upper tidal reach information is generally presented in this report with a yellow background color. The lower tidal reach information in this report is generally presented with a beige color background.

Statistical Analysis

Several package statistical programs were used to analyze the data for this project. These programs included EXCEL, SYSTAT 11, and PC-ORD (McCune and Mefford, 1999 and McCune and Grace 2002). PC-ORD was used to perform a variety of ordination analysis with the canopy, shrub and ground cover datasets by vegetative plot. Principal Components Analysis (PCA) and Canonical Correspondence Analysis (CCA) were used to examine clusters of floodplain plant communities (i.e. species). Dendrograms and scatterplots were produced to show the association of communities. Ward's Method (1963) was used to define the distance between clusters. For cluster analysis, all plots with no corresponding vegetation present and all plots identified as uplands were removed. The complete dataset of 138 plots with corresponding RMs, elevation (NGVD), and forest and soil types was used to examine environmental variables. Both forest types and soil types were assigned numerical codes.

Topographical Characteristics

Each transect was professionally surveyed and a permanent bench mark was established. Additional survey measurements and GIS locations were taken periodically by a Senior Geographer. Based on the permanent benchmarks established by surveyors, a laser level was used to determine elevation (feet MSL). Profiles were prepared for each transect and later over-laid with designated forest community types. This information was used to calculate water inundation within the floodplain area at various locations along the Northwest Fork of the Loxahatchee River.

Geographic Information System Coverage

GIS vegetation coverages were completed for all transects using Digital Ortho Quads (DOQQs) from year 2003 and the Florida Land Use, Cover and Forms Classification System (FLUCCS). Extensive GIS coverages were prepared for Kitching Creek, Cypress Creek and the North Fork. Historical coverages from 1940, 1985 and 1995 are available for most of the NW Fork transects. Additional GIS coverages (1953, 1964, and 1979) were available for the Taylor Alexander or Wilson Creek sites, which were part of a 6-decade analysis in the 2002 MFL document between RMs 6.0 and 8.0.

Water Sampling and Hydrologic Analysis

Real time water level (stage), water temperature, conductivity and salinity have been recorded at several stations by U.S.G.S. since November 2002. Real time (every 15 minutes) bottom and surface salinities and water level in the river are being collected near the study transects for the 3-D Hydrodynamic/Salinity Model. A total of seven monitoring stations for the river area have been established and are operational. Hobe Grove Ditch and Cypress Creek Stations provide current velocity and water level for estimates of freshwater input to the Northwest Fork.

Mean forest elevation of forest types, daily high stage, and flows over Lainhart Dam are used to calculate flood depths and duration. Ground water level data are being recorded at twelve shallow water wells with recorders placed along Transects 1, 3, 7, 8, and 9 for the Loxahatchee watershed groundwater monitoring network. Transects 1 and 3 served as background freshwater sites for study purposes. The remaining stations are exposed to different levels of tidal fluctuations and saltwater intrusion. Estimates of groundwater discharge and recharge, and other water quality constituents within several of the transects were examined during wet and dry periods. Groundwater data from the twelve Loxahatchee River well locations is an ongoing project and will be summarized in a future report.

Soil Characteristics

In May of 2004, soil profiles were collected within each transect as part of a SFWMD contract with the University of Florida. In addition, local soil maps for Palm Beach and Martin counties (USDA 1974a, 1974b) were consulted for general soil types. Most of the field work for the county surveys was conducted between 1968 and 1974.

For the University of Florida study (**Appendix D**), soil samples were collected within each 10 m² plot and combined to create a composite sample to represent each major forest type within a transect. A soil auger was used to collect the top 20 cm of soil. Soil moisture (percent saturation), soil texture, drainage class, soil classification, thickness of horizons, conductivity, nitrogen, potassium, phosphorus, pH, cation exchange capacity, and percent organic matter was determined for each composite sample. Soils types that were found within the vegetative transect are presented in **Appendix D**. The soil chemistry and soil moisture data are summarized in a University of Florida Report entitled “Soil and Hydroperiod Analysis in the Floodplains of the Loxahatchee River Waters” (Li et al., 2006). This data will be available in future reports from the University of Florida.

General soil types from the county soil surveys of Palm Beach and Martin Counties are depicted in **Figure 21**. The major soil type in the riverine floodplain portion of the Northwest Fork, and upper Cypress and Kitching Creeks was Winder Fine Sand followed downstream by a plug of Okeelanta Variant Muck where the Northwest Fork, Cypress Creek, and Moonshine Creek meet. Terra Ceia Variant Muck was identified as the major soil type in the vicinity of Hobe Grove Ditch to just downstream of the mouth of Kitching Creek on the Northwest Fork. Between Wilson Creek and Ketter Creek the major soil type was identified as Okeelanta Variant Muck with Pomello Fine Sand in the uplands. In the past, Okeelanta Variant Muck has been identified as more of a coastal muck whereas Terra Ceia Variant has been identified as more of an inland muck. A plug of Bessie Muck was identified inside the mouth of Kitching Creek. On the North Fork of the Loxahatchee River Waveland Sand Depressional was identified for the freshwater segments while Okeelanta Variant Muck was identified in the mostly mixed swamp hammock areas of the North Fork.

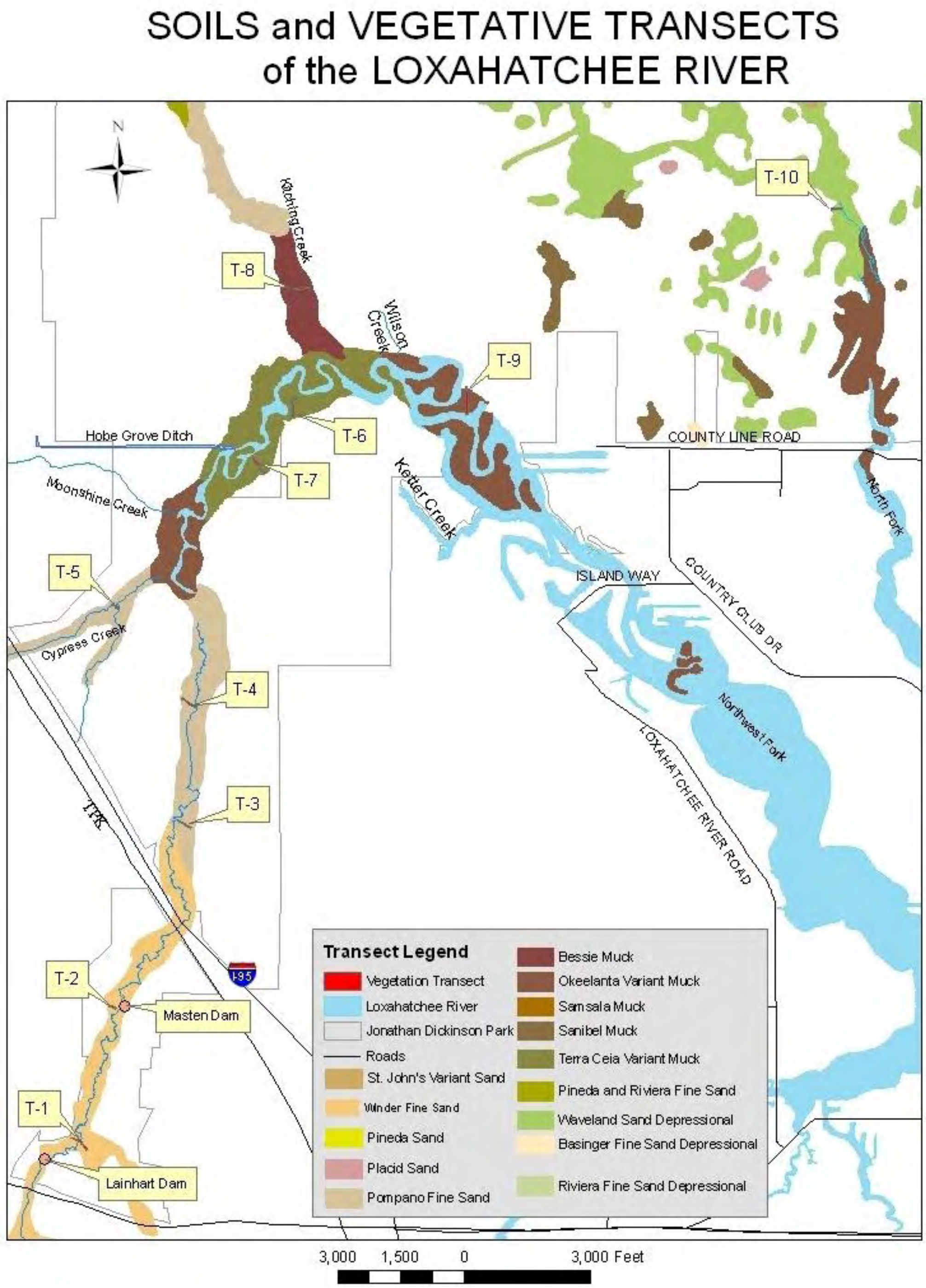


Figure 21. General Soil Survey of the Loxahatchee River floodplains and some isolated wetlands.

RESULTS

Overall View of Plant and Forest Type Distributions

Approximately 222 plant taxa identifications were made using standard field studies and taxonomic references as to occurrence within the various periods of records. As defined earlier they are the 1984, 1994 and 2003 studies, as well as the 1994 and 2006 observations. These plants included all indigenous vascular plants known to this locale, as well as non-native taxa (exotic plants) that were purposely or unintentionally introduced. As species located within the riparian and the associated uplands were previously collected, with voucher specimens in place at the University of South Florida Herbarium and a list of Vascular Plants of Jonathan Dickinson State Park published (Roberts, et. al, 2006), most species were identified in the field without taking voucher specimens.

Table 4 presents a summary of the forest types with hydrological conditions, soil textures, and dominant canopy species. Forest types clearly differ as a result of changes in hydrology, topography, vegetation, soils, and proximity to the coast (Darst et al., 2003). Other factors that influence forest type include logging and fire history, presence or absence of exotic species, and the availability of nutrients and light.

Table 6. Summary of hydrological conditions, soil textures, and dominant canopy species of forest types in the floodplains of the Loxahatchee River and its major tributaries (modified from Light and others, 2002).

Forest Type	Typical Hydrological Conditions	Primary Soil Textures	Dominant Canopy Species
Uplands	Flooded average of every 10 years; soils dry quickly after floods recede	Sand	*Pinus elliottii* *Quercus myrtifolia*
Hydric Hammock	Flooded average 2 months (30-60 days)	Sand	*Sabal palmetto*
Mesic Hammock	Rarely inundated at higher elevation; soils dry quickly after floods recede		*Quercus virginiana*
Rblh3 **Rblh2**	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*
Rblh1	Flooded average of one month every year remain saturated another month	Sand, loam, clay	*Acer rubrum* *Cephalanthus occidentalis* *Persea palustris* *Salix caroliniona*
Rsw2 **Rsw1**	Flooded average 4-7 months every year; soils remain saturated another 5 months	Clay, muck	*Taxodium distichum* *Fraxinus caroliniana*
Rmix	Flooded 2 to 3 months every year	Sand	*Taxodium distichum* *Sabal palmetto*
UTmix	Flooded 2 to 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*
UTsw3	Flooded monthly by high tides or high river flows	Muck	*Annona glabra* *Fraxinus caroliniana* *Rhizophora mangle* *Laguncularia racemosa*
UTsw2 and UTsw1	Flooded daily by high tides from 9-11 months of a year Most soils continuously saturated		
Hammock	Flooded every 1-2 years by either storm surge or high river flows, high water table, surface soils on higher elevations dry quickly and soils continuously saturated in lower areas	Muck	*Sabal palmetto* *Chrysobalnus icaco* *Quercus virginiana* *Myrica cerifera*

LTmix	Flooded daily or several times a month by high tides except in isolated areas; soils continuously saturated except for the interior of hammocks	Muck	*Lagunularia racemosa* *Sabel palmetto* *Rhizophora mangle* *Annona glabra*
LTsw2	Flooded daily for 9 months every year	Muck	*Laguncularia racemosa* *Rhizophora mangle* *Annona glabra*
LTsw1	Flooded daily every year	Muck	*Rhizophora mangle* *Laguncularia racemosa*

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 (**Figure 22**). 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, myrtle oak and saw palmetto.

Figure 22. Upland forest type.

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; whereas mesic hammocks are dominated by live oaks (**Figure**

23). Mesic hammocks are found at higher elevations than hydric hammocks. No mesic hammocks were found in the tidal reaches of the Loxahatchee River. Other fairly common species in the hammocks are myrsine, mulberry, red bay, and ficus. Hammocks are generally found between the uplands or bottomland hardwood forests and swamp areas. They may also appear as isolated islands or 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 may occur as an exotic pest species where there is sufficient high elevations.

Figure 23. Hammocks are found in both riverine and tidal reaches of the river.

In the riverine reach, high bottomland hardwoods (Rblh2 and Rblh3) are found on higher ridges (**Fig. 24**) while low bottomland hardwoods (Rblh1) are found on swamp margins. Rblh3 are dominated by water hickory, cocoplum, dahoon holly, and laurel oak. The forest type Rblh2 has approximately equal amounts of low and high bottom land species while Rblh3 has combinations of high bottomland mixed with hammock or even some upland representatives.

Rblh1 forests are found at lower elevations than Rblh2 and Rblh3. 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 are characterized by red maple, buttonbush, swamp bay and Carolina willow. Riverine Mixed forests (Rmix) support nearly equal mixtures of bald cypress and hammock species.

Figure 24. Bottomland hardwood forest type (Rblh2).

The exotic plant species, java plum, and strawberry guava are found in both riverine and tidal bottomland hardwoods. Java plum and strawberry guava may have been introduced by Trapper Nelson, a former private land owner along the river. The occurrence of a few royal palms is attributed to their spread from the adjacent Ornamental Garden property near RM8.43.

Riverine swamps are found growing on the lowest elevations and in the wettest areas that are inundated or saturated most of the time (**Figure 25**). Soils are sandy with some muck or clay. On the Northwest Fork of the Loxahatchee River, older riverine swamps are dominated primarily by bald cypress in Rsw1 swamps. 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. The most problematic exotic pest plant species in riverine swamp communities are golden pathos, nephthytes and wild taro.

Upper tidal swamps are present at elevations below median monthly high stage (**Figure 26**). Unlike riverine swamps, upper tidal surface soils consist of permanently saturated mucks. On the Northwest Fork of the river, upper tidal swamps are a mixture of brackish and freshwater vegetative communities. They primarily consist of pond apple, red and white mangrove with smaller numbers of bald cypress, pop ash, red maple and Carolina willow (**Table 3**). Areas of riverine swamp Rsw1 (mostly older bald cypress) are present on some primarily upper tidal transects and have probably survived at the back of the tidal floodplains due to surface and groundwater runoff from the adjacent uplands. 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 percent, 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 percent, then the forest type is identified as hammock. No bottomland hardwood communities are found in the upper or lower tidal reaches.

Figure 25. Riverine swamp forest type.

Figure 26. Upper tidal swamp forest type (UTsw1).

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 27**). 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 cocoplum are greater than 50 percent, 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. Today, cabbage palms are quite common along the shoreline of the tidal Northwest Fork of the river. In a comparison of the 1940 to the 1995 shoreline of the Northwest Fork, it was shown that the river channel has widened between the park boundary (RM 5.92) and the Trapper Nelson Interpretive Site (RM 10.50) (SFWMD, 2002). This widening suggests that erosion has occurred within these cabbage palm communities leaving them exposed to greater tidal fluctuations and saltwater exposure.

Figure 27. Lower tidal swamp forest type (LTsw1).

According to Kushlan (1990), 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 of the Loxahatchee River. These formerly sawgrass marsh communities 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. **Figure 12** depicts a former salt water marsh that has converted to mangroves. Local sea level rise and reductions in freshwater flow have probably contributed to the succession of marsh wetlands to forested communities in tidal areas.

Characteristics of Forest Composition on Transects

In the 2002 MFL document, the 1940 and 1995 aerial vegetative coverages of portions of the Loxahatchee River were presented. Florida Land Use, Cover and Forms Classification System (FLUCCS) codes were used to describe aerial views of the vegetative communities (See **Appendix B**: Historical Vegetation Distribution along the Northwest Fork of the Loxahatchee River). For the floodplain area the categories were mangrove swamp, inland ponds and sloughs, stream and lake swamp, mixed wetland hardwood, wet pine flatwood, cypress, and freshwater marsh. Through the study of the 10 vegetative belt transects of the river and its major tributaries, we were given a closer view of the plant communities that occupied the FLUCCS codes of the aerial photography analysis.

A summary of the 138 vegetative plots (location, river mile, elevation, forest type and soil type) is given in **Appendix E-1** while the complete listing of the 2003 canopy data is given in **Appendix E-2**. **Figure 28A** presents a summary of the 138 plots by forest type. Plots were also broken down by split and mixed plots. Within the 138 plots, forest types were distributed as 58 percent swamp (36 percent sw1, 18 percent sw2, and 4 percent sw3), 13 percent hammock (5 percent mesic and 9 percent hydric), 13 percent bottomland hardwood (2 percent blh1, 8 percent bhl2, and 3 percent blh3), 12 percent mixed hardwoods, 3 percent upland, and 1 percent freshwater marsh. Almost one-half of the floodplain vegetation plots (67) were located in the riverine reach while 37 percent (51) and 14 percent (20) were located in the upper tidal and lower tidal reaches, respectively. The percentage of swamp plots increased as transects were located downstream presumably because of the increase in floodplain width and decrease in elevation. Of the 67 plots in the riverine reach, 51 percent were swamp, 25 percent were bottomland hardwood, and 21 percent were hammock (**Figure 28B**). In the upper tidal reach which had 51 plots, 56 percent were swamp while 31 percent were mixed, 6 percent were hammock, and 4 percent were upland (**Figure 28C**). The lower tidal reach had the fewest number of forest types and consisted of 82 percent swamp, 8 percent hammock, and 5 percent mixed and upland (**Figure 28D**). The freshwater marsh was only found on Transect 10 on the North Fork of the river while communities of bottomland hardwood were only found in the riverine reach, although species generally associated with bottomland hardwoods were present in the upper tidal reach.

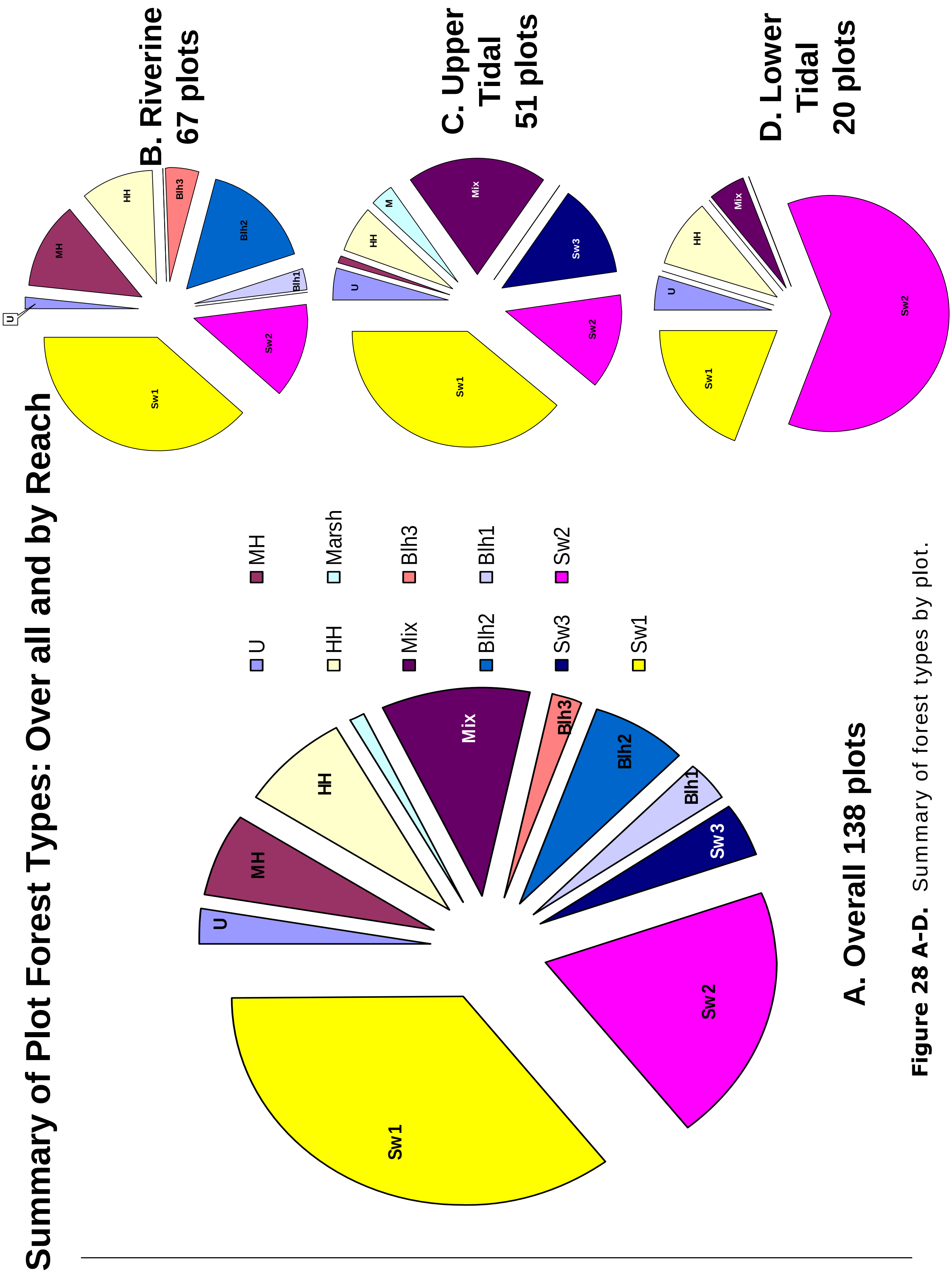


Figure 28 A-D. Summary of forest types by plot.

Species richness (total number of species) is a simple measure of diversity within plant communities. There were a total of 138 trees, shrubs, groundcover and woody vine species identified in the floodplain. The canopy species included 26 trees and 1 woody vine. In comparison, the lower Suwannee River (the second largest river in Florida with regards to average discharge) had a total of 77 tree, shrub and wood vine species (Light, 2002). In the shrub- layer, 49 species were identified while 118 species of herbaceous plants and young shrub/tree seedlings were identified in the groundcover. **Figure 29** shows the 2003 species richness on transects by community level (i.e. canopy, shrub and groundcover) and for all levels combined.

For all three plant layers (canopy, shrub, and groundcover) of the 2003 study transects, T3 (RM 12.07) had the highest species richness with a total of 58 species. T3 may have had more species because this transect has more topographical relief with its multiple braided streams (**See: Appendix J**) and has been disturbed more than other riverine transects. Transect 3, has been impacted by selective lumbering, and exotic plant management. T3 also had the greatest number of pop ash trees of any site. Pop ash are also found in areas in the upper tidal reach where bald cypress were selectively lumbered; while an area like T1 with a continuous bald cypress canopy had no pop ash. T2 was divided into two transect segments (T2-1 at RM 13.57 and T2-2 at RM 13.43) for comparison with the 1993-94 Ward and Roberts study. T2-1 is in an area just upstream of Masten Dam which is primarily swamp whereas T2-2 is in an area downstream of the dam, which is primarily hydric hammock. T2-2 had the lowest number with 24 species (**Figure 29**).

With regards to canopy, the upper tidal communities had the highest species richness (T6 (15), T7 (14); and T8 (14) presumably due to physical disturbances (i.e. logging activities, hurricanes), changes in salinity, and hydrological changes. Upper riverine transects, T1 and T2, had the lowest number at 8 and 7 total. Similarly, the highest species richness for shrub-layer communities were found on upper tidal transects T8 (23), T7 (17) and T6 (15). The lowest values were found on T9 in the lower tidal reach and T5 (Cypress Creek). Shrubs and groundcover are limited on T9 by low elevation, frequent inundation and high levels of salinity in soils on this peninsular. Shrub-layer species on T5 have probably been limited by the frequency of very high flows and shoaling from silt and sand deposition; however, it doesn’t appear to have affected the groundcover community as much. Species richness for groundcover communities was highest on T3 (37) and T7 (34) and lowest on T9 (17) and T2 (22).

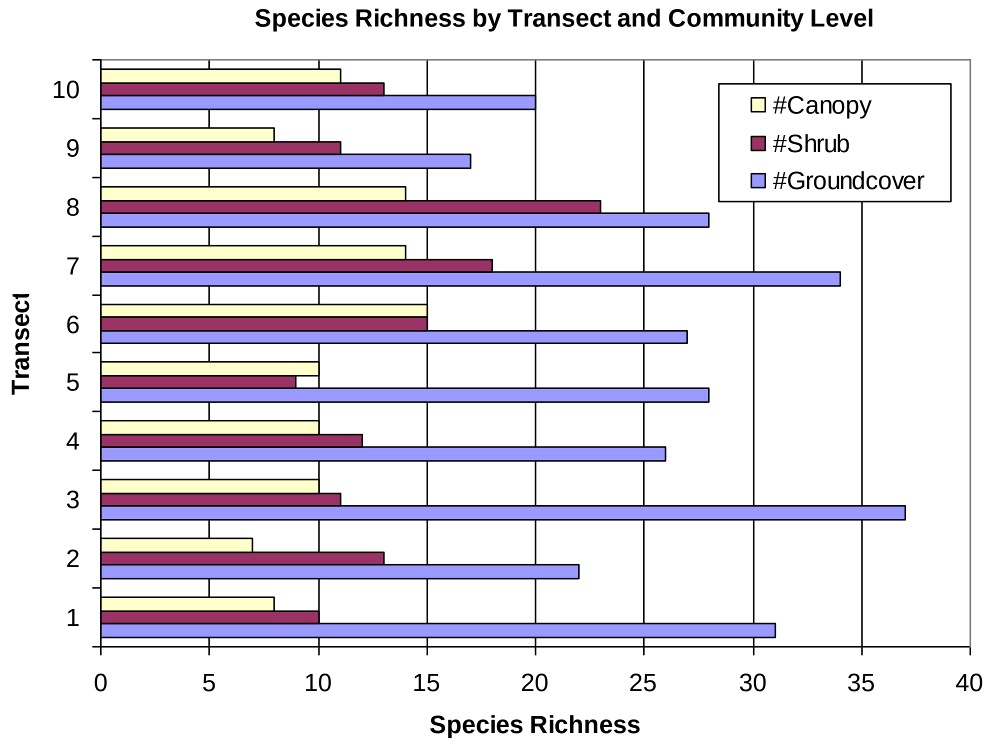


Figure 29. 2003 species richness by transect and community level (canopy, shrub and groundcover).

Density (abundance) is another characteristic of the composition of plant communities. The most commonly occurring 5 species on all transects combined were white mangrove (22.5 percent), red mangrove (14.2 percent), pond apple (13 percent), cabbage palm (12.4 percent) and bald cypress (9 percent) (**Figure 28**). The mangrove trees are denser than hardwoods in freshwater forests, and in this study, each trunk was considered a separate tree. Density varied by reach. Five species: cabbage palm (23.3 percent), pop ash (22.6 percent), bald cypress (21.4 percent), red maple (10.4 percent), and water hickory (8.1 percent) were the most common trees in the canopy of plots in the riverine reach (**Figure 29**). The most dense canopy species on plots in the upper tidal reach was pond apple (21.9 percent) followed by red mangrove (16 percent), white mangrove (15.7 percent), wax myrtle (12.5 percent), cabbage palm (9.6 percent) and bald cypress (7.6 percent) (**Figure 30**). These percentages reflected the impact of selective lumbering and the abundance of hummocks that occurred throughout the upper tidal reach. Hummocks were more common in upper tidal swamp communities and contained species that are intolerant of longer hydroperiods, like cabbage palm and wax myrtle. **Figure 31** illustrates the density of canopy species on the one lower tidal transect (T9). White mangroves were the densest species

(61.8 percent) in areas normally covered by water at high tide. Red mangroves were more dense (23.4 percent) adjacent to the river channel where elevations were lower and there was greater tidal action.

Because of the effect of multiple trunks on canopy species density, basal area more accurately reflected the actual aerial coverage of the canopy by species. **Figure 32** illustrates the relative basal area of species on the 10 vegetative transects combined. Approximately 63 percent of the canopy consisted of two species, bald cypress (40.6 percent) and cabbage palm (22.7 percent). Mangroves were reduced in importance to 8.4 percent (white) and 1.6 percent (red). Basal area was highest for bald cypress and cabbage palm within the riverine reach where the percentage of bald cypress was 49.1 percent and cabbage palm was 17.6 percent (**Figure 33**). Water hickory trees were the third most important species with 12.6 percent relative basal area in the riverine reach. In the upper tidal reach, relative basal area decreased for bald cypress (35.8 percent) and cabbage palm increased to 32.7 percent (**Figure 34**). Pond apple changed from less than 1 percent in the riverine to 9.8 percent in the upper tidal reach. White and red mangroves had higher relative basal areas on the upper tidal transects than on the riverine transects (7.1 and 3.5 percent). In the lower tidal reach, white mangrove accounted for 58.5 percent of the canopy basal area while cabbage palm and red mangrove accounted for 31.5 percent and 6.2 percent respectively (**Figure 35**).

The most frequently occurring canopy species on floodplain transect plots was cabbage palm (53 percent) followed by bald cypress (43 percent) and pond apple (32 percent) (**Figure 36**). The high frequency of cabbage palm reflects its presence on transects in all three river reaches. Wax myrtle appeared in 72 percent of the plots in the upper tidal reach (**Figure 37**); while white mangrove appeared in over 90 percent of the lower tidal plots (**Figure 38**). With regard to the frequency of exotics, Brazilian pepper was present in approximately 30 percent of the upper tidal plots and 40 percent of the lower tidal plots. The three most frequent species in the riverine canopy were cabbage palm (50 percent), bald cypress (49 percent) and popash (31 percent) (**Figure 39**).

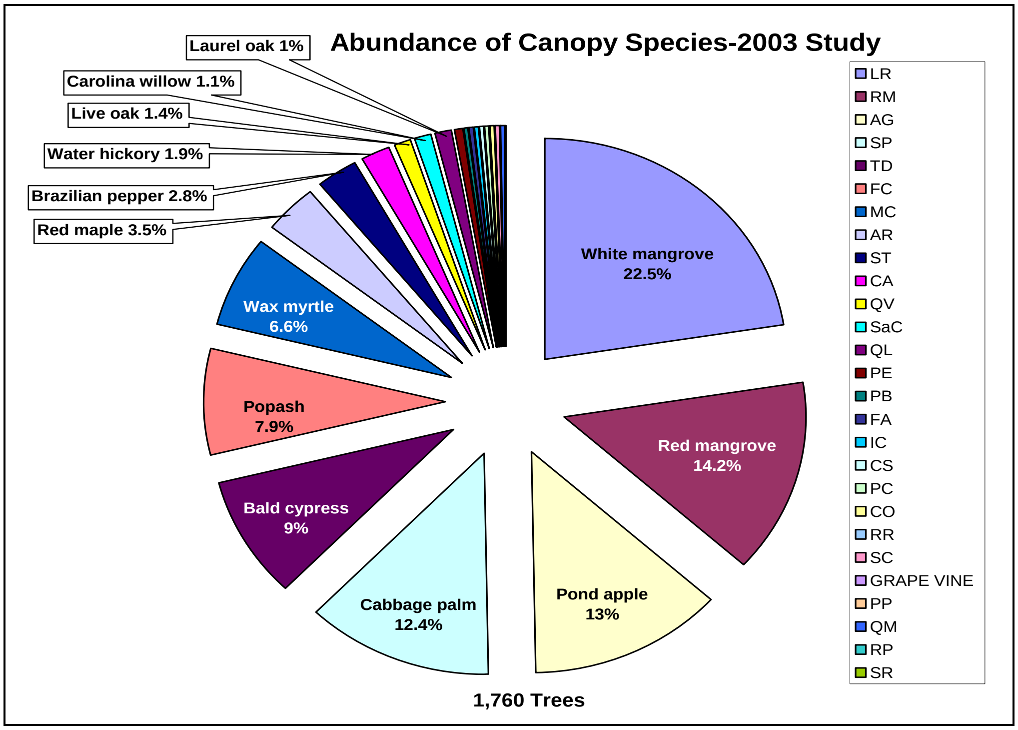


Figure 30. Overall abundance (density) of canopy species in the 2003 study.

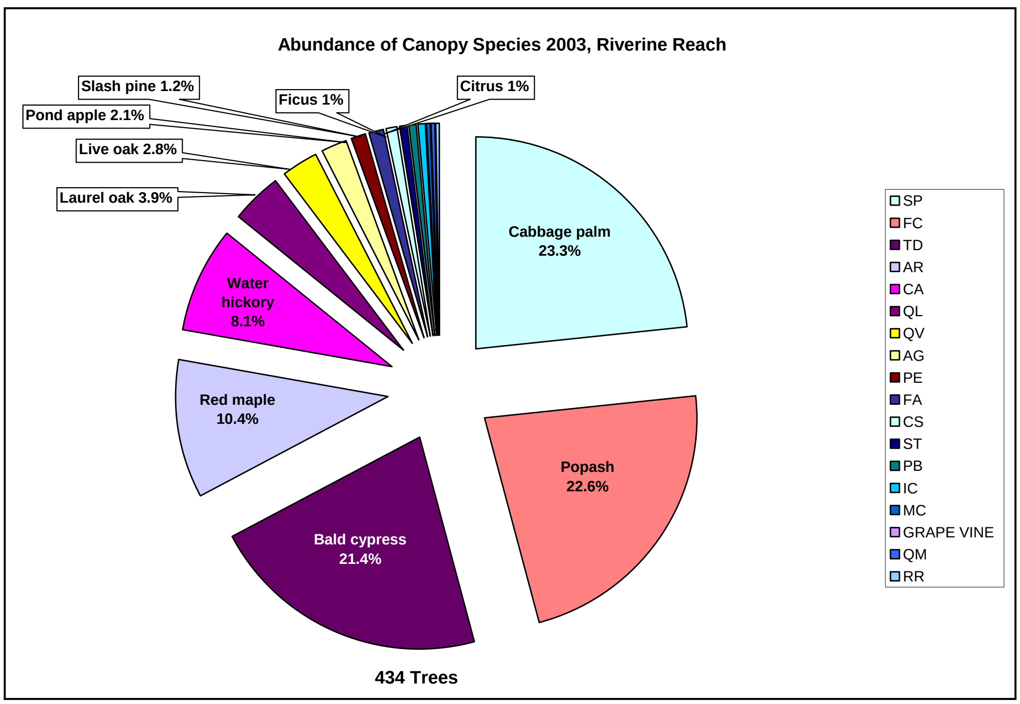


Figure 31. Canopy abundance (density) in the riverine reach.

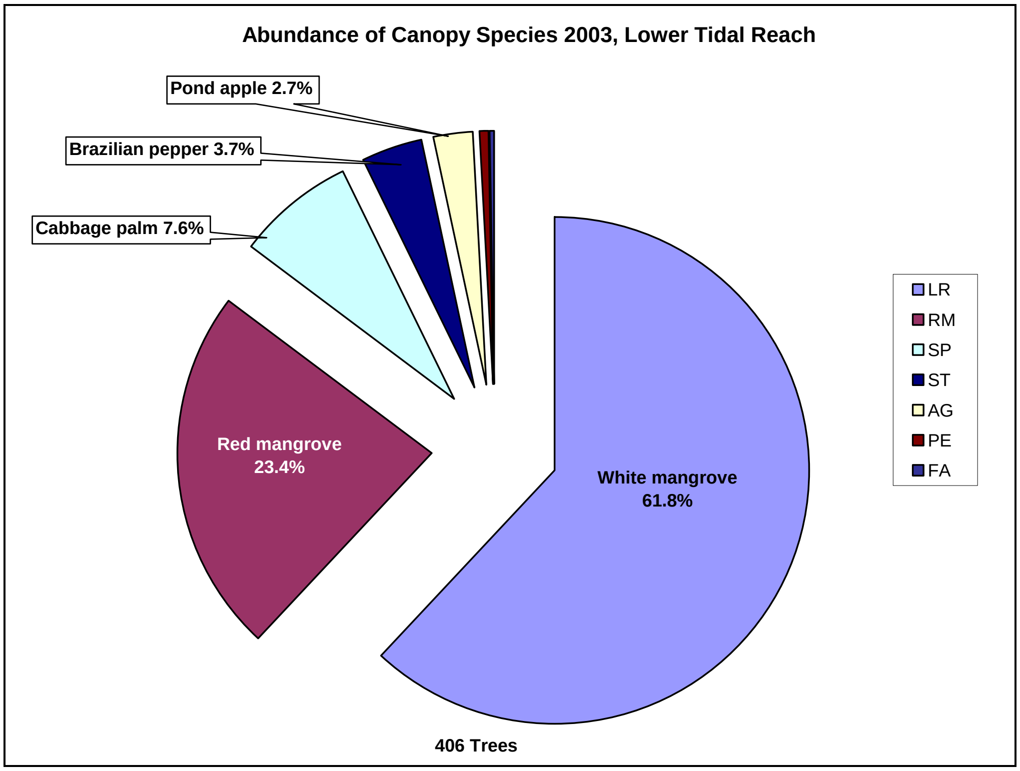


Figure 32. Canopy abundance (density) in the upper tidal reach.

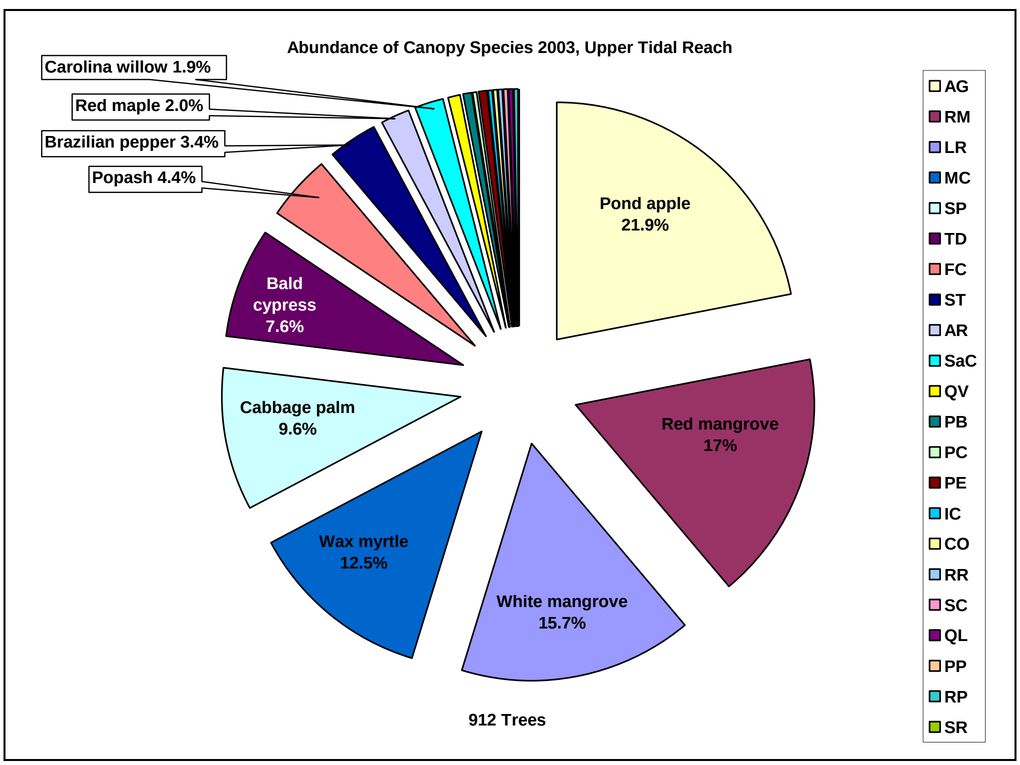


Figure 33. Canopy abundance (density) in the lower tidal reach.

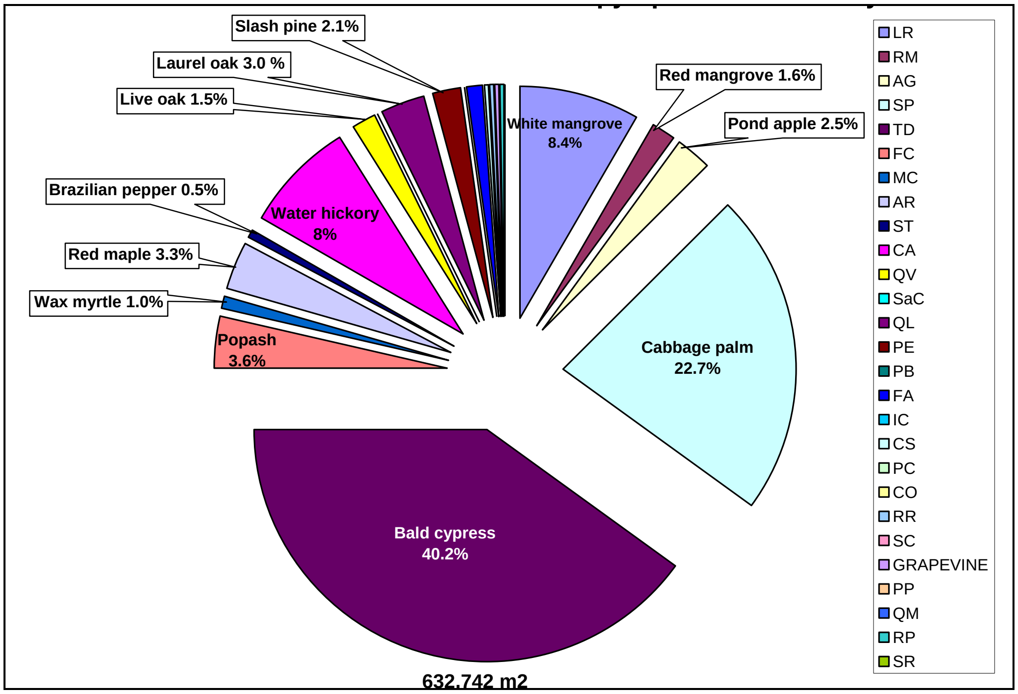


Figure 34. Overall total basal area for the 2003 study.

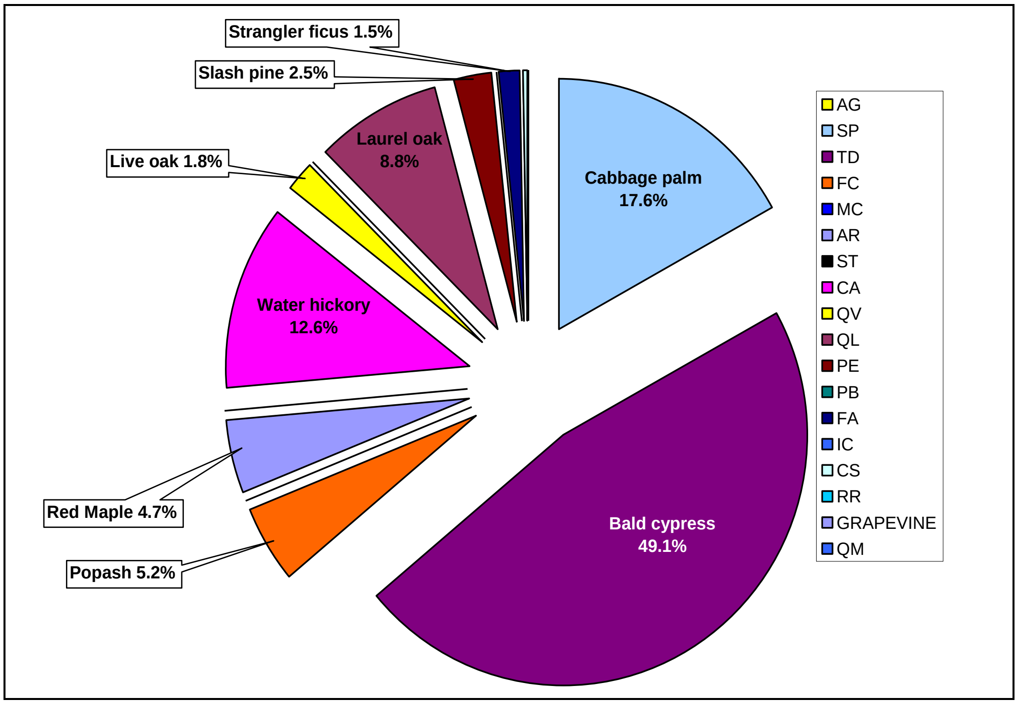


Figure 35. Basal area for the riverine reach.

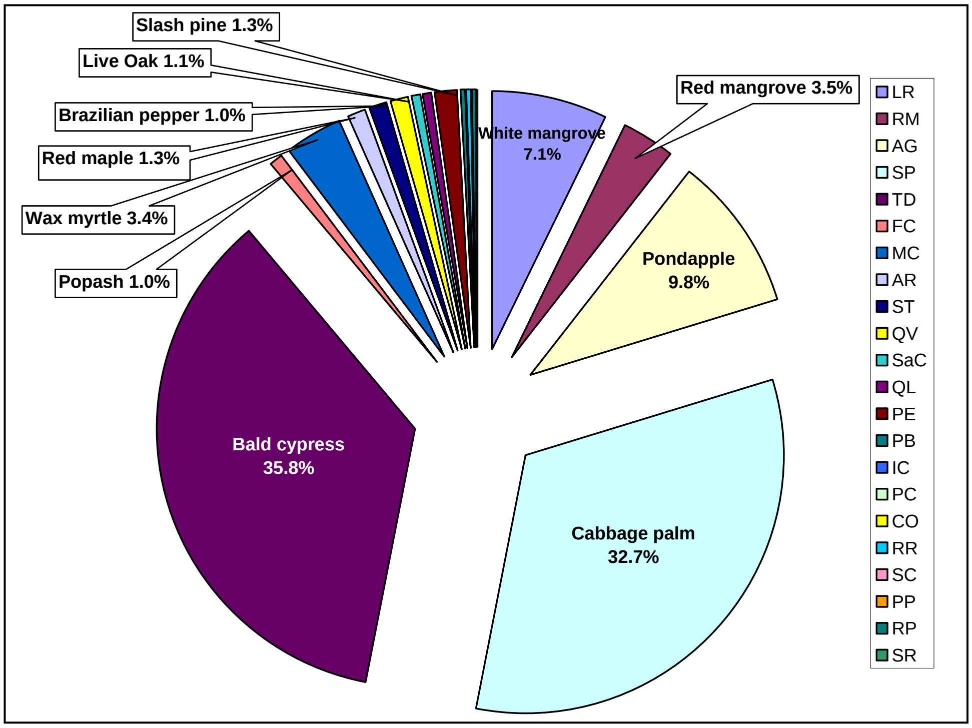


Figure 36. Basal area for the upper tidal reach.

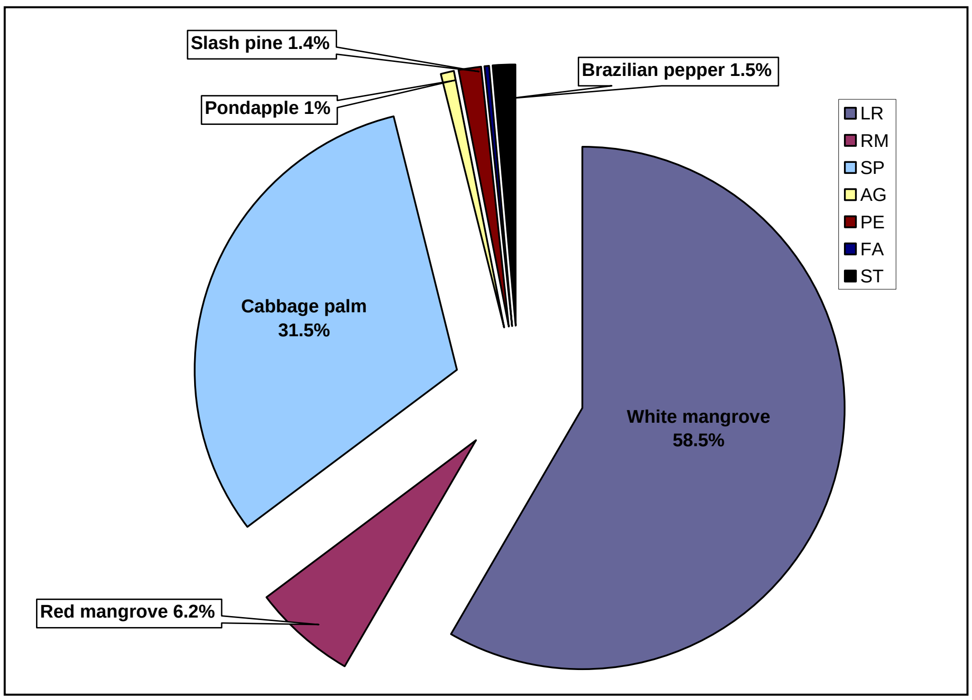


Figure 37. Basal area for the lower tidal reach.

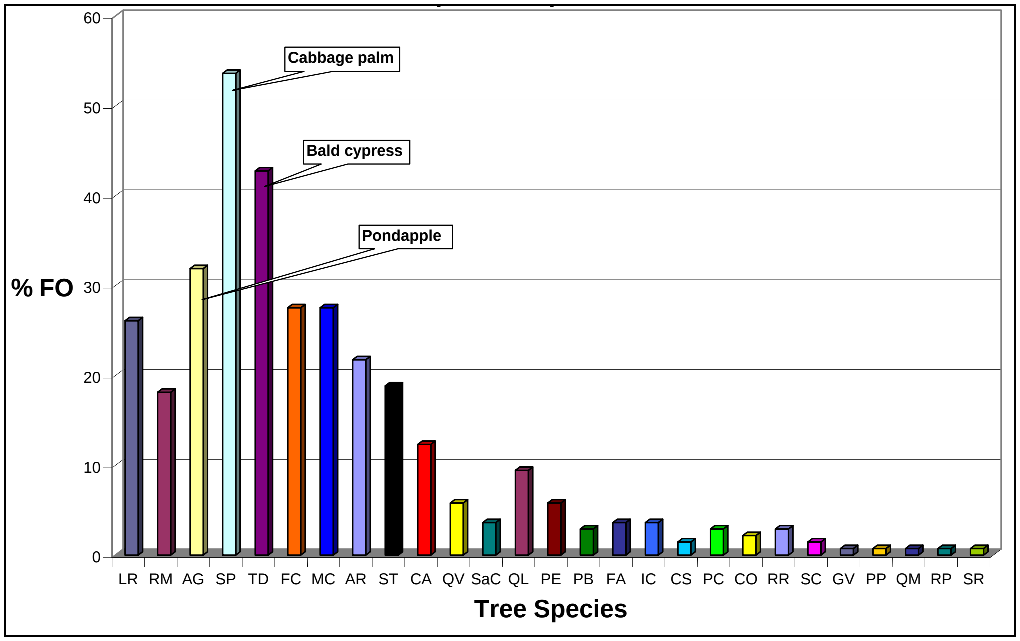


Figure38. Frequency of occurrence (FO) for all canopy species in the 2003 study.

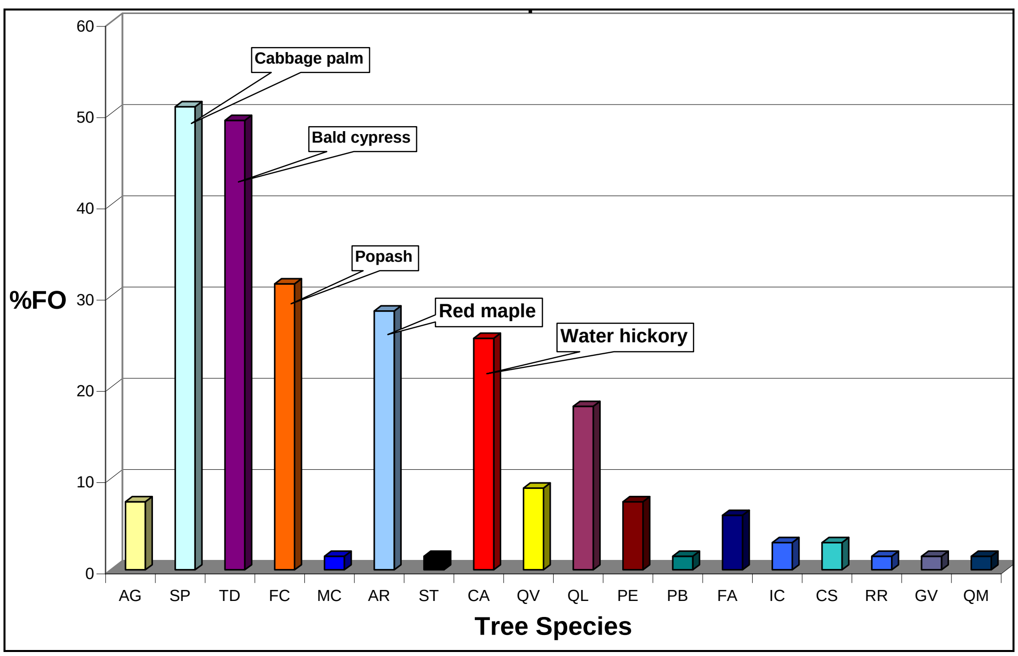


Figure 39. Frequency of occurrence (FO) of canopy species in the riverine reach.

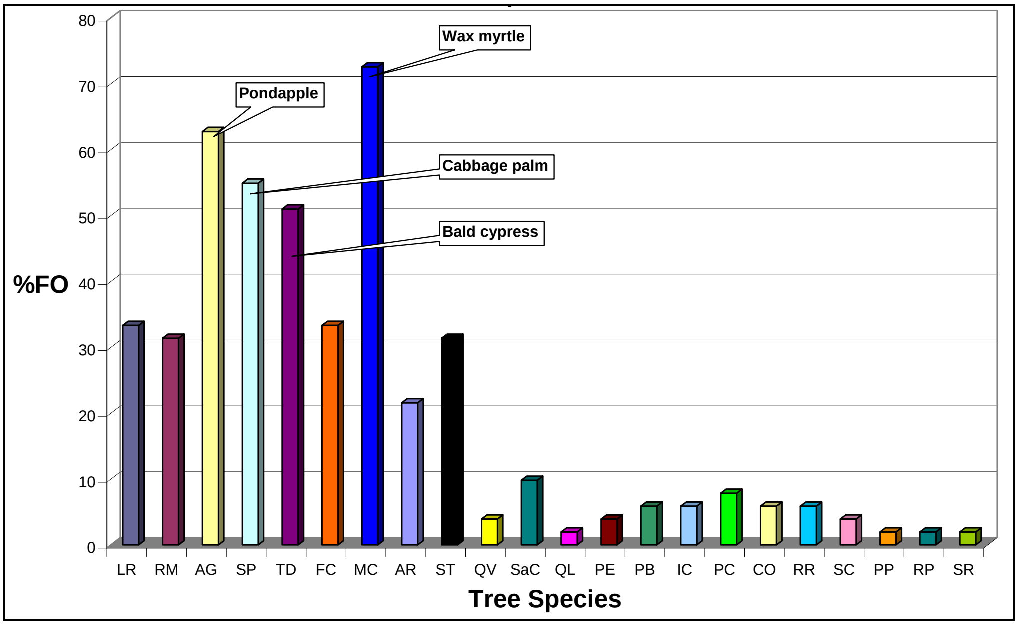


Figure 40. Frequency of occurrence (FO) of canopy species in the upper tidal reach.

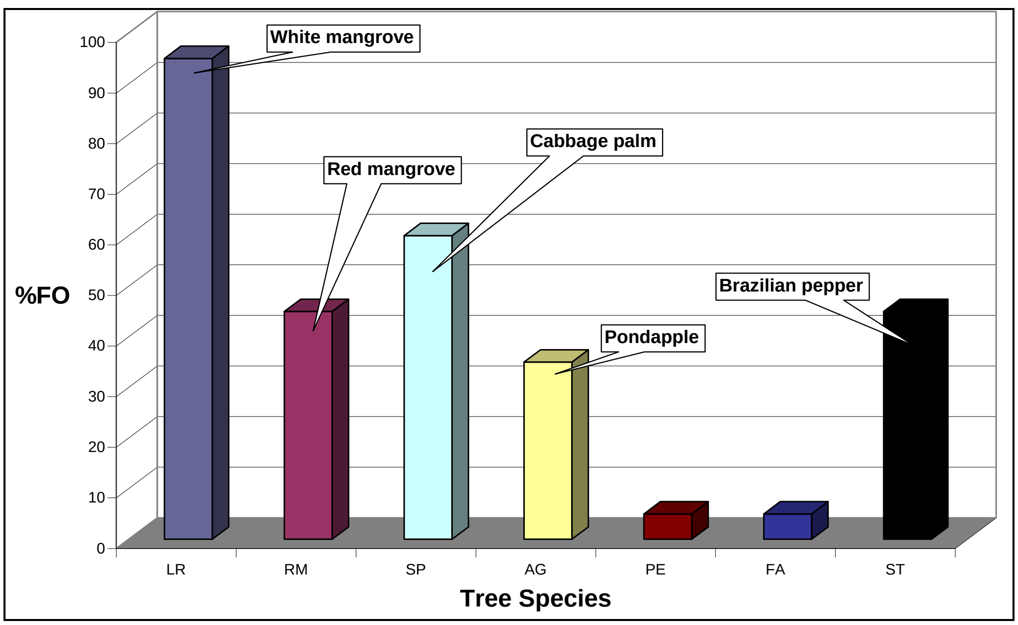


Figure 41. Frequency of occurrence (FO) of canopy species in the lower tidal reach.

The overall importance of the ten top canopy species is illustrated in **Table 7**. Species were ranked by their density, basal area, and frequency of occurrence. The three ranks were summed for a total rank for each species. An importance factor was developed by then re-ranking the total ranks of each species in ascending order. Overall, cabbage palm ranked as the most important species followed by bald cypress, white mangrove, pond apple, pop ash, red mangrove, red maple, wax myrtle, water hickory, and Carolina willow.

Table 7. Overall Summary of importance rankings of the top ten 2003 canopy species.

Rankings					
Species	**Abundance**	**Basal Area**	**Frequency**	**Total Rank**	**Importance**
Red maple	8	6	6	20	7
Pond apple	3	8	3	14	4
Water hickory	10	4	9	23	8.5
Pop ash	6	5	4.5	15.5	6
White mangrove	1	3	5	9	3
Wax myrtle	7	11.5	4.5	23	8.5
Red mangrove	2	10	8	15	6.5
Cabbage palm	4	2	1	7	1
Carolina willow	12	12	15	39	9
Bald cypress	5	1	2	8	2

Table 8, 9, and 10 show the importance rankings in each reach of the river for the ten canopy species in **Table 7**. In the riverine reach (**Table 8**), cabbage palm ranked as the most important species followed by bald cypress, pop ash, water hickory, red maple, laurel oak, live oak, slash pine, pond apple, and strangler fig. Cabbage palms are present and relatively dense in swamp, bottomland hardwood, and hammock communities found in the upstream portions of the floodplain. In the upper tidal reach (**Table 9**), pond apple was the most important species followed by white mangrove, red mangrove, cabbage palm, bald cypress, wax myrtle, pop ash, red maple, Brazilian pepper, and Carolina willow. Pond apple appears to be more tolerant of brackish water than most species that occur in the riverine reach. Of the seven canopy species that occurred in the lower tidal reach (**Table 10**), white mangrove ranked as the most important species followed by cabbage palm, red mangrove, Brazilian pepper, pond apple, slash pine and strangler fig. The high values for white and red mangrove reflect the significance of tidal amplitude, floodplain elevation, and salinity in the lower tidal reach. The exotic, Brazilian pepper is abundant in floodplain areas impacted by saltwater intrusion, brackish water species, and past lumbering activities.

Table 8. Summary of the importance rankings of the ten top canopy species in the riverine reach.

Riverine Reach Rankings					
Species	**Abundance**	**Basal Area***	**Frequency**	**Total Rank**	**Importance**
Red maple	4	5	4	13	4.5
Strangler fig	10	9	9	28	9
Pond apple	8	11	8.5	27.5	8
Water hickory	5	3	5	13	4.5
Pop ash	2	4	3	9	3
Slash pine	9	7	8.5	24.5	7
Cabbage palm	1	2	1	4	1
Laurel oak	6	6	6	18	5
Live oak	7	8	7	22	6
Bald cypress	3	1	2	6	2

*Citrus sp. was ranked 10^{th} with regards to basal area but was higher than 10^{th} in the other two categories.

Table 9. Summary of the importance rankings of the ten top canopy species in the upper tidal reach.

Upper Tidal Reach Rankings					
Species	**Abundance**	**Basal Area***	**Frequency**	**Total Rank**	**Importance**
Red maple	9	8	8	25	8
Pond apple	1	3	3	7	1
Pop ash	7	10	6	23	7
White mangrove	3	4	1	8	2
Red mangrove	2	5	2	9	3
Brazilian pepper	8	11	9	28	9
Cabbage palm	5	2	4	11	4
Carolina willow	10	12	10	32	10
Wax myrtle	4	6	7	17	**6**
Bald cypress	6	1	5	12	**5**

- Slash pine and live oak were ranked as 7th and 8th with regards to basal area but were higher than 10th in the other two categories.

Table 10. Summary of the importance rankings of the canopy species in the lower tidal reach.

Lower Tidal Reach Rankings					
Species	**Abundance**	**Basal Area**	**Frequency**	**Total Rank**	**Importance**
Pond apple	5	6	4	15	**5**
Strangler fig	7	7	5.5	19.5	**7**
White mangrove	1	1	1	3	**1**
Red mangrove	2	3	3.5	8.5	**3**
Slash pine	6	5	5.5	16.5	**6**
Cabbage palm	3	2	2	7	**2**
Brazilian pepper	4	4	3.5	11.5	**4**

Exotic Species

In the publication "Vascular Plants of Jonathan Dickinson State Park" (2006), Roberts et al. noted several exotic tree, shrub, and vine species in wetland plant communities. The most problematic species were Old World climbing fern, punk tree, Brazilian pepper, nephthytes, strawberry guava and java plum. Of the 173 non-native species found in Jonathan Dickinson State Park, Old World climbing fern has become the primary concern for continued management of existing biological communities since it first appeared in the early 1970s in the ecotone between the pinewoods and wetlands in the lower Kitching Creek basin. More recently, it has invaded the floodplains and strand swamps, cypress domes, wet prairies, wet flatwoods, hydric hammocks, depression marshes, ditches, and even scrub habitats. The fern aggressively forms a thick mat over vegetation and eliminates understory native species.

In the 1993-1994 (Ward and Roberts, unpublished), 2003, and 2006 vegetation studies, 37 species of exotic trees, shrubs, and vines were identified in the floodplain of the Loxahatchee River (**Table 11**). All of the species listed were noted with the exception of punk tree. The most prevalent species was Old World climbing fern, which was absent in 1993-1994 Ward and Roberts' Study only on Transects T1 and T2. In the 2003 study, the fern was found on all of transects except T1, T2, T5, and T7. In fact, it was not found on T1 until the 2006 study. Other significant exotic understory plants found more frequent on the transects were Caesar weed, day flower, and downy shield fern, which were primarily found in the riverine reach. With regards to hardwoods per transect, Brazilian pepper, strawberry guava and java plum were the most common exotic canopy species in the floodplain. Brazilian pepper was found on all study sites except T5 while strawberry guava was found on T1 and T2 in the 1993-1994 study and on all tidal sites. Java plum was not as widely distributed and was only found on T5, T6, and T7. In the riverine reach, Brazilian pepper was very low in abundance, basal area, and occurrence; however, in the tidal reaches it was high in occurrence (31 percent in the upper tidal and 45 percent in the lower tidal reach). Both strawberry guava and java plum were less than 1 percent in abundance and basal area, and 7.8 and 3.9 percent, respectively, in occurrence. Disturbances are often associated with an increase in invasive species, but disturbances do not have to be large or a result of human activity to promote infestations of invasive plants (Marler, 2000). Old World climbing fern, Brazilian pepper, nephthytes, strawberry guava, Java plum, wild taro, day flower, Indian swamp weed, and Asian marsh weed have invaded relatively undisturbed sites and ecotones separating wetlands and uplands (Richard Roberts, pers. observ.).

Table 11. Summary of Exotic Species

Exotic Species	Common Name	Transects										
		T-1	T2-1	T2-2	T-3	T-4	T-5	T-6	T-7	T-8	T-9	T-10
Abrus precatorius	Rosary Pea	OY									OY	
Alternanthera philoxeroides	Alligator weed	XOY		X								
Alternanthera sessilis	Sessile joyweed	O					X					
Ardisia elliptica	Shoebutton									Y		
Bischofia javanica	Bishop wood						O					
Citrus sp.		OY										
Colocasia esculenta	Wild taro	OY										
Commelina diffusa	Dayflower	XOY	XO	XOY	XOY	X	XOY					
Cyperus virens	Wood rush flat sedge						Y					
Desmodium incanum	Zarzabacoa	X										
Desmodium triflorum	Beggar weed									O	O	
Eichhornia crassipes	Water hyacinth	XY										
Ficus microcarpa	Indian laurel ficus										O	
Gomphrena serrata	Globe amaranth										OY	
Hygrophila polysperma	Indian swamp weed	Y	Y	Y			OY					
Limnophila sessiliflora	Asian marsh weed	X			XY	XOY	Y					
Ludwigia peruviana	Peruvian primrose willow	XY								Y		
Lygodium microphyllum	Old World climbing fern	Y	XY		XOY	XOY	XY	XOY	Y	OY	O	OY
Momordica charantia	Wild balsum apple						X					
Nephrolepis cordifolia	Tuberous sword fern				Y							
Nephrolepis multiflora	Boston fern			XY		Y						
Panicum maximum	Guinea grass						Y					
Pouzolzia zeylanica	Pouzoulz's bush	Y			XY	Y	Y					
Psidium cattleianum	Strawberry guava	X	X					XOY	Y	OY	OY	OY
Psidium guajava	Guava				X					Y		
Ptychosperma macarthurii	MacArthur's palm										Y	
Salvinia minima	Water spangles	X										
Schinus terebinthifolius	Brazilian pepper	X	X	X	XOY	OY		XOY	OY	OY	OY	OY
Senna pendula	Climbing cassia	OY	O									
Sphagneticola trilobata	Creeping oxeye	OY										
Synogium	Arrowhead vine,	XOY		X								

Exotic Species	Common Name	Transects										
		T-1	T2-1	T2-2	T-3	T-4	T-5	T-6	T-7	T-8	T-9	T-10
podophyllum	Nephthytis											
Syzgium cumini	Java plum						Y	Y	OY			
Syzgium jambos	Rose apple	X										
Thelypteris dentata	Downy shield fern	XOY	XO	Y	X	XO	OY		Y			
Urena lobata	Caesar-weed	XOY	XY	XOY	XOY	XOY	XOY					
Urochloa mutica	Paragrass	X					Y					
Xanthosoma sagittifolium	Wild taro, elephant ear	OY										

X=1993/1994 Ward and Roberts Study; O=2003 Study; Y=2006 Observations

Ordination Analysis of Floodplain Canopy Communities

A step beyond obtaining baseline information on the floodplain vegetation is community ecology analysis or ordination analysis. In community ecology analysis, large datasets can be reduced into categories and the affect of environmental variables investigated. There were 26 canopy, 52 shrub, and 73 groundcover species within the 138 vegetation plots in the Loxahatchee River study. For canopy, there were three characteristics available for examination (abundance (density), basal area and frequency of occurrence), and for shrub and groundcover there were percent cover and stem counts. The environmental variables included river mile, elevation, forest type and soil type. The software package PC ORD (MjM Software Design, 1999; McCune and Grace, 2002) was used to run the ordination analysis. Once the datasets were formatted correctly, they were analyzed using Principal Components Analysis (PCA), Canonical Correspondence Analysis (CCA) and Detrended Correspondence Analysis (DCA) and graphed as dendrograms and/or scatterplots. Some of the major results from this analysis are presented below. Additional runs were done by using the various plots associated with each of the three reaches (riverine, upper tidal, and lower tidal) but are not presented in this document. A manuscript is being prepared that will include the more detailed ordination analysis by reach.

In a PCA run of floodplain canopy frequency of occurrence by species and by plot the following dendrogram was produced (**Figure 42**). There were 136 total plots used in the analysis as one upland plot and one plot that did not have any canopy size trees were deleted from the analysis. The environmental parameters of elevation and river mile and the categorical values for forest type classification were used as a second overlay on the ordination.

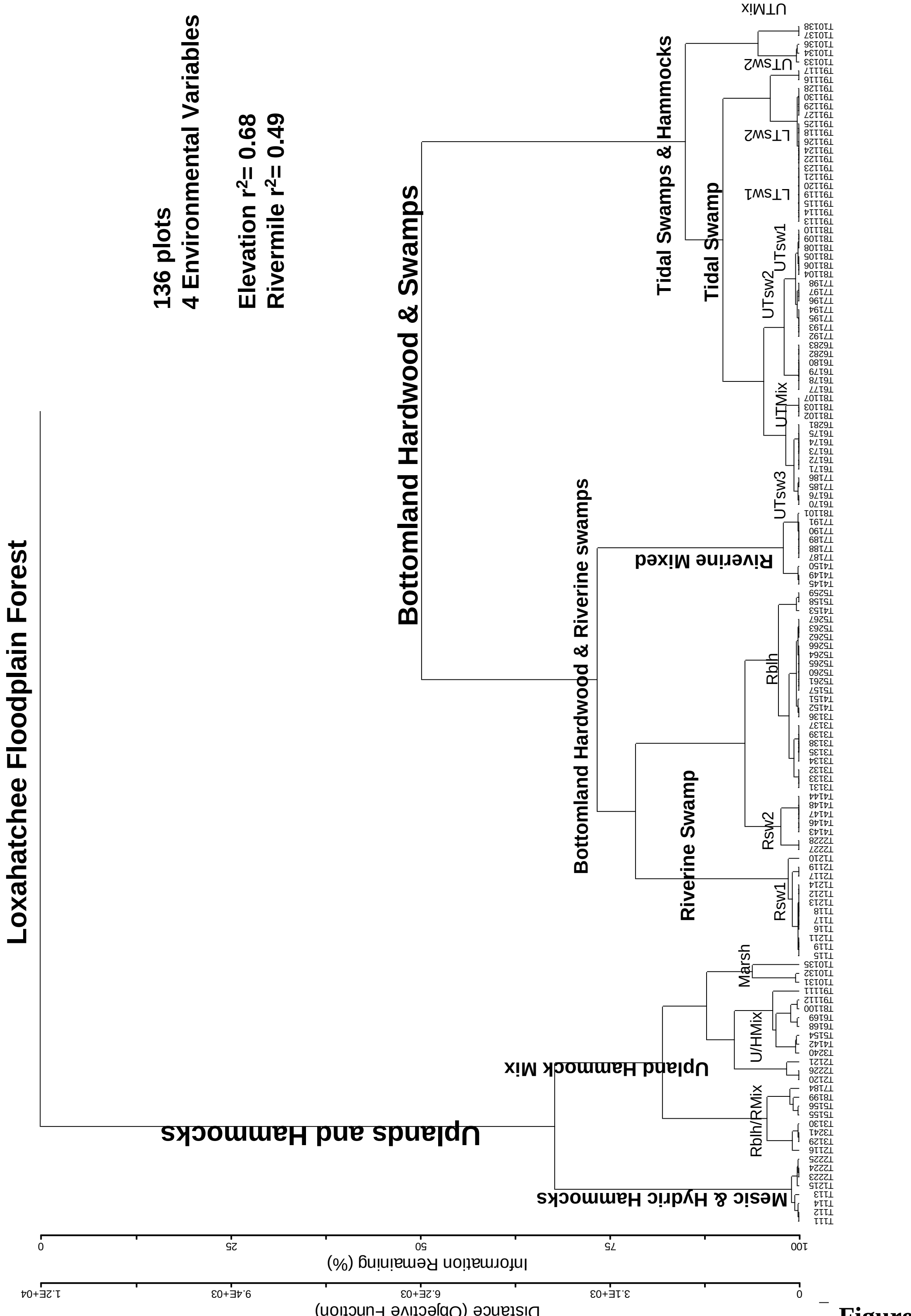


Figure 42. Dendrogram of 136 vegetative plots with RM, elevation, and forest type.

The resulting algorithum identified 2 major canopy groups (upland/hammock, and bottomland hardwood/swamp) and 6 sub-groups consisting of mesic and hydric hammock, upland/hammock mix, riverine swamp, riverine bottomland hardwood and swamp mix, tidal swamp, and tidal hammock mix (**Figure 42**). Pearson's correlation coefficients (r^2) for elevation and river mile were 0.68 and 0.49, respectively. Codes for the forest types were those introduced in the Methods Section (**Tables 4** and **6**).

As Davis (1943) indicated in his vegetation studies of south Florida, mixed groups of forest types (i.e. upland/hammock, hammock/swamp and bottomland hardwood/swamp) were substantial on the floodplain of the Loxahatchee River and are worth further investigation. The first cluster was a combination of mesic and hydric hammocks, mixed hammock/bottomland hardwood, and freshwater marsh. The hammocks were associated with communities of primarily cabbage palm and oaks of Transects 1 and 2. The upland/hammock mix subgroup was associated with plots on Transects 2, 3, 4, 5, 6, 7, 8, 9, and 10. The species within this cluster were primarily slash pine, laurel oak, red maple and cabbage palm. The marsh community, which only occurred on Transect 10 (North Fork of the Loxahatchee River) was dominated by saw grass and was in association with a few very small red maple (6.7 cm dbh), wax myrtle (6.2, 6.0 and 5.3 cm dbh), and pond apple (shrub and seedling size) representing new arrivals into this community. Under the major clustering of bottomland hardwood and riverine swamp, were those species associated with the forest types Rsw1 (bald cypress), Rsw2 (pop ash), and Rblh (water hickory and red maple). The cluster of riverine mixed was primarily from Transect 7 and reflected the presence of hummocks in the tidal reaches with a mixture of bald cypress (swamp species), and cabbage palm and wax myrtle (hammock species). The last sub-group, tidal swamps and hammocks, was dominated on the left hand side by those communities consisting of a mixture of primarily pond apple (UTsw2) and white mangrove (UTsw3) with additional appearances of red maple, cabbage palm, and wax myrtle. The right hand side encompasses the tidal communities associated with the lower tidal reach and its mangrove and mixed hammock communities. Those areas dominated by red and white mangrove were identified as LTsw1 and LTsw2 forest types, respectively. The last sub-group was the outer plots of UTMix on Transect 10 of the North Fork of the Loxahatchee River, which is transitioning from a coastal freshwater marsh/riverine cabbage palm hammock community to a salt water tidal mixed hardwood community of pondapples and white mangroves with hummocks of wax myrtle and dahoon holly. This has probably come about as a result of opening of the inlet, which extended the tidal prism inland, reduced freshwater flow from the Atlantic Ridge area north of Bridge Road and perhaps sea level rise.

Figures 43 and **44** are scatterplots of 136 of the vegetation plots and 26 canopy species and were produced by a CCA run of the canopy frequency data. The triangles in **Figure 43** represent the 135 vegetation plot while the "+" in **Figure 44** represent the 26 canopy species. The two-digit species codes are given in Appendix C. The outliers (myrtle oak, citrus, slash pine and strawberry guava) are identified by their two-digit code and their common names. The distance between the plots in **Figure 43** and the canopy species in **Figure 44** in the ordinations are approximately proportional to the dissimilarity between the forest types of the plots and the canopy species. Eight overlay groups were identified in **Figure 43**, with the largest group identified as the mixed swamp and bottomland hardwoods group that also had overlap with the uplands and hammock group. The North Fork (Transect #10) of the Loxahatchee River was a more coastal system and was clearly different from the more inland transects of the Northwest Fork and Kitching and Cypress Creeks. In **Figure 43**, three groups of species (riverine swamp, tidal swamp, and hammock) were identified as overlays in the scatterplot of canopy frequency. The remaining species were the outliers and species found consistently in the mixed swamp community. The axis statistical summary is presented in **Table 12**. Other observations in **Figure 44** included the close proximity of water hickory (CA) and red maple (AR), which are bottomland hardwood species to the riverine swamp species (TD, bald cypress and FC, popash). Strangler fig (FA) was identified in **Table 4** as an epiphyte on swamp and bottomland hardwood species. In addition, there was a very close relationship between the hammock species myrsine (RP), and Carolina willow (SaC) and java plum (SC), which are low bottomland hardwood species (**Figure 44**). This odd grouping of species would suggest a change has occurred in hydrology. Therefore, the results of the ordination analysis would suggest that particularly in the riverine reach inundation of the floodplain is not adequate in depth and duration to discourage the landscape displacement of the various floodplain communities.

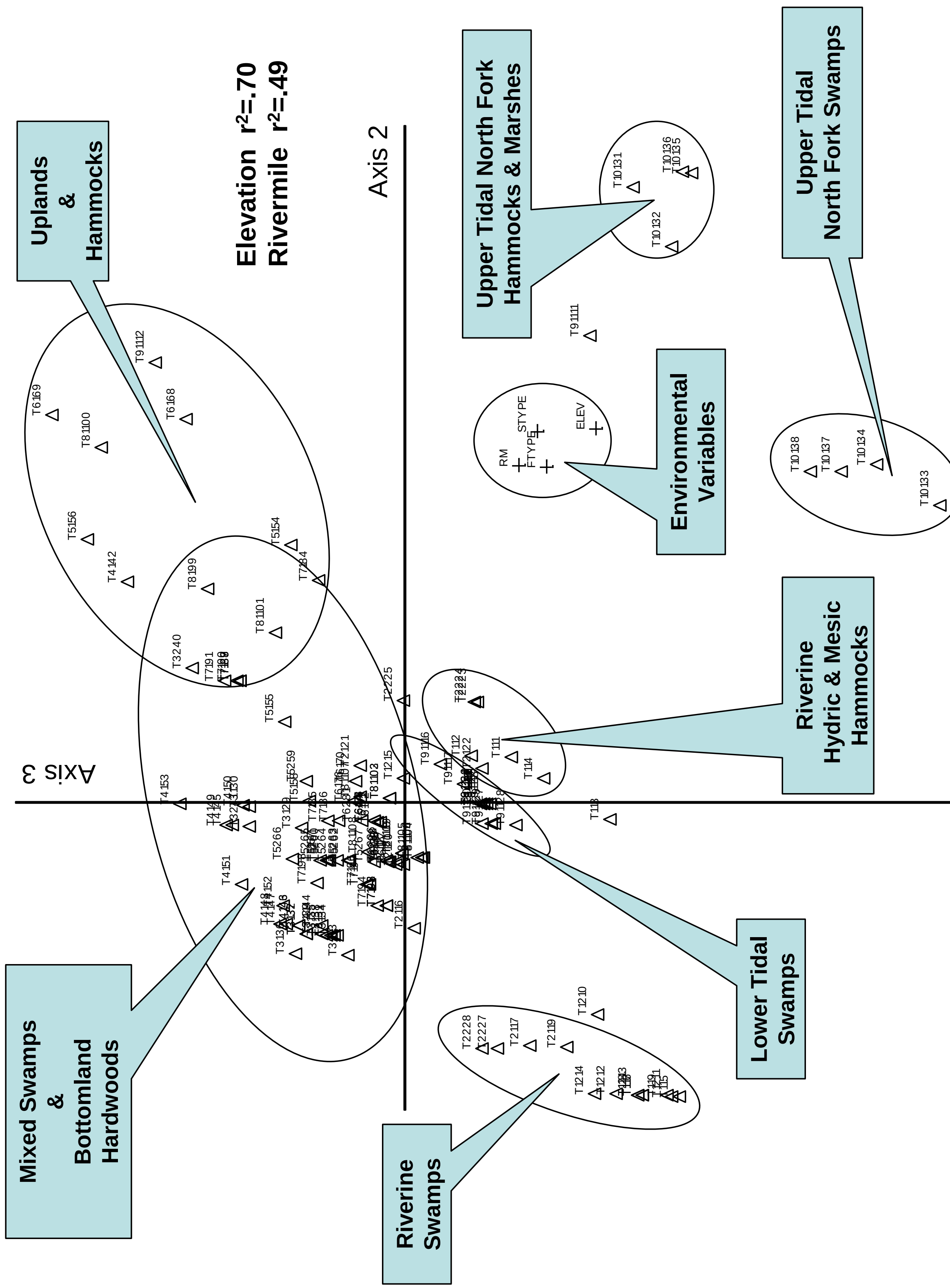


Figure 43. Scatterplot of the 136 vegetative plots (triangles) and four environmental variables.

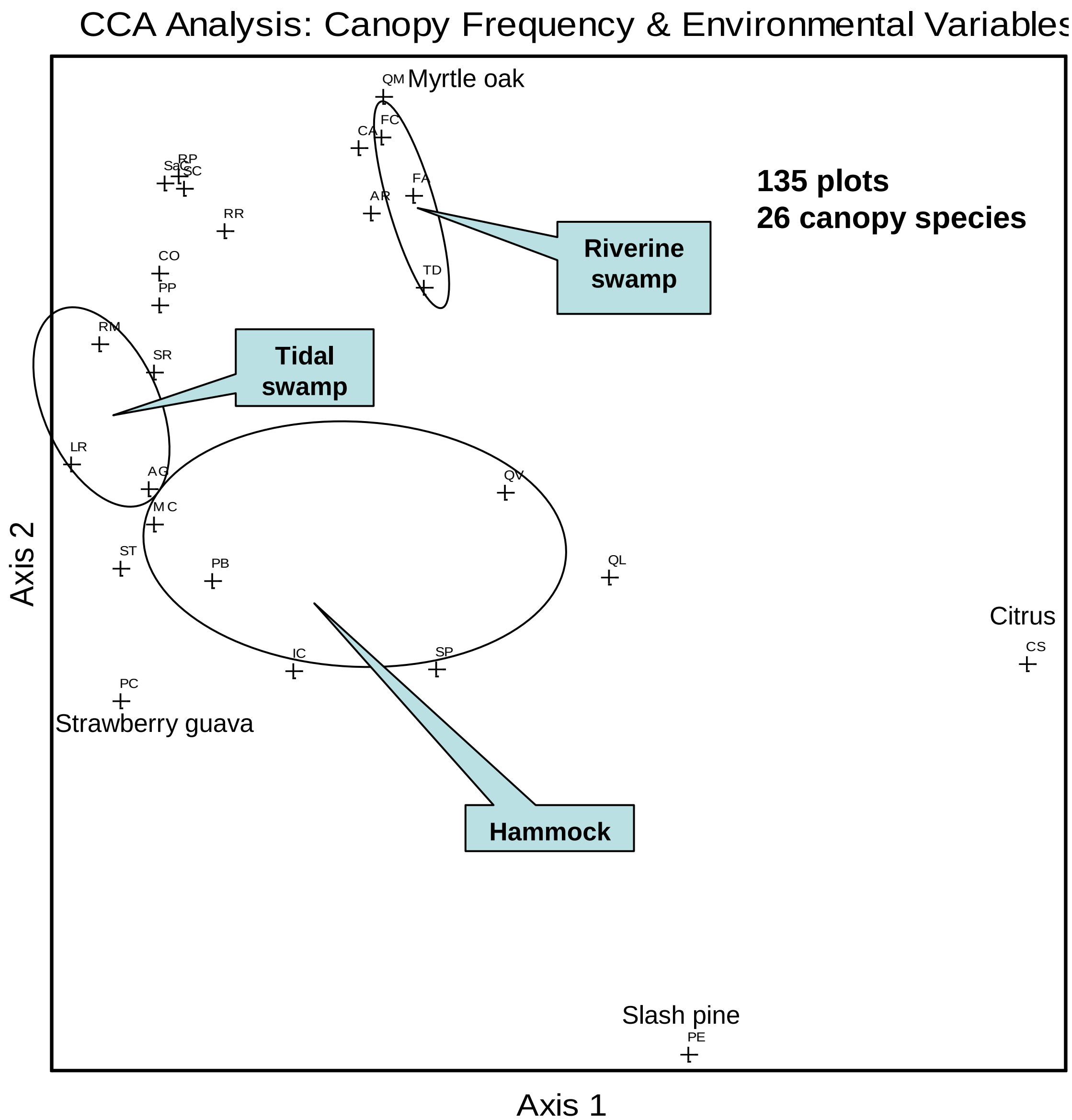


Figure 44. Scatterplot of canopy species (+) with notation of general forest types and outliers. Non-circled species are primarily associated with bottomland hardwood and upland communities.

Table 12. Axis Summary Statistics for the CCA results of Canopy Frequency by Species.

Number of canonical axes: 2				
Total variance ("inertia") in the species data: 7.1130				
		Axis 1	**Axis 2**	**Axis 3**
Eigenvalue		0.393	0.147	0.657
Variance in species data				
	% of variance explained	5.5	2.1	9.2
	Cumulative % explained	5.5	7.6	16.8
Pearson Correlation, Spp-Envt[a]		0.777	0.538	0.000
Kendall (Rank) Correlation, Spp-Envt		0.653	0.480	0.000
[a] Correlation between sample scores for an axis derived from the species				

Final Scores and Raw Data Totals (Weights) for 26 species.					
Species					
Number	**Code**	**Axis 1**	**Axis 2**	**Axis 3**	**Raw Data Totals**
1	AR	0.855704	1.326977	-0.330356	61.0000
2	AG	-0.508221	-0.381695	0.374798	228.0000
3	CA	0.783184	1.729386	-0.032128	33.0000
4	CO	-0.447914	0.957556	0.214771	3.0000
5	CS	4.893340	-1.464360	1.053203	4.0000
6	FA	1.114683	1.436242	0.267805	5.0000
7	FC	0.923283	1.803127	0.761807	141.0000
8	IC	0.380593	-1.507771	0.370450	4.0000
9	LR	-0.986105	-0.223456	-0.226441	388.0000
10	MC	-0.472438	-0.596791	0.092070	117.0000
11	PB	-0.119014	-0.952991	0.274225	6.0000
12	PP	-0.444899	0.755363	0.308691	1.0000
13	PE	2.813082	-3.891098	-2.092741	10.0000

14	PC	-0.684299	-1.697668	0.376040	4.0000
15	QL	2.318058	-0.928238	-0.913106	16.0000
16	QM	0.935877	2.051639	-4.175004	3.0000
17	QV	1.685338	-0.402145	-7.758882	24.0000
18	RM	-0.808668	0.513936	0.047934	250.0000
19	RP	-0.326522	1.554836	0.402835	1.0000
20	RR	-0.042857	1.221486	0.140247	3.0000
21	SP	1.258726	-1.499231	0.171844	218.0000
22	SR	-0.471254	0.338274	1.129388	1.0000
23	SaC	-0.412711	1.509472	0.502311	13.0000
24	SC	-0.295328	1.485640	0.173823	3.0000
25	ST	-0.679186	-0.875258	0.137030	49.0000
26	TD	1.186129	0.862848	0.409064	155.0000

Correlations and Biplot Scores for two Environmental Variables

		Correlations[a]			Biplot Scores		
Variable		Axis 1	Axis 2	Axis 3	Axis 1	Axis 2	Axis 3
1	Elevation	0.817	-0.577	0.000	0.512	-0.221	0.000
2	River Mile	0.805	0.593	0.000	0.505	0.228	0.000

[a] Correlations and “intraset correlations” after Braak (1986). Set to 0.000 if axis is not canonical.

Inter-Set Correlations for two Environmental Variables

		Correlations		
Variable		Axis 1	Axis 2	Axis 3
1	Elevation	0.634	-0.311	0.000
2	River Mile	0.625	0.319	0.000

Set to 0.000 if axis is not canonical.

Transect Summaries

Transects 1, 2, 3, and 4 on the Northwest Fork and Transect 5 on Cypress Creek were in the riverine reach of the floodplain. Transects 6, 7, 8 and 10 were upper tidal and Transect 9 was lower tidal floodplain forest. Abundance (density), basal area, and frequency of occurrence were examined for canopy species on each transect. The forest type of each plot, along with the survey profile of each transect are shown. Survey profiles of transect elevations are expressed as feet NGVD29. DBH size class frequencies for all canopy species are presented to establish changes in species composition (i.e. new recruitment and loss of mature trees) over time and changes in hydrology and salinity. A more detailed discussion of shrub and groundcover layers is given in the next section.

RIVERINE TRANSECTS

Transect 1 with two segments (T1-1 and T1-2) is located just downstream of Lainhart Dam at RM 14.7 (**Figure 17**). This site transverses the north and south sides of the Northwest Fork with (15) $10m^2$ plots. The thick canopy showed no evidence of past logging activities. It was primarily composed of native vegetation with the major exceptions being the exotic wild taro, elephant ear and arrowhead vine present as groundcover within the swamp community. T1 was the only riverine transect without pop ash.

Soils in the hammock area of T1-1 were Riviera fine sand while they were Pineda fine sand on T1-2. Swamps communities were found in Aquents soils on T1-1 and T1-2. The soil of the bottomland hardwood plot adjacent to the river on T1-2 was also Aquents (**Appendix D**).

T1-1 on the south side (**Figure 45**, 9 plots) had several elevation changes from 14.04 ft at the top of the mesic hammock to about 9.34 ft in the deeper swamp areas and 5.44 ft in the river channel. Several plots of upland and hammock areas were on the landward-side of T1-1 before the transect dropped down into a cypress swamp (Rsw1) that bordered the floodplain There is an old agricultural ditch that runs through the hammock area and into the swamp. Ground elevations on either side of the ditch may have been altered by the placement of fill from the original excavation of the ditch. Dewey Worth (unpublished) examined flows from this ditch for several months between February 1984 and December 1985. Other than some occasional low readings of 4 cfs, he measured peak flows of about 17 cfs in mid-September and 31 cfs in mid-December, 1984. Total inundation of the swamp community on T1 occurs when water levels exceed 10.4 ft, which corresponds to a flow of approximately 114 cfs over Lainhart Dam. Top of bank for the river channel was achieved around 90 cfs at T1.

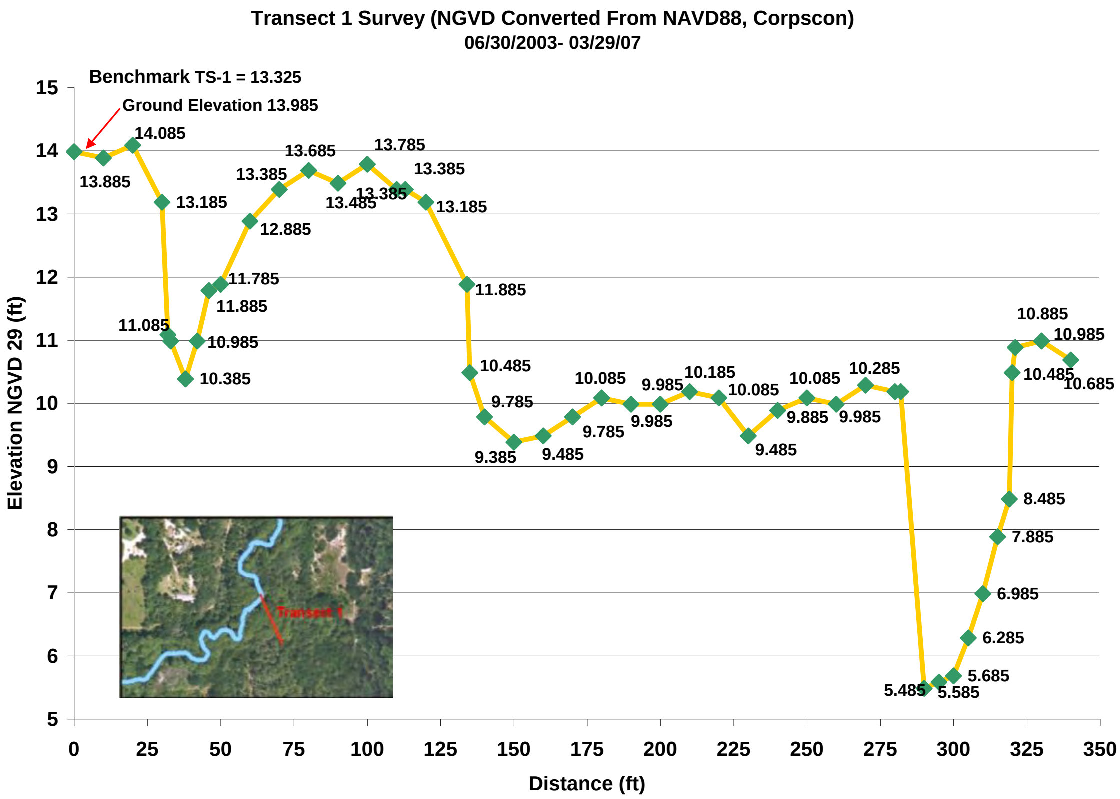


Figure 45. Profile of T1-1 (RM 14.5) with forest types.

T1-2 is located on the north side of the river and includes a side-channel or creek that dead-ends into a low swamp area containing numerous very large bald cypresses and contains 6 plots. The channel itself had been observed dry in this area; however, the dead-end always appeared to have some standing water, which leads one to think that perhaps there is a confining layer of clay or substantial groundwater runoff in this area. T1-2 on the north side of the river is not pictured; however, it transitioned from bottomland hardwood (Rblh1) at the river, to 4 plots of swamp (Rsw1), and to 1 plot of hydric hammock adjacent to the mesic hammock and uplands. The higher area adjacent to the bank of the river on T1-2 was classified as Rblh1 because red maple occurred within the plot and water hickory just outside of the measured plot.

Cabbage palm, live oak, and slash pine dominated the hammock and uplands plots while a stand of mostly very old bald cypress with an average dbh of 49 cm dominated the Rsw1 plots of T1 **(Figure 45)**. Pond apple was only found associated with the river channel banks, so it is shown in **Figure 46** as primarily a tidal swamp species although it occurs in freshwater. Canopy composition and tree size are illustrated in **Figures 46 and 47** showing the abundance (density) of canopy species by dbh size frequencies. Bald cypress was found in five of the six dbh size classes although they primarily ranged between the size classes of 21 to 80 cm dbh. The smallest bald cypress had a dbh of 9.9 cm while the largest was 80.4 cm. The presence of five dbh size frequencies for bald cypress is an indication of multiple year classes in a canopy dominated by trees estimated between 300-500 years old. On the other hand, only two bald cypress trees were present in the 5-20 cm dbh size class, which is an indication of fewer successful recruits in recent years. Cabbage palms were predominately in the 21-40 cm range while red maples were all very young trees in the 5-20 cm range.

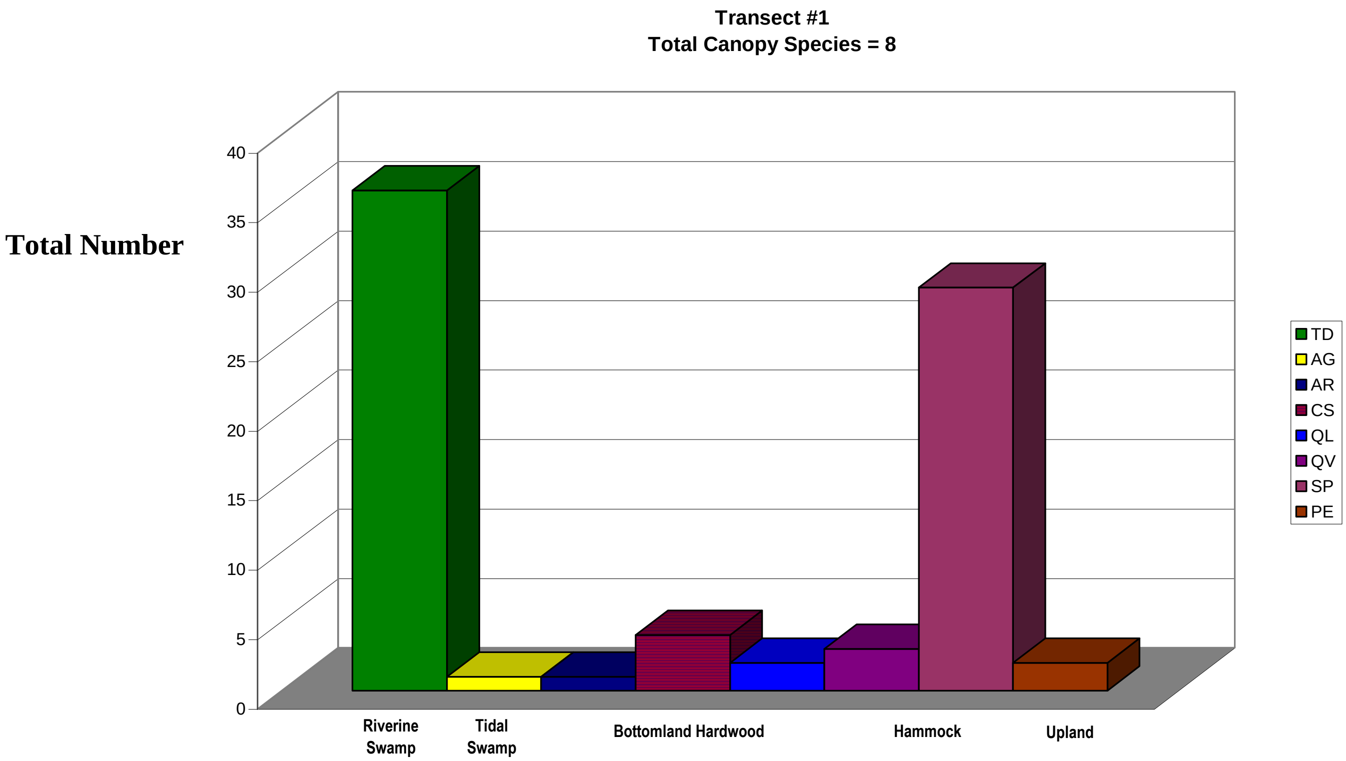


Figure 46. Canopy species abundance (density) at T1.

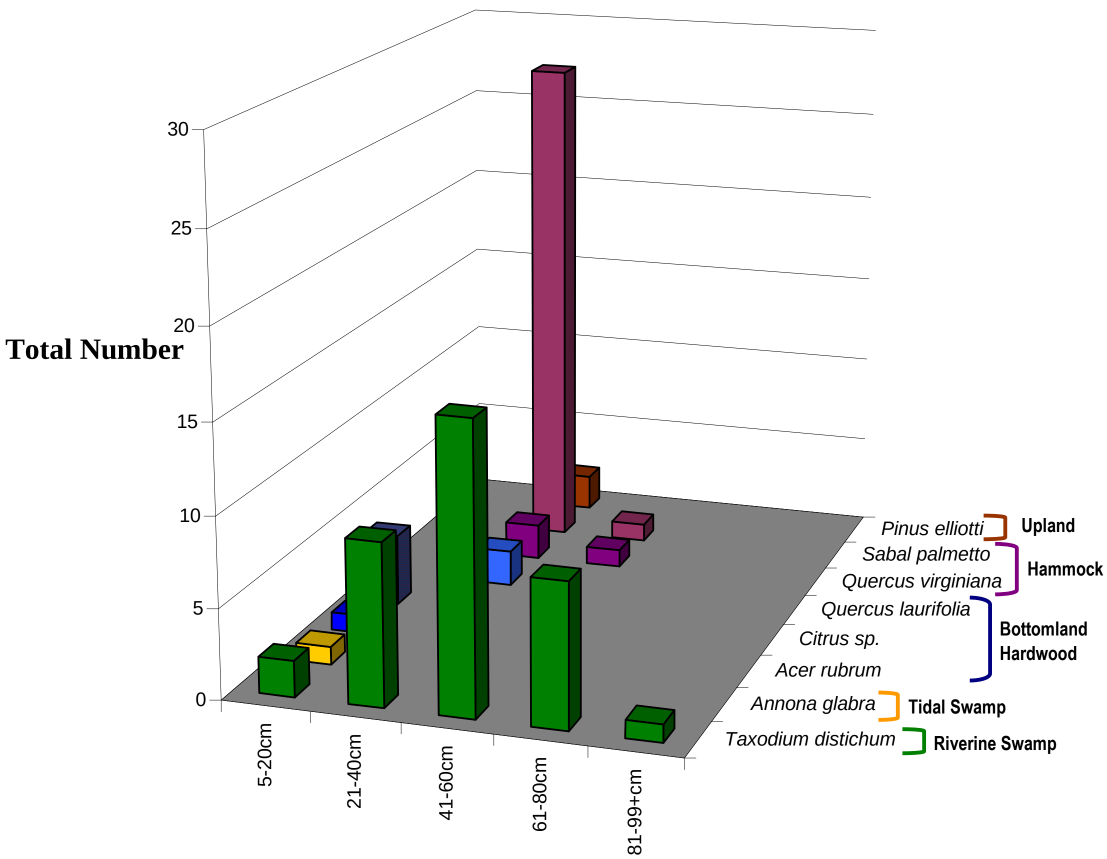


Figure 47. DBH size classes at T1.

Tree heights of cabbage palm, bald cypress, red maple and laurel oak were randomly measured on both T1-1 and T1-2 sites. One cabbage palm was measured at 14.1 meters. Seventeen bald cypress on T1-1 averaged 20.8 m in height while 20 on T1-2 averaged 21.8 m. One young red maple on T1-1 was measured at 8.23 m while one laurel oak on T1-2 measured 18.8m.

Because the canopy is so well established on T1 and because of periodic high flow velocities, there is very little indication of a subcanopy (the 5-20 cm size frequency group) present at this transects (**Figure 47**). Shrubs and groundcover in the Rsw1 areas were dominated by swamp lily, tri-veined fern, and downy shield fern. Groundcover densities were directly related to hydroperiod in the swamp communities. It was noted shortly after the 2004 Hurricanes Frances and Jeanne that the extended periods of flooding reduced ground cover to only a few species while the extended dry season of 2006 saw a tremendous expansion in groundcover density and species richness. Increased light availability resulting from hurricane impacts (branch loss, broken trunks, etc.) also contributed to the expansion of ground cover.

Transect 2-1 (7 plots) is located at RM 13.6 just upstream of the western side of Masten Dam while, T2-2 (6 plots) is located downstream of Masten Dam on the same side of the river (**Figure 17**). On T2-1, there are several elevation changes between bottom land hardwood (7.85 ft), split plots of hammock (7.4 and 7.53 ft) and swamp (7.65 and 8.27 ft), a braided channel (6.32 ft), swamp area (7.53), and hammock areas adjacent to the river with elevations of 7.92 and 9.95 ft (**Figure 48**). Water flows continuously through the braided channel, which is connected to the river above and below Masten Dam. On T2-2, ground elevations in the hammock ranged from 11.4 to 10.2 ft while elevations in the swamp ranged from 6.4 to 6.6 ft (**Figure 49**).

Soils in the hammock and swamp areas of T2-1 were Chobee/Sapric muck while the bottomland hardwood area was Wabasso fine sand. The three plots of mesic hammock on T2-2 were Pineda fine sand while the swamp community was Gator/Sapric muck (**Appendix D**).

Figure 50 illustrates the combined distribution of canopy species on T2-1 and T2-2. Transect 2 had more hammock forest types (7 out of the 13 plots) than any other transect. Two and a half of the six plots on Transect 2-2 were mesic hammock that consisted of 100 percent cabbage palm. The Rsw1 and the Rmix plots were more diverse with younger pop ash, red maple and water hickory intermixed with the cypress.

Figure 51 illustrates the dbh size classes for the canopy species at Transect 2. Cabbage palms were primarily in the 21-40 cm range. Bald cypress were found in the four larger size classes (21-99+ cm) while none occurred in the 5-20 cm range. A few red maples were found in the three smaller size classes (5-60 cm). Tree heights of laurel oak and bald cypress were measured on T1-2 while in addition to these pond apple; water hickory and cabbage palm were measured on T2-2. One laurel oak on T2-1 measured 18.8 m in height while another on T2-2 measured 10.6m. Twenty-one cabbage palms on T2-1 averaged 9.93 m. twenty bald cypress on T2-1 averaged 21.83 m while 7 on T2-2 averaged 21.17 m. Three water hickories on T2-2 averaged 23.63 m.

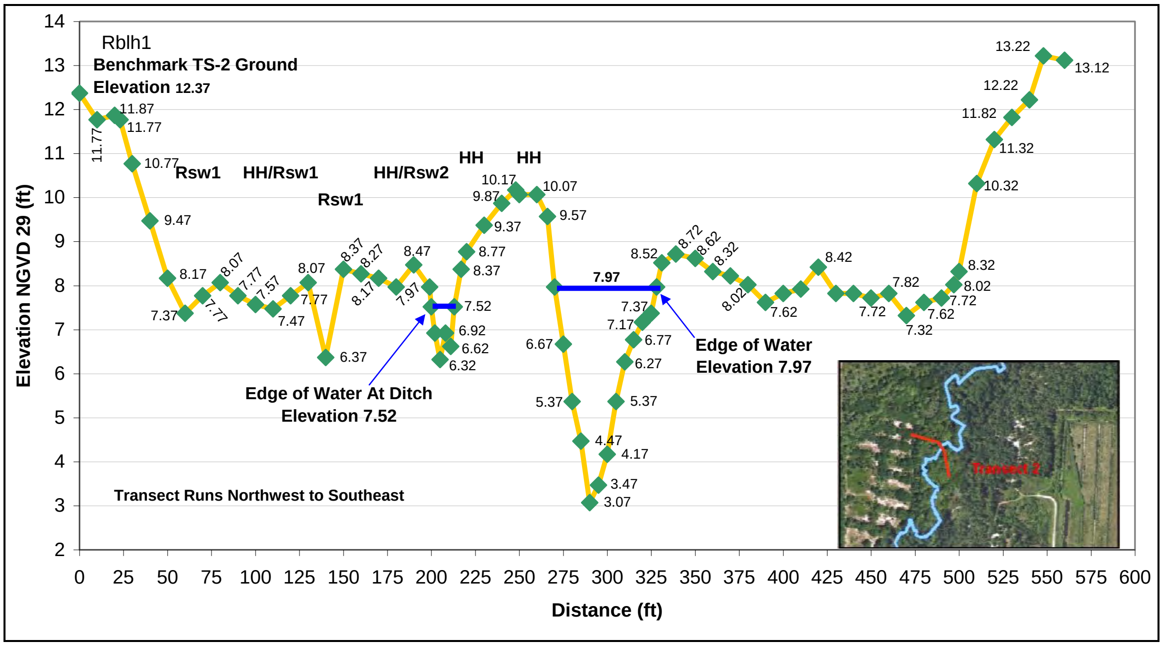


Figure 48. Profile of the floodplain at T2-1(RM13.57) (surveyed in 1983).

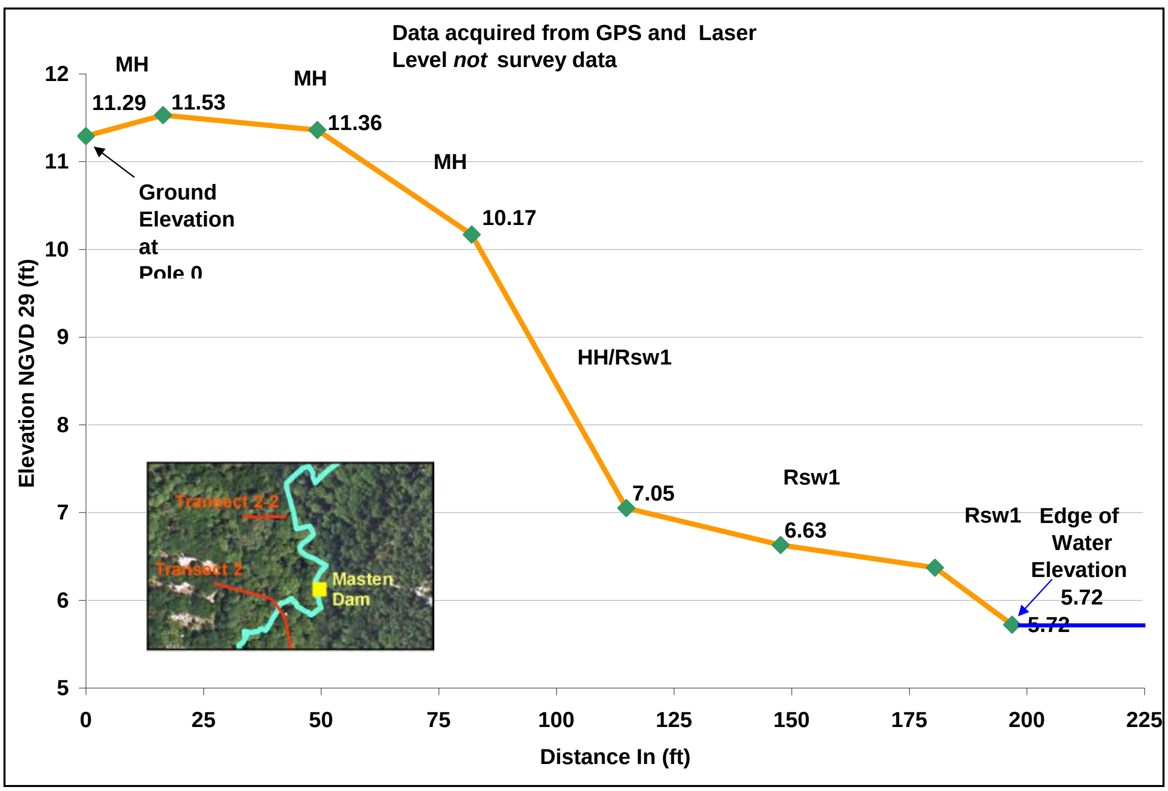


Figure 49. Profile of Transect 2-2.

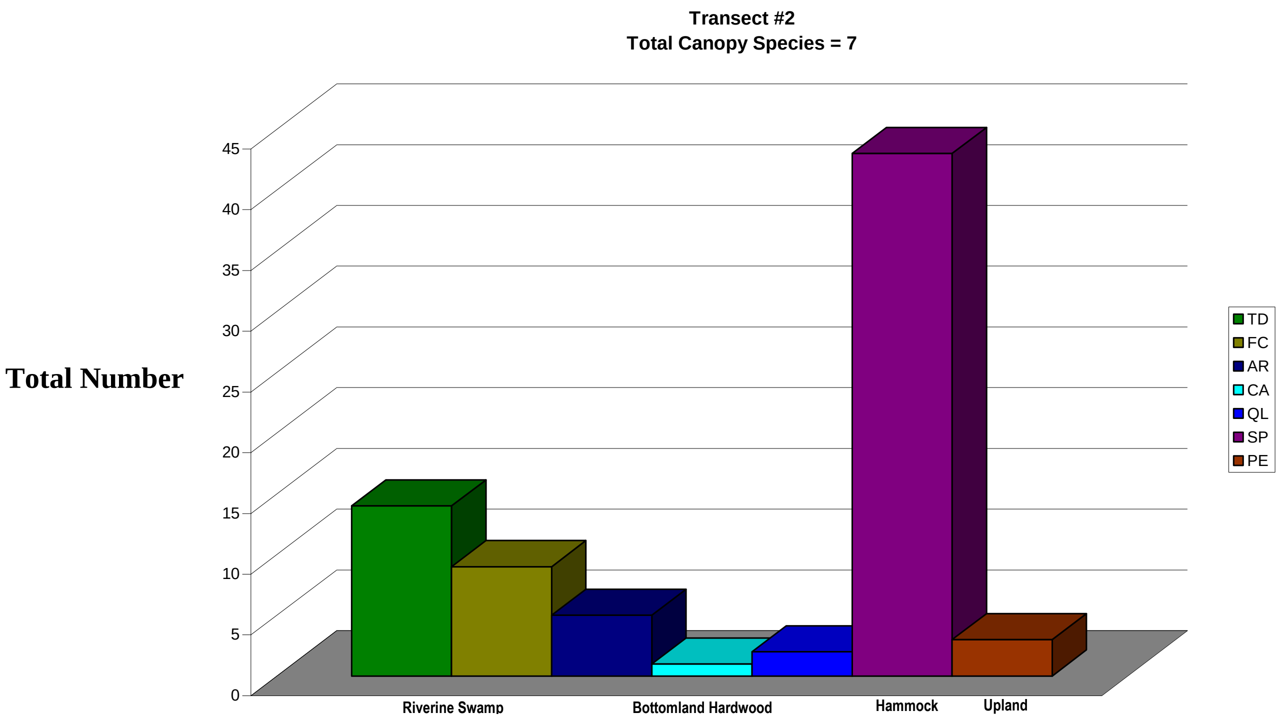


Figure 50. Canopy abundance (density) at Transect 2.

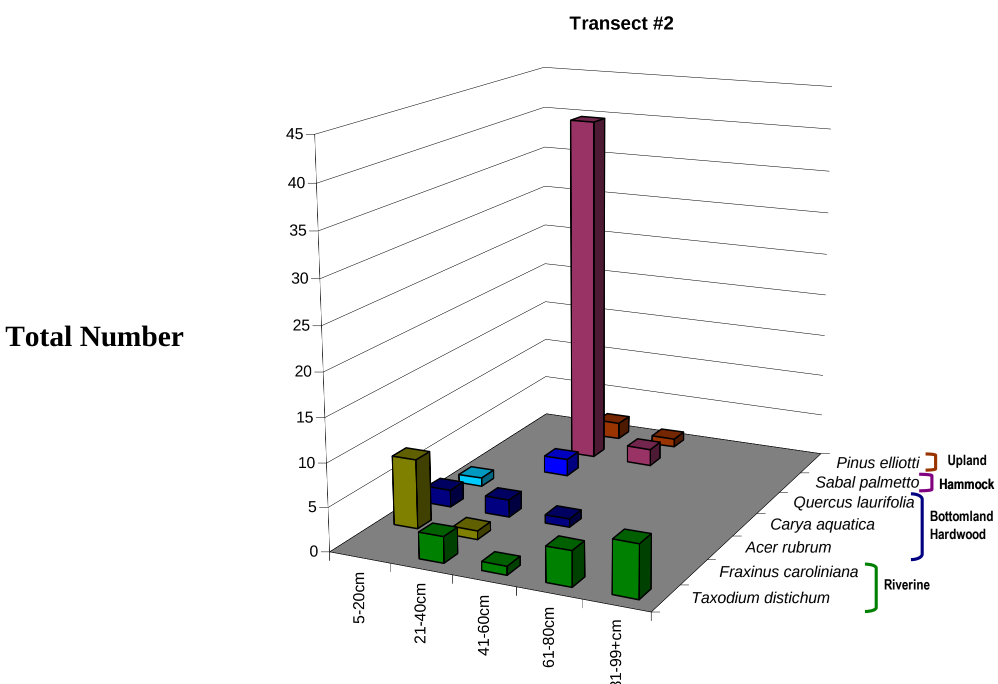


Figure 51. DBH size classes at T2.

Shrubs and groundcover were primarily tri-veined fern, Meniscium fern, leather fern, swamp fern, Virginia willow, downy shield fern, royal fern, lizard's tail, and swamp lily. Tri-veined fern, day flower and wild coffee (a hammock or upland species) were prevalent in the Rblh1 plot.

Transect 3 is located at RM 12.1 downstream of I-95 and the Florida Turnpike on the east side of the river just south of Governor's Dock and contains 13 plots (**Figures 17 and 52**). In the past, this site has been impacted by selective logging and by the presence of Old World climbing fern. There are multiple-braided channels within the floodplain at this site. The first and second braided channels originate in the uplands and join with freshwater flow from the river channel while the braided channel closest to the river receives flow from another braided channel to the north (See: the figures in Appendix J Floodplain Foundation Analysis of T3). The first braided channel flows north and ends adjacent to Governor's Dock (**Figure 52**). Elevations ranged from 5.54 ft at the benchmark to 2.03 ft at the bottom of the braided streams, and -9.87 ft in the river channel bed. The majority of the floodplain had an elevation of approximately 4 ft in this area. Nine of the 13 plots were either Rsw1 or Rsw2. The profiles of the 2 plots of T3-2 are not shown; however, they were Upland/Hydric hammock and Rblh2 with average ground elevations of 5.35 and 4.53 ft. **Appendix J** presents a three dimensional floodplain inundation analysis of Transect 3 using ArcGIS. Inundation is depicted at flows of 65, 90, 110 and 200 cfs.

There were two soil types on T-3. Soil types in the hammock and bottomland hardwood areas were represented by Nettles sand while swamp areas were represented by Aquents (**Appendix D).**

Bottomland hardwood and hammock were present near the uplands and adjacent to the floodplain. Transect 3 had the highest concentration of pop ash of any of the ten transects (**Figure 53**). Their average dbh was 17 cm; however, the range was 5-41 cm. Only four bald cypress are within the transect canopy but they are very large with an average dbh of 91.5 cm. Pond apple and red maple are also present with average dbhs of 7.1 cm and 14.4 cm, respectively.

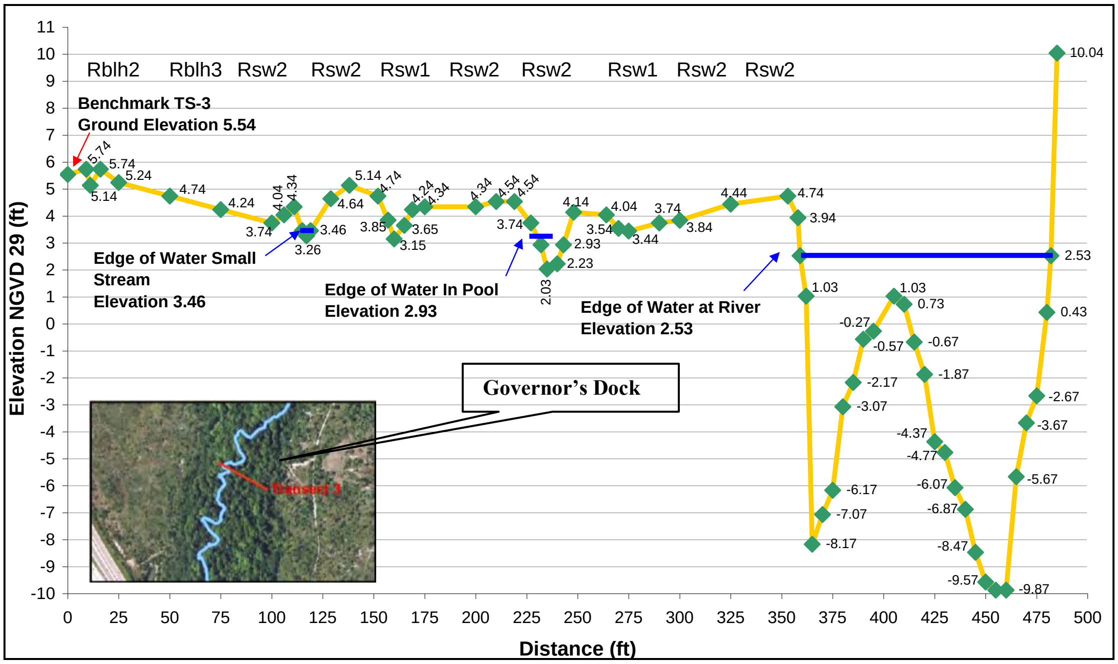


Figure 52. Profile of T3 (RM13.43).

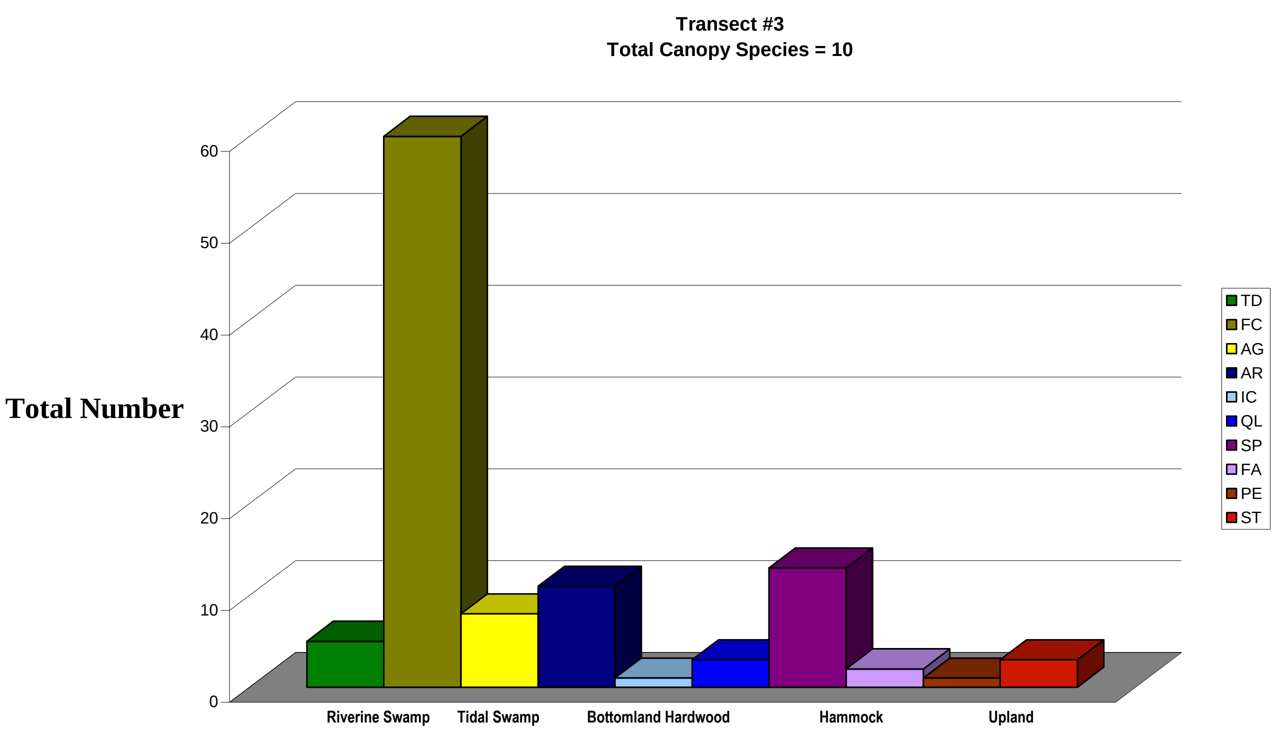


Figure 53. Canopy abundance (density) at Transect 3.

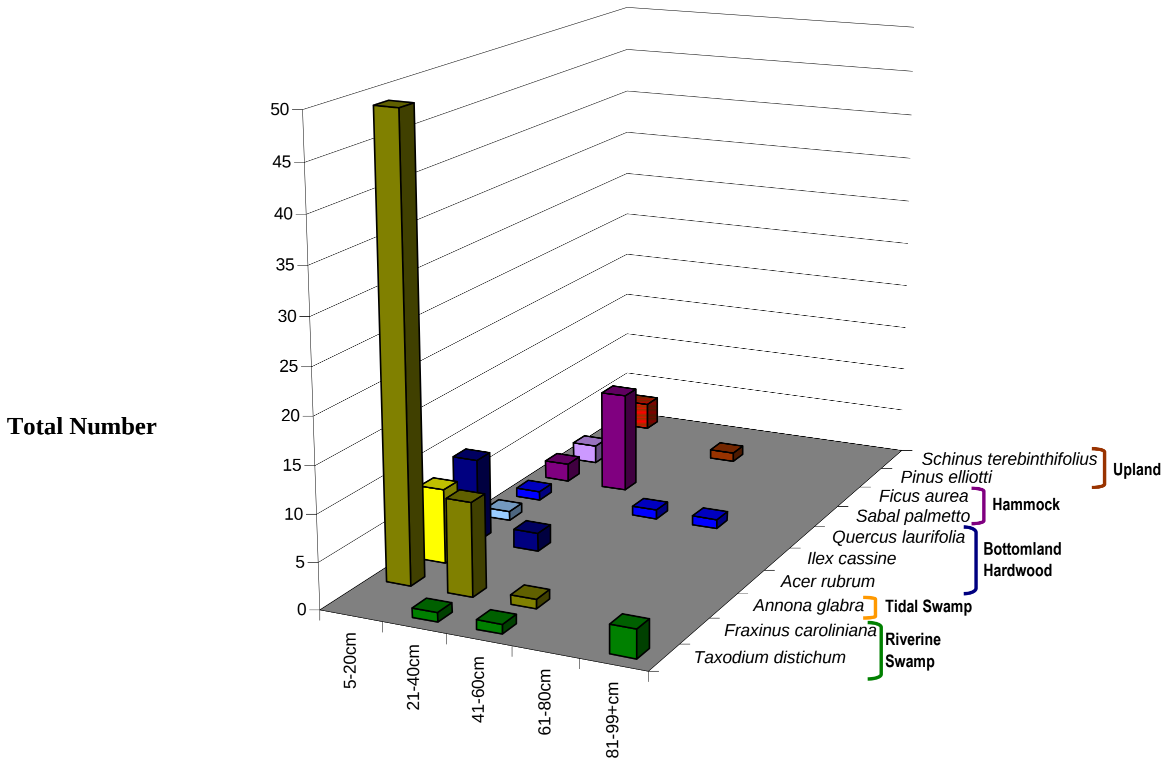


Figure 54. DBH size classes for species at Transect 3.

Pop ash was present in the first three dbh size classes (5-60 cm); however, the majority of pop ash was from the 5-20 cm class (**Figure 54**). Bald cypress was present in three size classes (21-40 cm, 41-60 cm, and 81-99+ cm). There were none present in the 61-80 cm class. Again, we are probably observing the effects of selective lumbering and the opportunistic nature of pop ash. The largely upland exotic, Brazilian pepper was present only in the 5-20 cm class, which reflects a newer species entry into the floodplain communities.

Tree heights were measured on 5 canopy species at Transect 3. Four pond apple averaged 8.53 m, 35 pop ash averaged 11.05 m and 5 bald cypress averaged 21.64 m in the swamp community. Cabbage palm (5) and one oak were 9.45 m and 38.05 m, respectively.

Shrubs and groundcover on Transect 3 were primarily leather fern, maiden fern, Meniscium fern, and lizard's tail in the swamp while tri-veined fern and swamp fern were the most dominant in the bottomland hardwood plots.

Transect 4 is located at RM 11.18 on the west side of the river approximately 1 mile upstream of Trapper Nelson Interpretive Site and contains 12 vegetation plots (**Figure 17**). This transect is just downstream from an old logging road that crossed the floodplains and river. The site was probably selectively logged in the past and the road was used to remove the trees. There are several elevation changes between the upland edge of the floodplain and the channel on these 12 plots (**Figure 55**). The benchmark for this site is very near a large dead pine tree, which is on the slope at about 5.62 ft. From the hammock the transect drops down into several Rsw1 plots intermixed with plots of Rlbh2 and Rlbh3. Elevations of the Rlbh2 and Rlbh3 plots were approximately 2.51 to 3.91 ft. Bottom elevations of the swamp plots were approximately 2.17 ft while the bed of the river channel was -2.45 ft.

There were three soil types present on T4. Soil types for Transect 4 were identified as Smyrna fine sand in the mesic hammock and Histic Haplaquoll and Aquents in the swamp and bottomland hardwood communities (**Appendix D**).

The 12 plots were a mixture of mesic hammock (a very narrow band adjacent to the uplands), and bottomland hardwood and swamp communities in accordance with elevation (**Figures 55 and 56**). This transect had some of the largest water hickory observed in the watershed **(Figure 57)**. The average dbh of water hickory on the transect was 36.1 cm and with the largest at 88.6 cm. Some of these large hickory trees exhibit the allelopathic nature of this species as little groundcover or shrubs are present beneath their canopy. Bald cypresses varied considerably in size and age across Transect 4 and were present in all five dbh size classes (**Figure 57**). The average dbh was 30.0 cm; but, they ranged in size from 5.7 to 83.6 cm dbh indicating that several generations were present. They were most abundant in the 5-20 cm class. Pop ash and red maples averaged 12.2 and 11.0 cm dbh, respectively. No tree heights were measured on this transect.

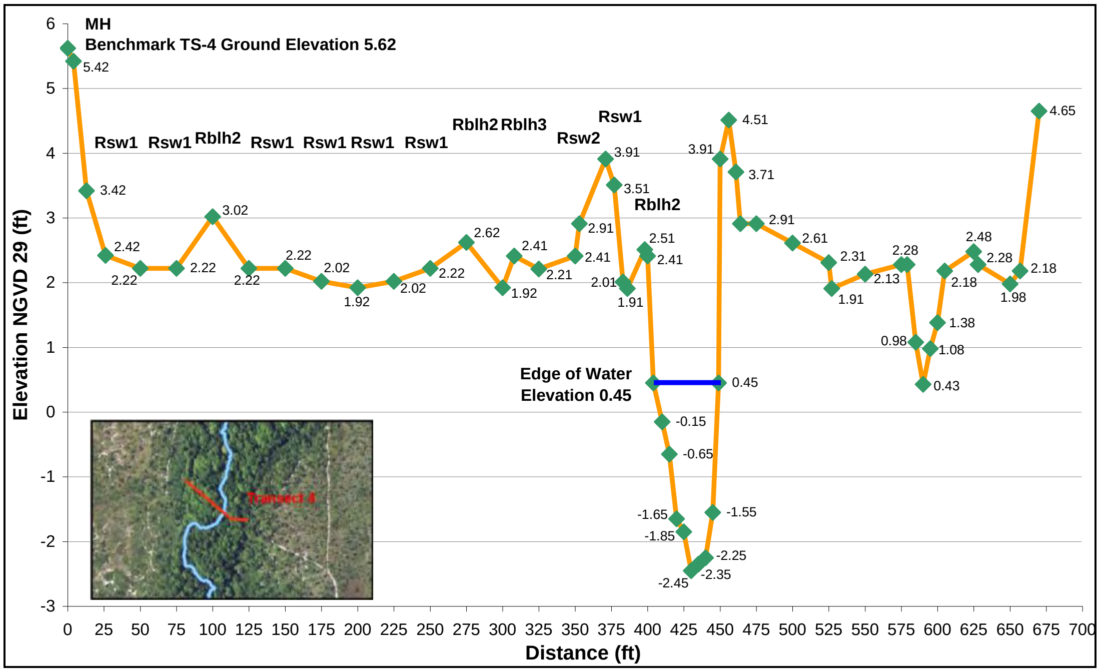


Figure 55. Profile Transect 4 (RM11.8) and the remaining floodplain.

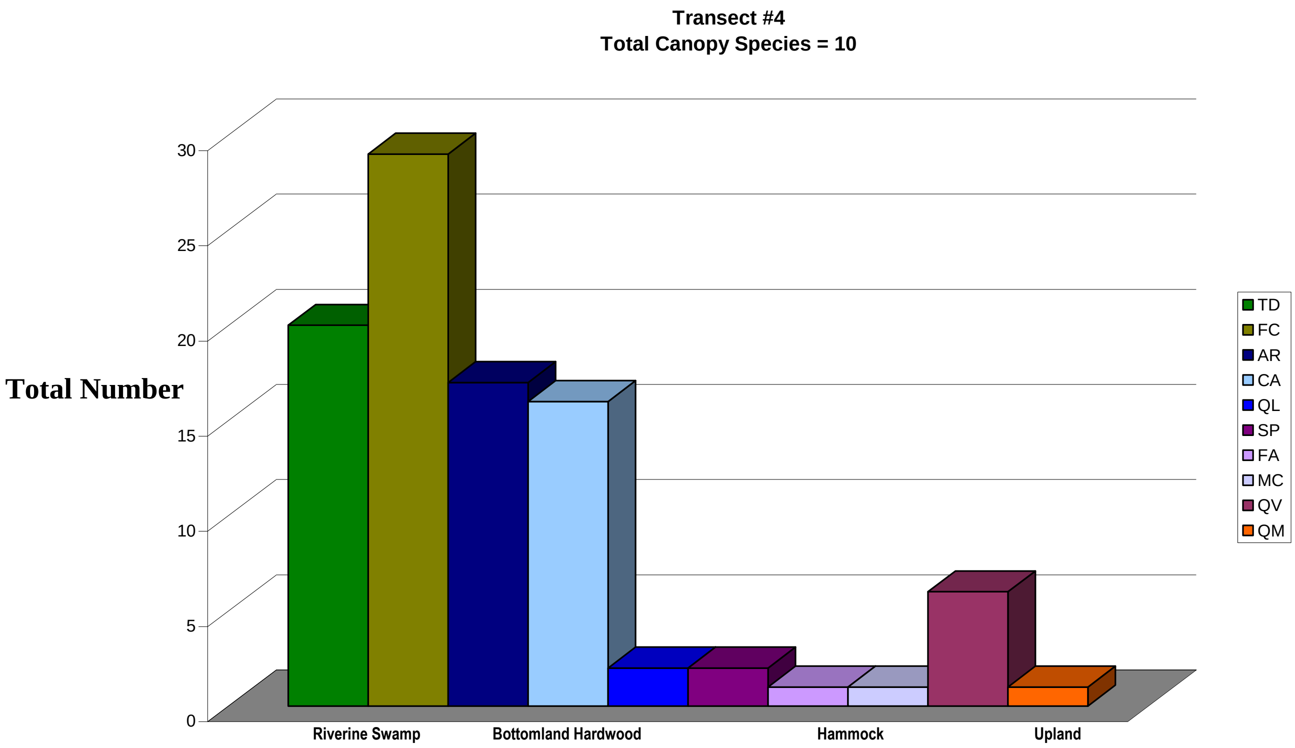
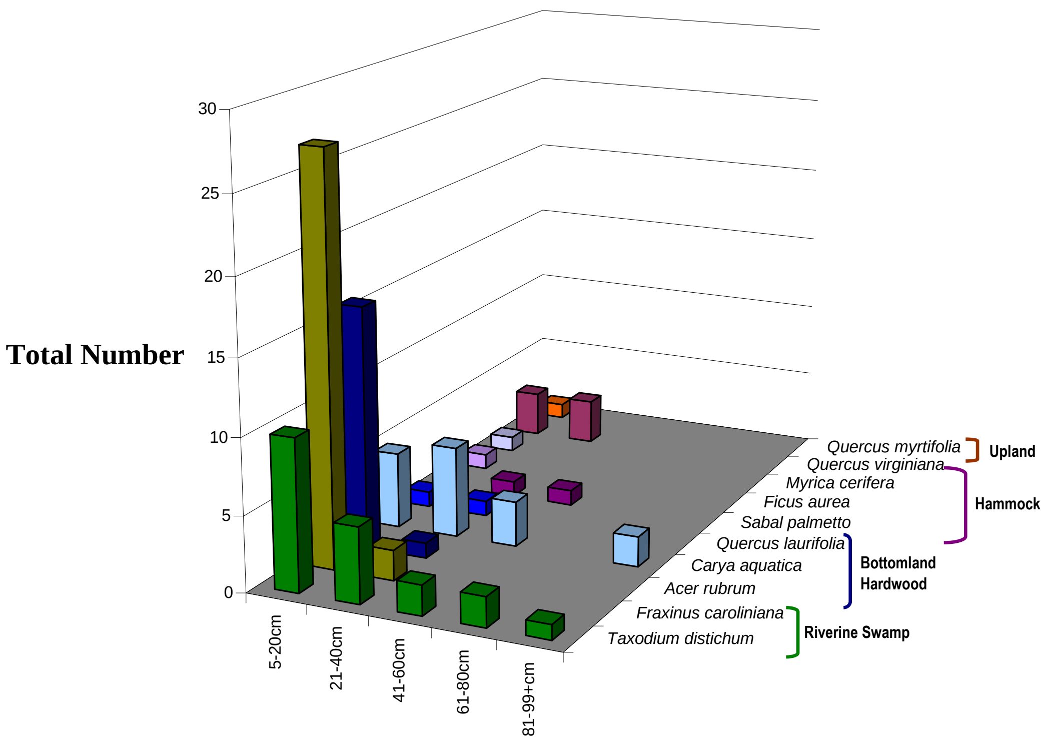


Figure 56. Canopy species abundance (density) at Transect 4.

Figure 57. DBH size classes for species at Transect 4.



Shrubs and groundcover on Transect 4 were primarily leather fern, maiden fern, downy shield fern, Virginia willow, swamp fern, royal fern, lizard's tail, swamp lily, and pond apple.

Transect 5 is located on lower Cypress Creek (**Figure 17**) just east of Interstate 95 and the Florida Turnpike and contains 14 plots. **Figure 58** illustrates the remaining historic flowway (blue line) and the impacted flowway, which no longer exist (dashed green). This creek enters the Northwest Fork of the Loxahatchee River at RM 10.33 just downstream from the Trapper Nelson Interpretative Site in Jonathan Dickinson State Park. The majority of the land is owned by state and local governments. The Cypress Creek basin is located in Martin and Palm Beach Counties. This pine flatwood/wetland mosaic habitat supports many species of wildlife including wood stork, deer, sandhill crane, and snail kite. It is also potential habitat for red-cockaded woodpecker.

The Cypress Creek basin contains hardwood hammocks, pinelands, xeric oak scrub, marshes, cypress swamps, wet prairies and open water. Ranch Colony Canal runs west to east and drains into the northern branch of Cypress Creek (**Figures 58**). There is an old water structure located on the canal just east of a USGS Gage Station and Gulfstream Road. The water control structure was further damaged by the hurricanes of 2004 (see**: Appendix E**). A manmade drainage ditch, designated Hell's Canal, was excavated to provide runoff for agricultural lands just east of I-95 and Florida Turnpike (**Figure 59**). It was directly connected to the Northwest Fork of the river, resulting in negative impacts to the natural hydrology, runoff retention and groundwater recharge. In 2006 to negate this impact, the canal was filled in and the water flows rerouted to the southern arm of Cypress Creek. The rerouting of the canal to Cypress Creek will help to restore the hydrology of a dewatered portion of this natural creek, reducing peak flows to the river and improving water quality.

Figure 59 illustrates the historic and impacted pathway of surface water flow for two branches of Cypress Creek. Portions of the lower branch were filled in with the advent of agricultural row crops which has broken the connection to upstream wetland areas. The area south of Ranch Colony Canal and north of Indiantown Road and adjacent to Gulfstream Road is owned by Palm Beach County and is known as the Cypress Creek Natural Area. The Pine Glades Natural Area and the John C. and Marianna Jones/Hungryland Wildlife and Environmental Area are located between Beeline Highway and South Indian Trail Water Control District. Also, **Figure 59** provides a more detail view of the floodplain wetland systems (stream swamp, mixed hardwood, and cypress strands) associated the current surface water flow pattern on Cypress Creek. Other land covers include pine flatwood and wet prairies that with the marsh system forms a linkage between the Dupuis Preserve, Corbett Water Management Area and Jonathan Dickinson State Park.

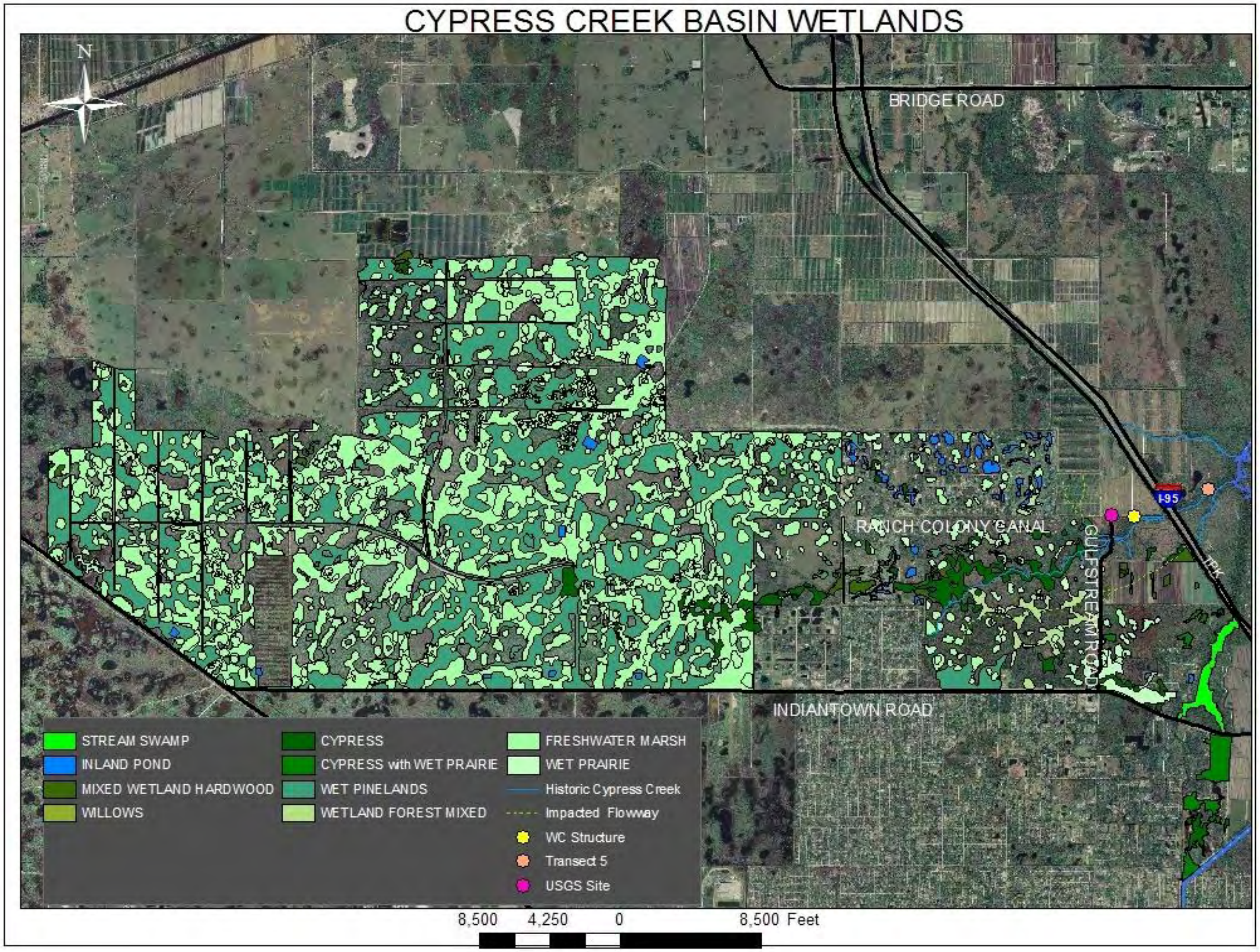


Figure 58. Cypress Creek wetland systems and neighboring drainage basins.

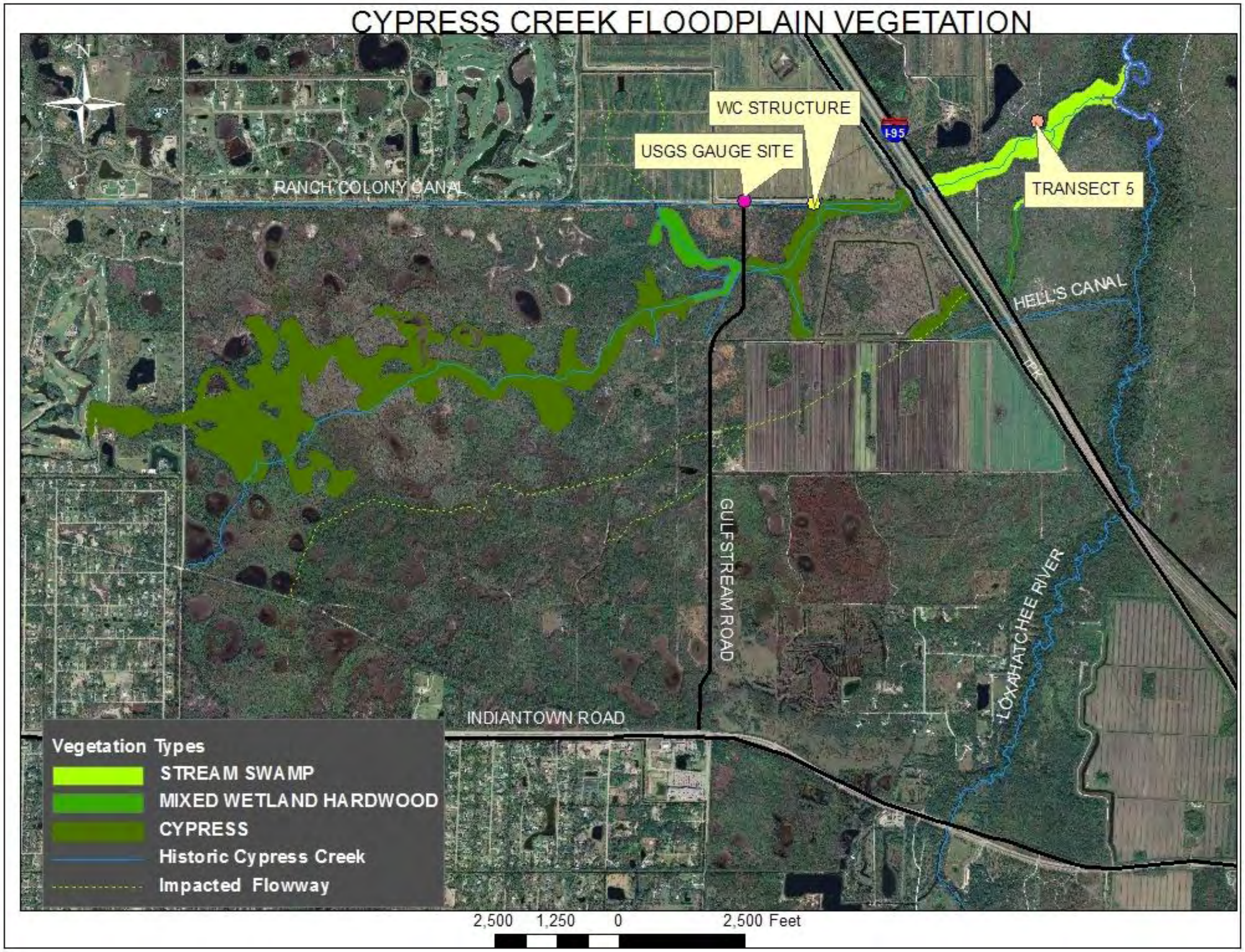


Figure 59. Map of the vegetation in the eastern portion of Cypress Creek Basin.

The Loxahatchee River Watershed Action Plan (FDEP, 2002) addressed the need to protect the headwaters of Cypress Creek and return to a more sustainable natural water flow. Currently during periods of heavy rain, runoff from development causes canal bank scouring and carries suspended solids into the creek and into the Northwest Fork of the Loxahatchee River resulting in siltation and shoaling downstream.

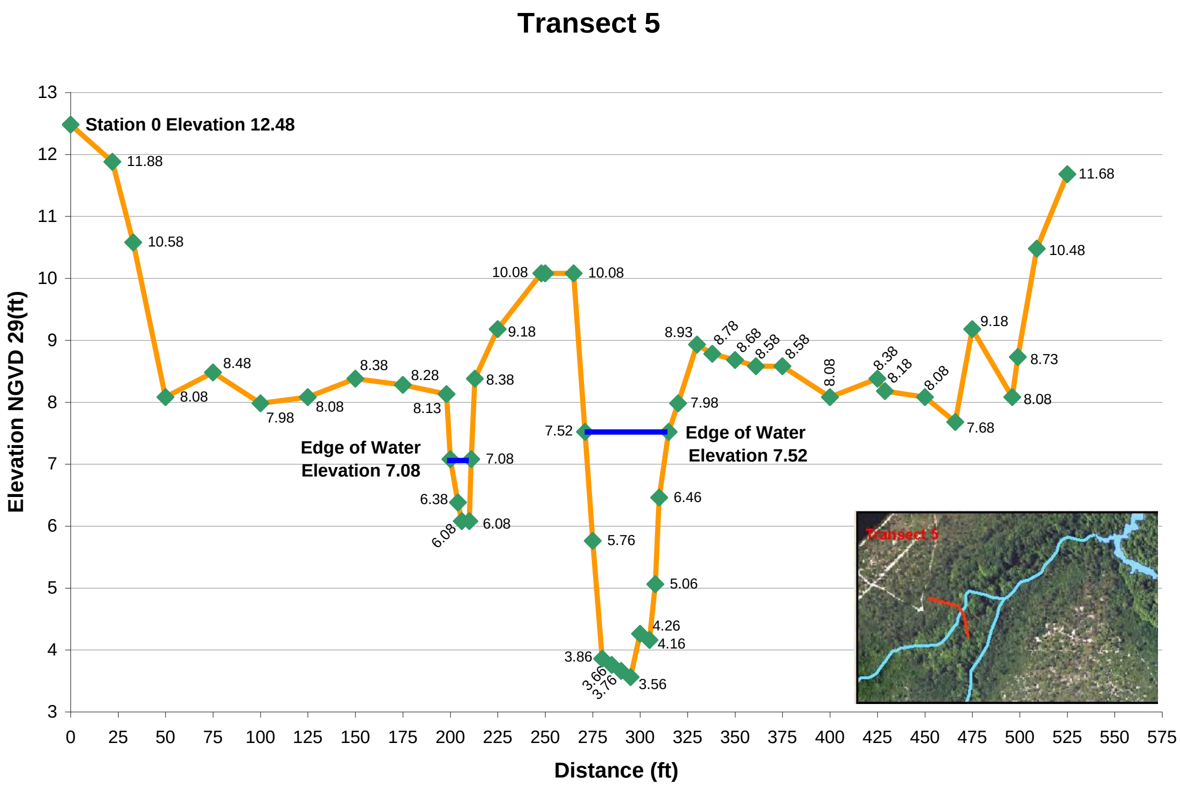
Cypress Creek is a significant source of surface water to the Northwest Fork of the Loxahatchee River. It is an outlet for an extensive network of agricultural canals and natural wetlands. There is an active USGS gage station that monitors stage and flow just east of the bridge on Gulfstream Road (**Figure 59**). Cypress Creek drains Ranch Colony, and Cypress Trail developments (Pal/Mar) into the Northwest Fork of the Loxahatchee River. It is estimated that an average daily flow contribution to the Northwest Fork from the historic Cypress Creek basin was 3 percent while Pal/Mar land was 28 percent (SFWMD, 2006).

Seven of the 14 plots on T5 (RM 10.3, T5-1, 5 plots and T5-2, 9 plots) were bottomland hardwoods, The T5-2 segment with 5 continuous plots of Rblh2 (not pictured) had the widest band of bottomland hardwoods observed in the 2003 study. Plot 1 of T5-2 is a Rblh1 followed by 3 plots of Rsw1. T5-1 consisted of two plots of mesic hammock, a Rblh3, and Rswl, and a split plot of Rsw1/Rblh2. A survey was conducted of the transect; however, there were some problems later once the data was examined. **Figure 60** pictures a survey that was conducted of the floodplain in the vicinity of T5 in 1983 for the SFWMD study. Laser level measurements of the plots in 2006 indicated an elevation of 6.43 ft in the mesic hammock adjacent to the uplands while the mesic hammock further from the uplands was 3.04 ft on T5-1. Bottomland hardwood and swamp communities had elevations of 10.08 ft and 8.28 ft, respectively. On T5-2, bottomland hardwood ranged from 2.9 ft to 3.81 ft while swamp ranged from 3.03 ft (adjacent to the uplands) to 3.4 ft.

There were two soil types present on T5. They were represented by Pompano fine sand in the mesic hammock and Rblh3 plots of T5-1 while Aquents were present in the bottomland hardwood and swamp communities (**Appendix D**).

The canopy on Transect 5 was dominated in abundance by bald cypress, water hickory, and red maple (**Figure 61**). Many of the water hickory and red maple trees were overturned in this area during the 2004 and 2005 hurricane seasons (**see: Appendix K**). Water hickory was present at all five dbh size classes (5-99+ cm); but, they were most abundant in the 5-20 cm and 41-60 cm classes (**Figure 62**). Bald cypresses were also present at all 5 dbh size classes; but they were most abundant at the 21-40 cm class. Red maple was present in the three smallest size classes (5-80 cm).

Figure 60. Profile of the entire floodplain in the vicinity of Transect 5 (Cypress Creek, RM10.33).



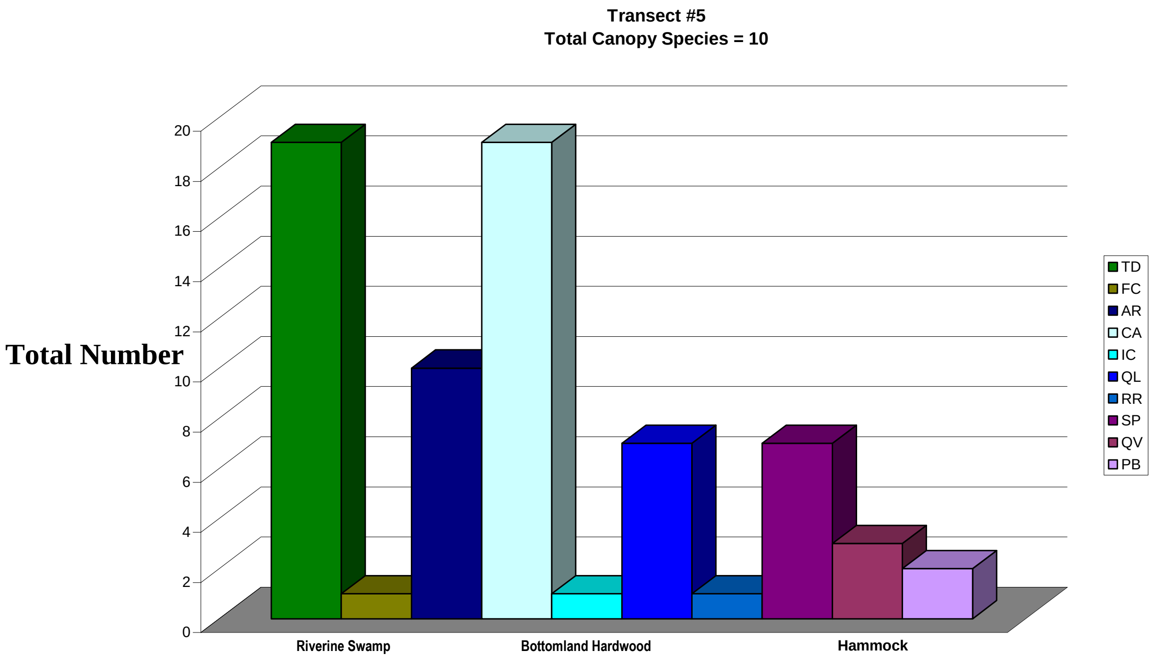


Figure 61. Canopy abundance (density) at Transect 5 (Cypress Creek).

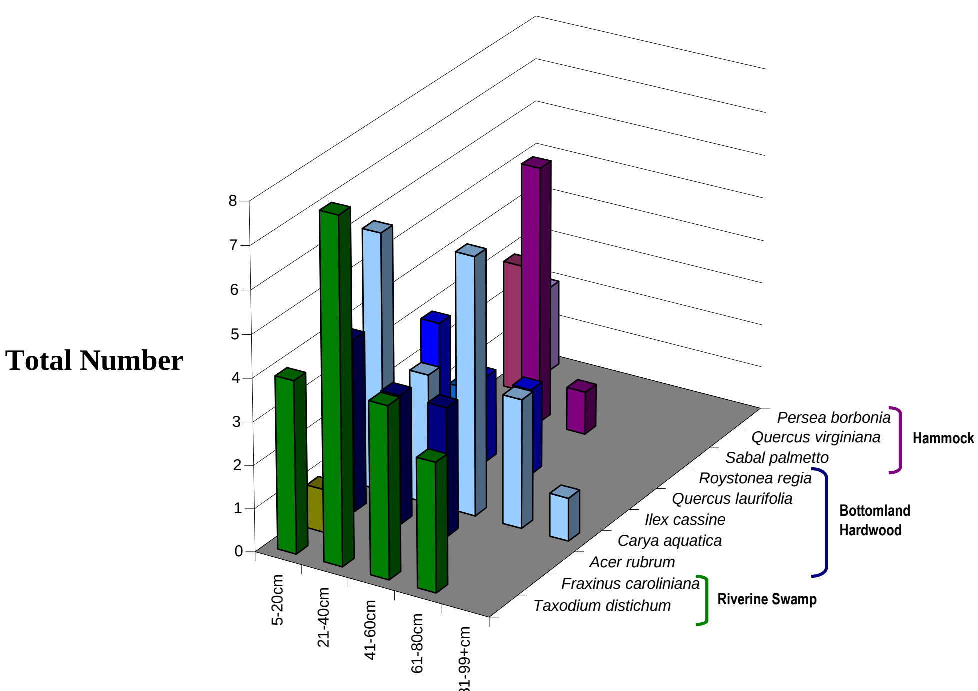


Figure 62. DBH size classes for species at Transect 5.

Tidal Transects

Gonzalez (2005) noted that there was no tidal influence at Transects 1 and 2, little influence at Transect 3, and a strong affect at Transect 4 in the river channel, which is still fresh in non-drought conditions. Of the five saltwater tidal transects, three are on the Northwest Fork of the Loxahatchee River and two are located in the upper tidal reach (T7 at RM 9.10 and T6 at RM 8.43), and one in the lower tidal reach (T9 at RM 6.46). The remaining saltwater tidal transects are found in the upper tidal reach on Kitching Creek (T8, RM 8.13) and in the upper tidal reach of the North Fork (T10). The elevational cross sections of these tidal transects are generally flatter and lower (with fewer changes in topographical relief) and contain fewer braided streams than in the riverine reach of the floodplain. There are no bottomland hardwood plots in the tidal reaches, although indicator species for those forest types were present. In the tidal reaches, canopy diversity is increased by the presence of hummocks (elevated mounds) and cypress stumps. Some canopy size trees that would not normally be present in swamp communities are able to grow on hummocks and large cypress stumps. Forest types in the tidal reaches are generally mixtures of swamp species (fresh and brackish water species) and mixtures of swamp, hammock, and upland species. Historical records and aerial photography show that the most abundant vegetative species in the fresh and saltwater tidal reaches of the Northwest Fork of the Loxahatchee River were bald cypress, cabbage palm, and pond apple. Saltwater intrusion, increasing sea level, lowered groundwater levels, and decreased freshwater flows have resulted in increases in the distribution of red and white mangrove throughout the tidal reaches. In addition, historical logging, fire, freezes, exotic plants (Old World climbing fern, Brazilian pepper, java plum, and strawberry guava), and erosion of the river channel have impacted sections of the tidal transects

Transect 6 (T6-1 and T6-2, 16 plots, **Figures 63A and B**) is located at RM 8.43 on a peninsula just upstream of Kitching Creek and adjacent to Ornamental Garden (**Figure 17**). T6-1 consists of thirteen plots that begin in the uplands and transverse the floodplain due north for 125 meters towards the river channel while T6-2 continues from that point due east for an additional three plots.

The Transect 6 peninsula had been selectively logged in the past and contained remnants of many dead bald cypress from logging activities and saltwater intrusion. Today, there are still live bald cypress growing among the pond apple and mangrove and a band of bald cypress trees still exist adjacent to the uplands. At approximately 85 meters from the uplands on T6-1, there is a large bald cypress (live and healthy looking) totally surrounded by red mangroves. Greater distances from the river channel and groundwater runoff from the uplands probably provide additional protection from saltwater intrusion in this area of the upper tidal reach.

Of the sixteen plots on Transect 6, there were two upland, one Rsw1, six UTsw1, six UTsw3, and one UTmix plot. Elevations ranged from 6.82 ft in the uplands to an average elevation of 1.59 ft over the remaining transect (**Figures 63 A and B**). Red mangrove and pond apple were more prevalent in the plots over 100 meters from the uplands. Cabbage palm and wax myrtle were only found on hummocks. This is another illustration of the significance of floodplain topography in species distribution.

There were two soil types present on Transect 6. They were represented by Pompano fine sand in the uplands and Terra Ceia Variant in the riverine and upper tidal swamp communities (**Appendix D**).

The most prevalent canopy species were red and white mangrove and pond apple (average dbh 8.3 cm) (**Figures 64** and **65)**. Red and white mangroves were only found in the 5-20 cm dbh frequency. There were no canopy trees beyond the 41-60 cm size class with the exception of one bald cypress tree in the 61-80 cm frequency. Red maple (dbh 17.5 cm) and pop ash (average dbh 5.7 cm) were present in much smaller numbers. The average dbh of the living bald cypress was 29.8 cm. An exotic species, Brazilian pepper, was found in the 5-20 cm dbh size class and numbered less than twenty.

Shrubs and groundcover consisted primarily of very young red and white mangrove, leather fern, pond apple, buttonbush, maiden fern, swamp fern, and rubber vine.

Figure 63A. Profile of Transect 6-1 (RM8.43) and the adjacent peninsular.

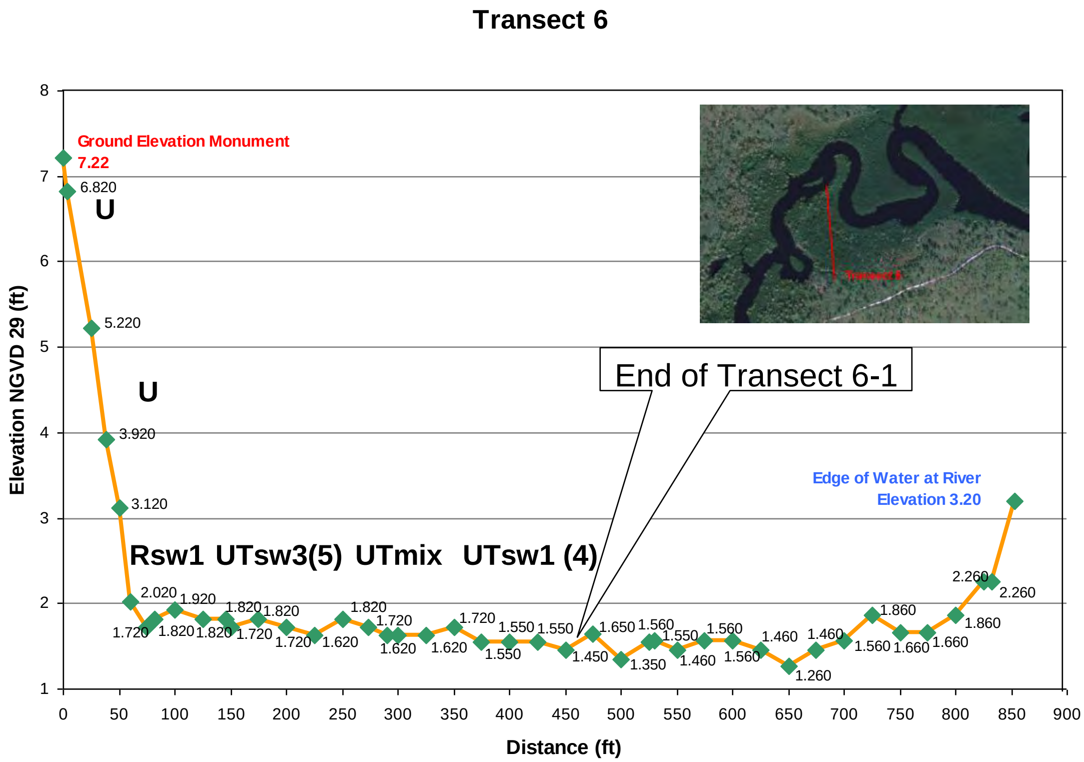
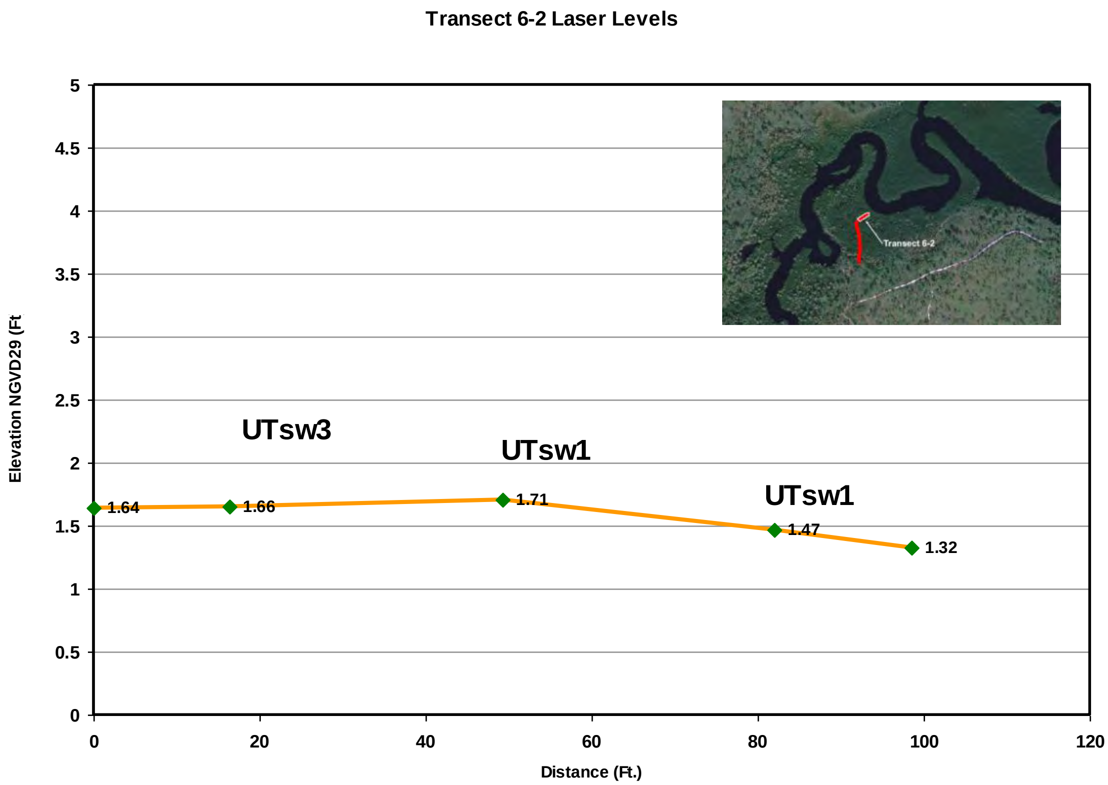


Figure 63B. Profile of Transect 6-2.



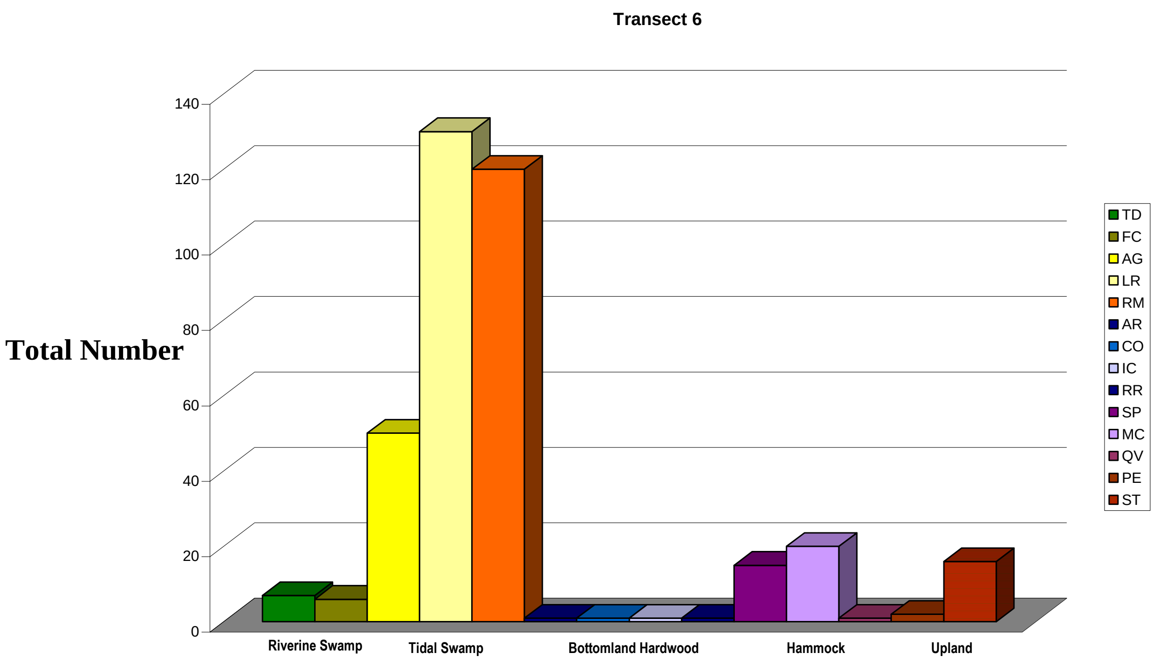


Figure 64. Canopy abundance (density) on Transect 6.

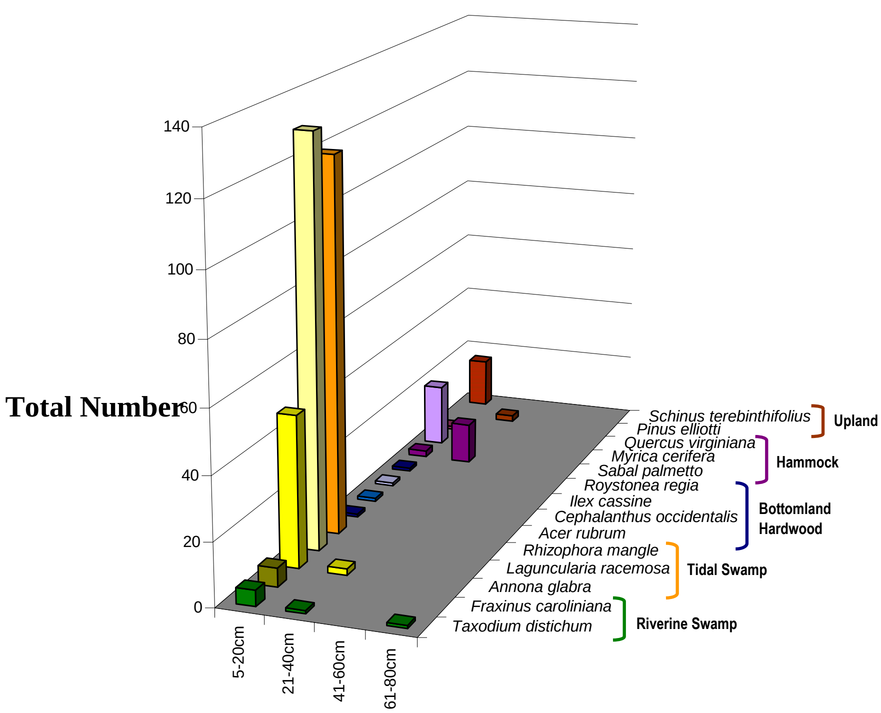


Figure 65. DBH size classes on Transect 6.

Transect 7 is located at RM 9.1 on the south side of the middle of the Northwest Fork across from the eastern end of Hobe Grove Ditch and contains 15 plots (**Figure 17**). This transect has been impacted by salt water intrusion, exotics (mostly Old World climbing fern, Brazilian pepper, and java plum) and logging activities. It is a very long transect with 15 plots that contain a mixture of eight riverine and seven upper tidal plots **(Figures 66 and 67)**. Elevations changed from 10.06 ft at the benchmark in the uplands to 5.12 ft at the mesic hammock and finally to an average of 1.58 ft across most of the floodplain swamp (**Figure 66**).

The riverine section of the transect consists of a mixed plot (Hammock/Rsw1) with live oak, wax myrtle, and a large cypress (50.1 cm dbh) followed by two plots of Rsw1, and five plots of Rmix (**Figure 68**). Bald cypress, cabbage palm and wax myrtle were the most abundant species in these plots (**Figure 67**). Cabbage palm and wax myrtle coexist with the swamp species by growing on small hummocks, old logged cypress stumps, and fallen logs. The Upper Tidal segment of Transect 7 has four plots of UTsw1, and three plots of UTsw2 (**Figure 66**). At a distance of 120m from the upland, red mangroves are more abundant along with pond apple (**Figure 67**). White mangrove were present but too small to be considered canopy (>5 cm dbh). Live bald cypresses are present from the edge of the uplands to within 30 m of the river channel (**Figure 66**).

All fifteen canopy species were represented in the 5-20 cm dbh size class group (**Figure 69**), which directly reflects the impacts of past logging activities and the increase in available sun light. Bald cypress trees in this plot had an average dbh of 28.3 cm and ranged in size from 7.2 cm to 50.1 cm and were present in three dbh size classes (5 cm to 60 cm).

Red maple was present primarily in the 21-40 cm dbh class. Exotic species, Brazilian pepper and java plum, were also present in the 5-20 cm dbh class while strawberry guava were present as shrub but not large enough to meet the 5 cm dbh canopy criteria.

On Transect 7, tree heights were measured on pond apple, white and red mangrove and buttonbush. Fourteen pond apples on the transect averaged 6.2 m while three button bush averaged about the same, 6.3 m. Similarly, eleven red mangroves averaged 6 m. Two white mangroves measured in a little taller at 8.87 m.

Soil types on Transect 7 varied between the hammock, riverine and upper tidal swamp communities. The mesic hammock half plot that begins Transect 7 consisted of Immokalee fine sand. The riverine swamp and mixed plots consisted of Terra Ceia Variant inclusion, which is generally considered to be a more inland muck while the upper tidal swamp plots consisted of Okeelanta Variant muck, which is considered to be a more coastal muck.

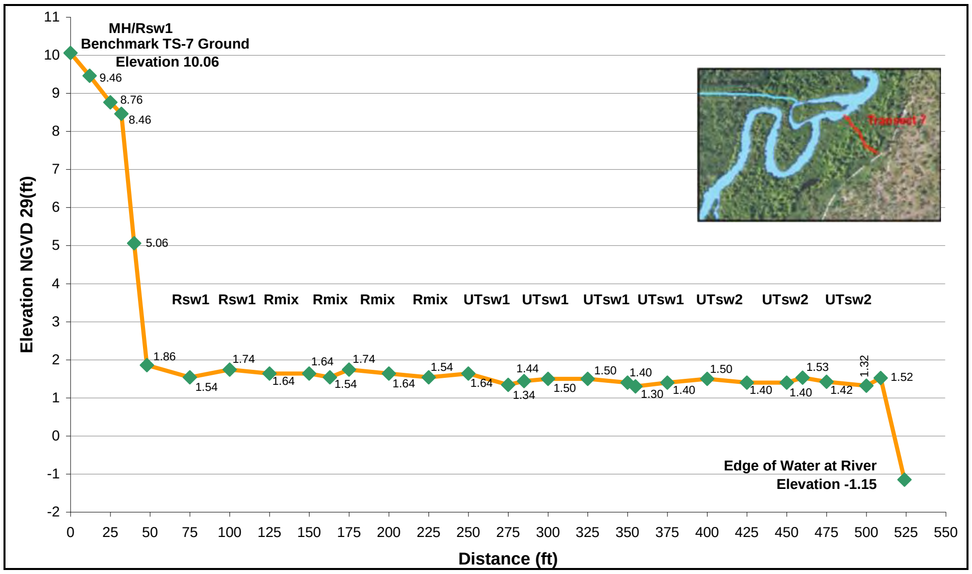


Figure 66. Profile of Transect 7 (RM9.10).

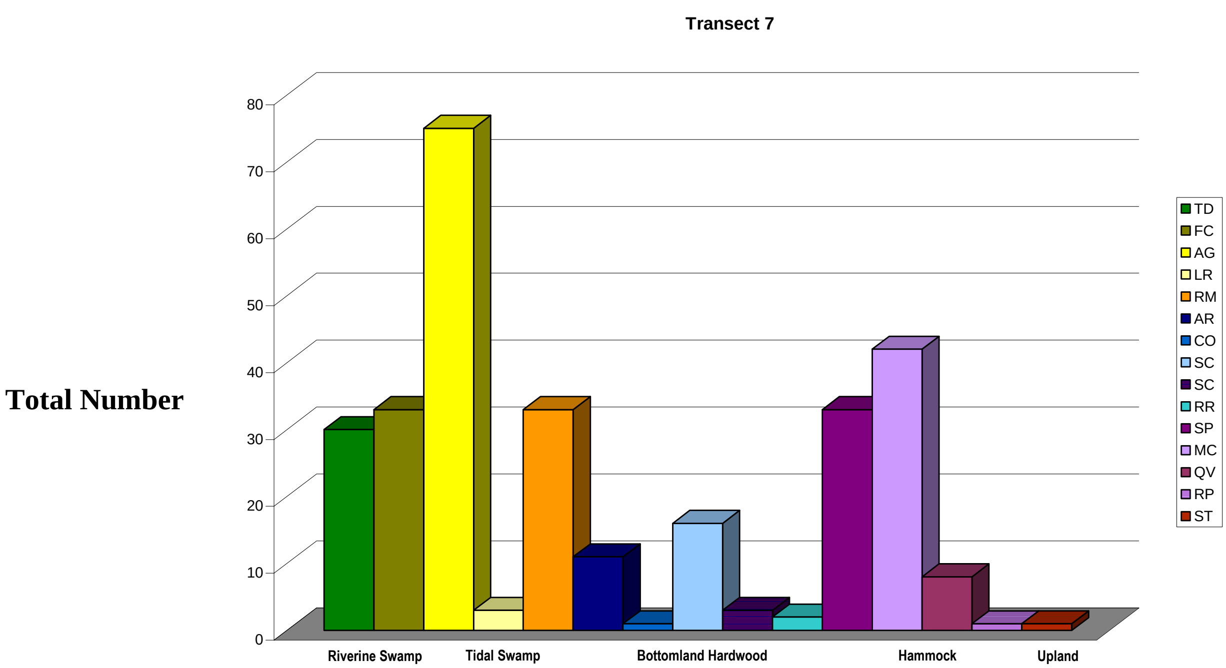


Figure 67. Canopy abundance (density) on Transect 7.

Figure 68. Forest type Rmix (pond apple, bald cypress, red maple, wax myrtle and cabbage palm) in a selectively logged area of Transect 7.

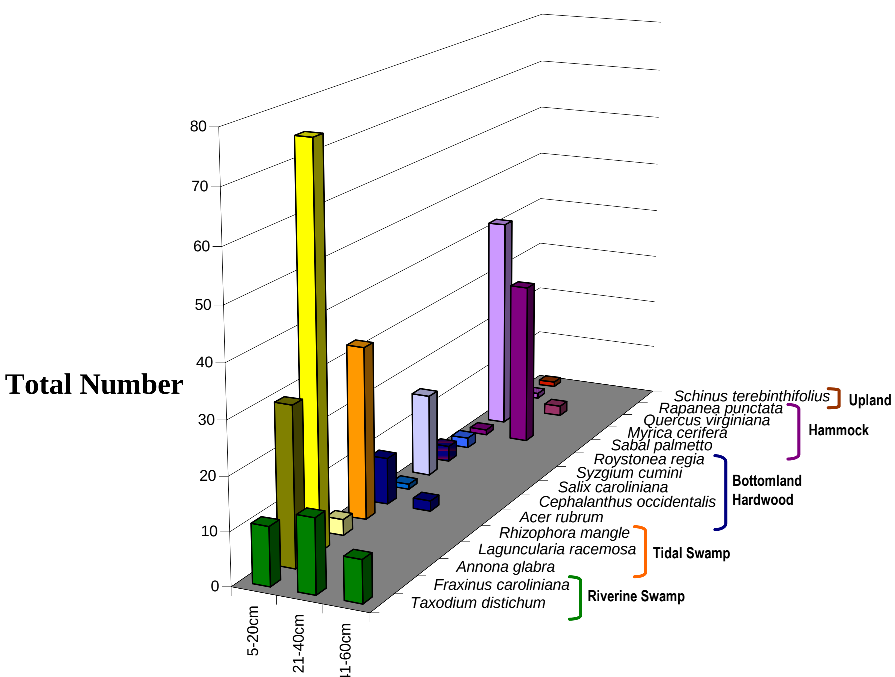


Figure 69. DBH size classes on Transect 7.

Shrubs and ground cover consisted primarily of leather fern, wax myrtle, buttonbush, salt bush, primrose willow, poison ivy, swamp fern, marsh fern, Meniscium fern, royal fern, swamp lily, milk vine and young mangroves, pond apples and pop ash.

In the late fall of 2003, Transect 7 had an extremely large number of cypress seedlings ranging from 5 cm to 7.6 cm in height. Germination of new seedlings continued well into the late spring. The following dry season (December 2003 to May 2004) was very dry.

Tides did not reach the entire transect during this period and the rains did not come until mid-July 2004. This dry period may have been advantageous for germination and early bald cypress seedling growth. During a visit in 2003, USGS botanists, Helen Light and Melanie Darst, suggested that the stress of the salt may have made the trees more reproductively active. They also noted that the bald cypress trees on this site were probably younger than their counterparts in the riverine reaches of the river. Also in the riverine portion of the river, the cypress tree canopy was much taller and thicker. Therefore, less light may be available for the development of an extensive subcanopy and groundcover in the riverine reach. Duever (personal communication) suggested that a good recruitment season for bald cypress may take place every 30 to 450 years. During a visit to Transect 7 in August 2004, it was noted that many of the fall 2003 bald cypress seedlings were gone. Daily tides had returned to the interior of the Transect 7. Seedling deaths may have occurred because the seedlings were too short to survive the periods of tidal flooding (twice a day) or because of increased salinity.

Transect 8 is located on lower Kitching Creek, which enters the Northwest Fork at RM 8.13 and contains 12 plots (**Figures 4 and 17**). Kitching Creek is located within the Jonathan Dickinson/Hobe Sound sub-basin of the Loxahatchee River Watershed. Kitching Creek is in that portion of the sub-basin known as the Eastern Flatlands. The headwaters of Kitching Creek are located north of Jonathan Dickinson State Park with the natural channel lying within the Park boundary (FDEP, 2002). The basin has been divided for some time by the construction of Bridge Road (SR 708) in the 1930s. Most of the water flowing to Kitching Creek enters the northwest corner through Jenkins Canal (**Figure 70**). Kitching Creek is credited with contributing approximately 4 percent of the total flow to the Northwest Fork of the Loxahatchee River (Russell and McPherson, 1984). Average daily flow was estimated at 17.4 cfs in the Restoration Plan (SFWMD, 2006).

In the past, water originating from and entering the creek through Jenkins Canal was thought to be of poor quality, but it was never documented. Also, during periods of heavy rainfall, surface water has tendency to pile-up on the north side of Bridge Road due to the insufficient number of culverts to carry the water southward. Furthermore, Jenkins Canal diverts water that has historically drained into the upper portion of Kitching Creek, which has dewatered the area and contributed to a lowered groundwater table. Freshwater flow to Kitching Creek is now extremely rainfall driven. Martin County continues to lead an effort to recreate a natural flowway and improve water quality.

Natural communities within the Kitching Creek area include pinelands, freshwater marsh, wet prairie, and strand swamp with open water (**Figure 71**). The headwaters of the creek are included along with several other natural areas within the Loxahatchee River Watershed in the Loxahatchee Greenways Projects (1997). This project identified those natural communities along key natural areas and allow for recreational, wildlife use and water quality and supply. Two monitoring stations exist within Kitching Creek (**Figure 70**). The USGS has maintained a long term stage and flow monitoring station about one-quarter mile upstream of its confluence with the Northwest Fork of the river. The other USGS monitoring station is located at the mouth of the creek and has monitored stage, flow, conductivity and temperature since 2003.

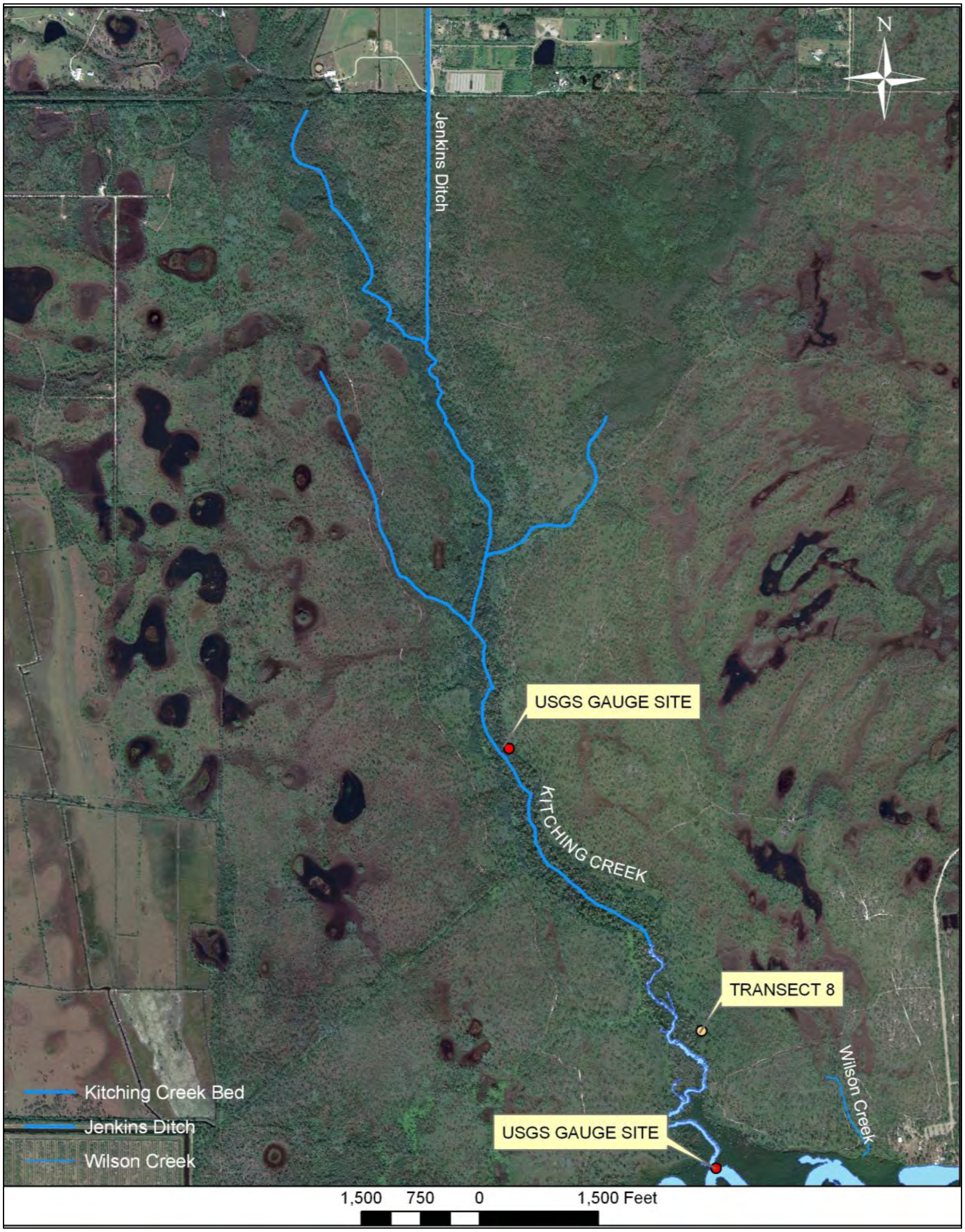


Figure 70. Map of the Kitching Creek Area and the natural pathway of its channel.

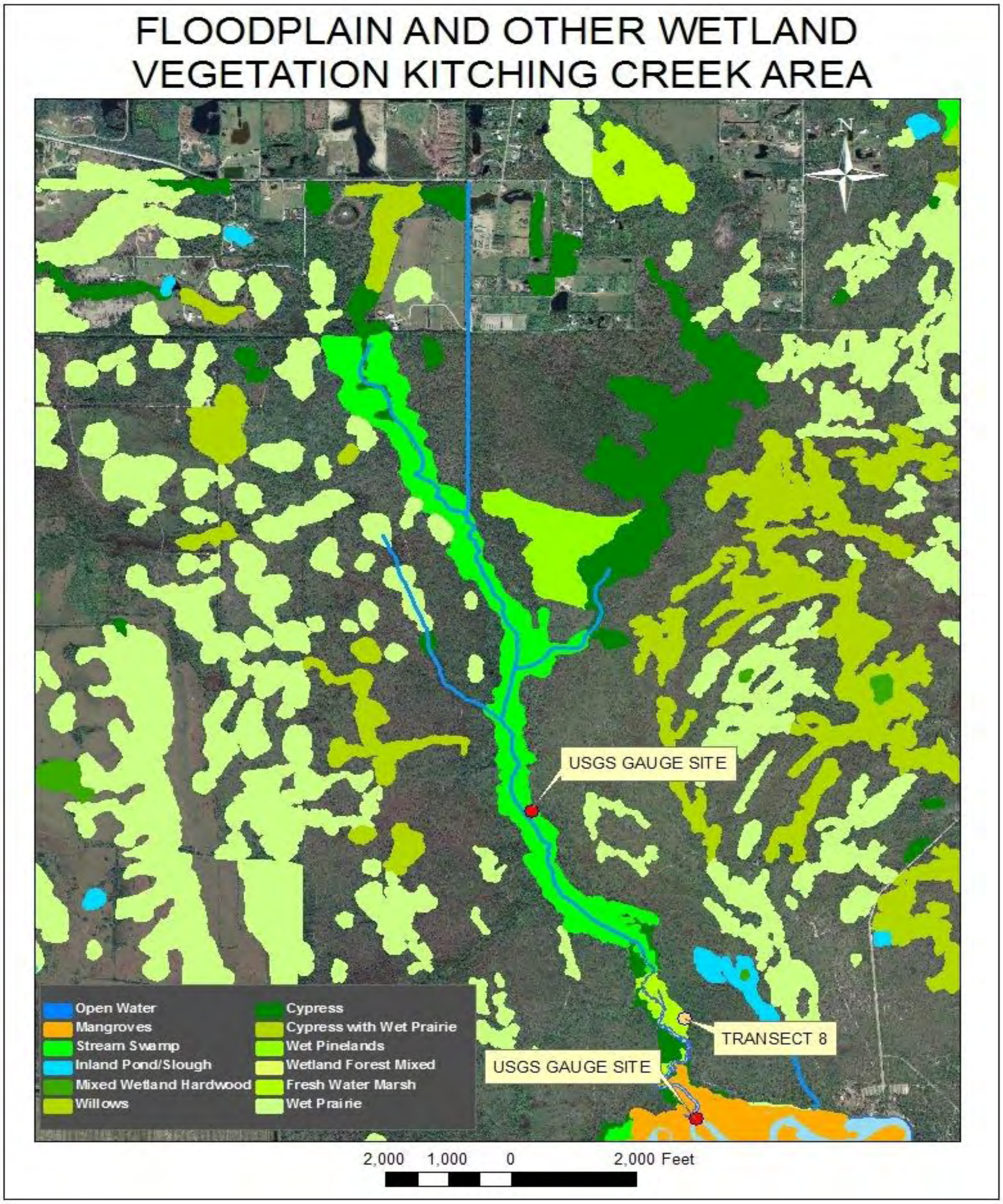


Figure 71. Kitching Creek and adjacent wetland systems.

The Kitching Creek Transect (8) is located on the east side of the floodplain approximately one tenth of a mile north of the mouth of the creek and just upstream of the Kitching Creek viewing platform in the Park. Transect 8 consists of twelve plots in the saltwater tidal portion of lower Kitching Creek (**Figure 72**). The first three plots are Rmix, hydric hammock (HH) and

Rmix with elevations of 8.36 ft, 6.56 ft. and 4.2 ft, respectively. The remaining nine plots are upper tidal swamp and mixed communities (UTsw1 and UTmix) and range in elevation from 2.06 to 1.27 ft. There is one braided channel on this transect at approximately 95 meters (312 ft) from the upland and two plots away from the creek channel. The bottom of the braided channel is at about 0.4 ft in elevation. Red mangroves are present within the braided channel, which is primarily surrounded by pond apples. Therefore, it appears that the braided channel has contributed to the dispersal of red mangrove seeds into the interior of the floodplain. In the transitional area, along with a quick change in topography, the upland communities change very rapidly into hammock and then riverine swamp communities.

Soil types are represented by Nettles/Myakka sand in the most landward two plots of Rmix and HH followed by Okeelanta Variant muck in the second Rmix plot and Okeelanta Inclusion in Bessie muck in the upper tidal plots (**Appendix D**). In the soil survey performed by the University of Florida study (unpublished, 2006), it was noted that a mineral/sand layer was present below approximately 120cm on all of the upper tidal plots.

With regard to vegetation and logging activities on Kitching Creek, Bessie Wilson DuBois in her 1981 book "The History of the Loxahatchee River" wrote:

> Wishing not to have the cypress cut around his Kitching Creek property, John DuBois marked the trees that should not be cut. He went with a bucket of white paint and marked 27 trees that stood around the camp and they were saved. Later, when he went to Tallahassee hoping to get the land back, which had been taken for Camp Murphy in 1942, he was told he could not possibly have it because of all of those nice trees which he had saved from the woodman's axe years before!

Some of these trees are pictured below in the 2004 photograph of lower Kitching Creek (**Figure 72**). Along the shoreline, the canopy is primarily bald cypress and cabbage palms with a sub-canopy of mangroves. In photographs of this area taken in the 1970s, the mangrove sub-canopy is not as prominent as it is today (T. Alexander, communication).

Canopy trees on Transect 8 belonged to fourteen species. Pond apples were the most abundant species followed by wax myrtle, and bald cypress (**Figure 73**). Pond apples were found in all upper tidal plots but did not occur in the Rmix plot. Red and white mangroves were not abundant; however, they were present as sub-canopy and seedlings. Red mangroves appeared to be restricted primarily to the braided channel and the plots adjacent to the creek channel. Cabbage palms, wax myrtle, and Brazilian pepper nearly always grew on hummocks.

Although vegetation in the upper freshwater segments of Kitching Creek were not studied, aerial photograph and site visits indicated the presence of freshwater mixed hardwoods and bald cypress swamp and strands either on or associated with this strand swamp.

Thirteen of the fourteen canopy species were present in the 5-20 cm dbh size classes (**Figure 73**). Cabbage palms were only found in the 21-40 cm class. Pond apple was only present in the 5-20 cm and 21-40 cm classes. Bald cypresses were found in all three classes (5-60 cm). Only a few pop ashes were observed and they were all in the 5-20 cm dbh class. The exotics, Brazilian pepper and strawberry guava were only found in the 5-20 cm dbh class.

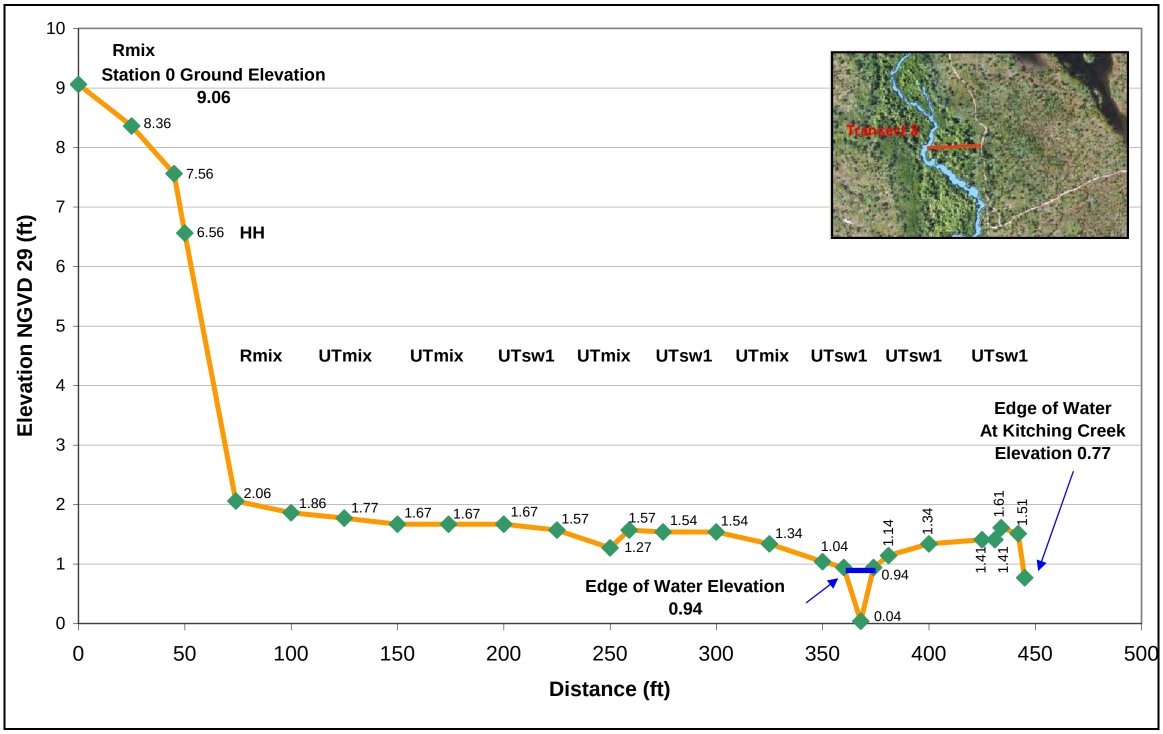


Figure 72. Profile of Transect 8 (Kitching Creek, RM8.13).

Figure 73. The 2004 shoreline of lower Kitching Creek where bald cypress were spared from lumbering activities.

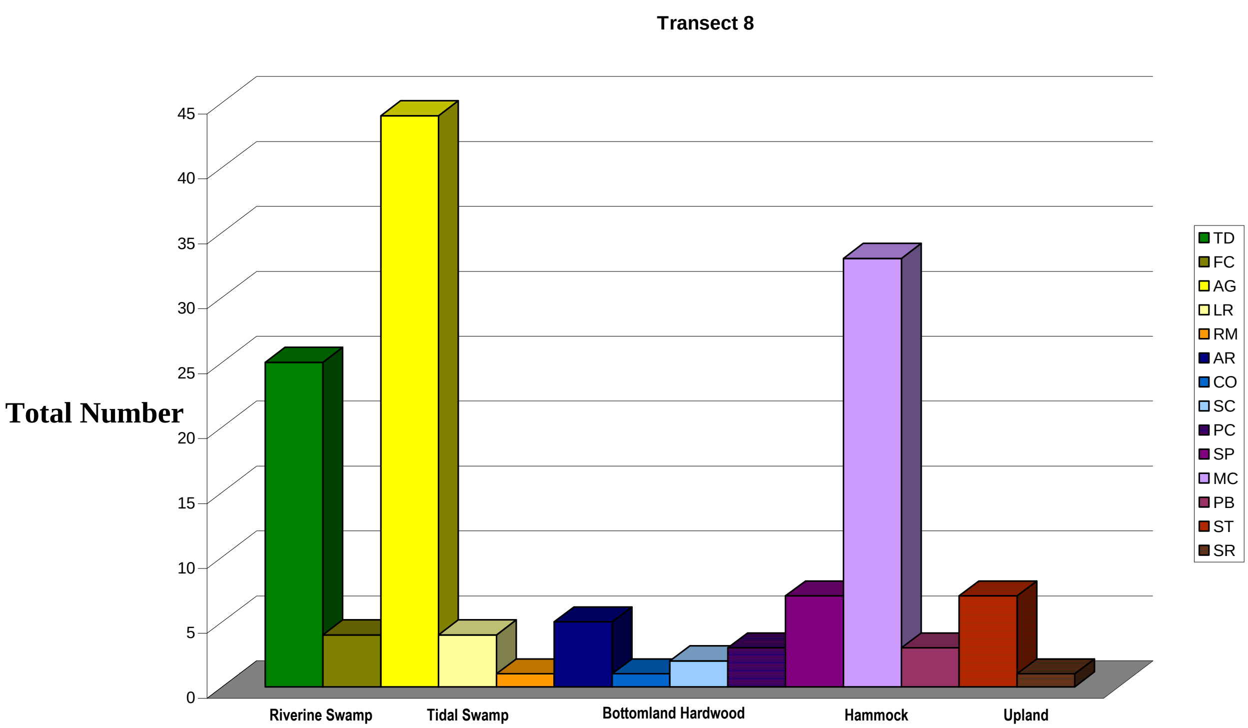


Figure 74. Abundance of canopy species on Transect 8 (Kitching Creek, RM 8.13).

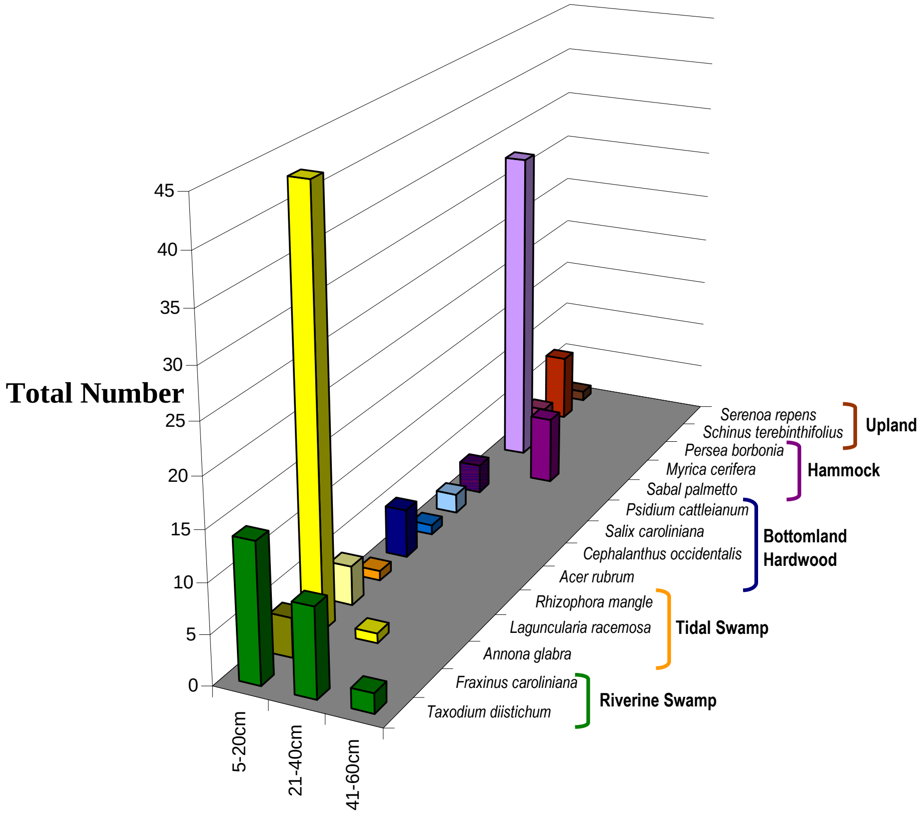
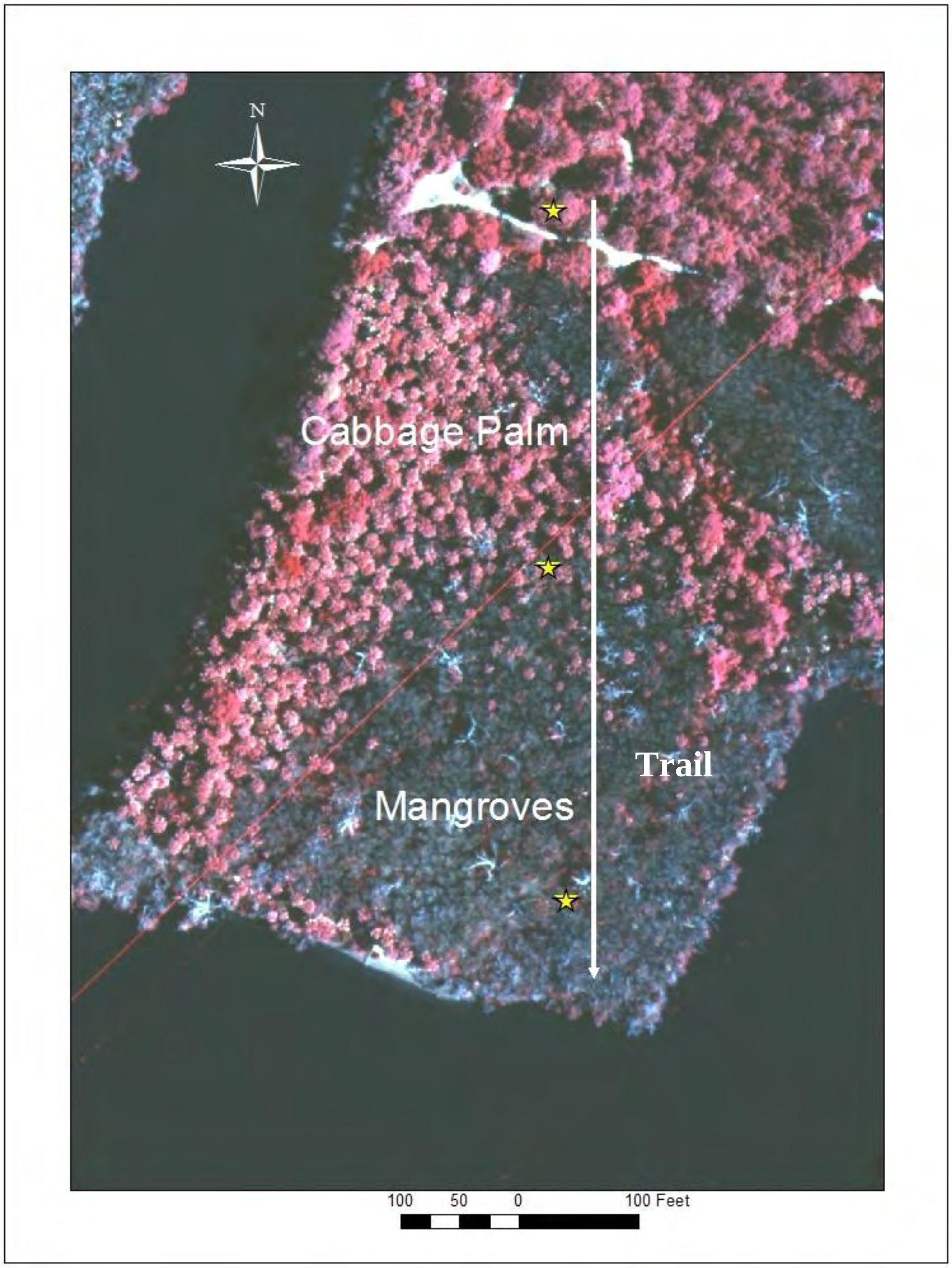


Figure 75. DBH size classes on Transect 8.

Transect 9 is located at RM 6.46 on a peninsula near the JDSP boat ramp (**Figures 17 and 76**) and contains 20 plots. The hydrology of the floodplain in this area has been impacted by the placement of a one foot fill compacted trail that divides a portion of the peninsula. During extreme high tides, the trail acts as a barrier and traps saltwater in the predominantly white mangrove community in the interior of the peninsula. Elevations across T9 range from 1.31 ft at the shoreline to 9.48 ft at the benchmark, which is at the corner of the first plot (**Figure 77**). Between 50 and 70 meters from the upland a quite pronounced LTmix area exists (i.e. hammock and swamp). Elevations in the hammock range from 1.95 ft to 2.05 ft and elevation along the trail is 2.01 ft; the remaining areas in the floodplain are approximately 1.63 ft.

There were three soil types present on Transect 9 (**Appendix D**). Pomello sand was present in the upland and hammock communities while Okeelanta Variant muck and Gator muck were present in the primarily mangrove swamp communities. The Gator muck was associated with a

Figure76. Location of Transect 9 (white line) and the three groundwater wells (yellow stars) from a 1985 infrared photograph, which also reflected damage to the mangroves as a result of a local freeze. The pink in the floodplain is cabbage palms.



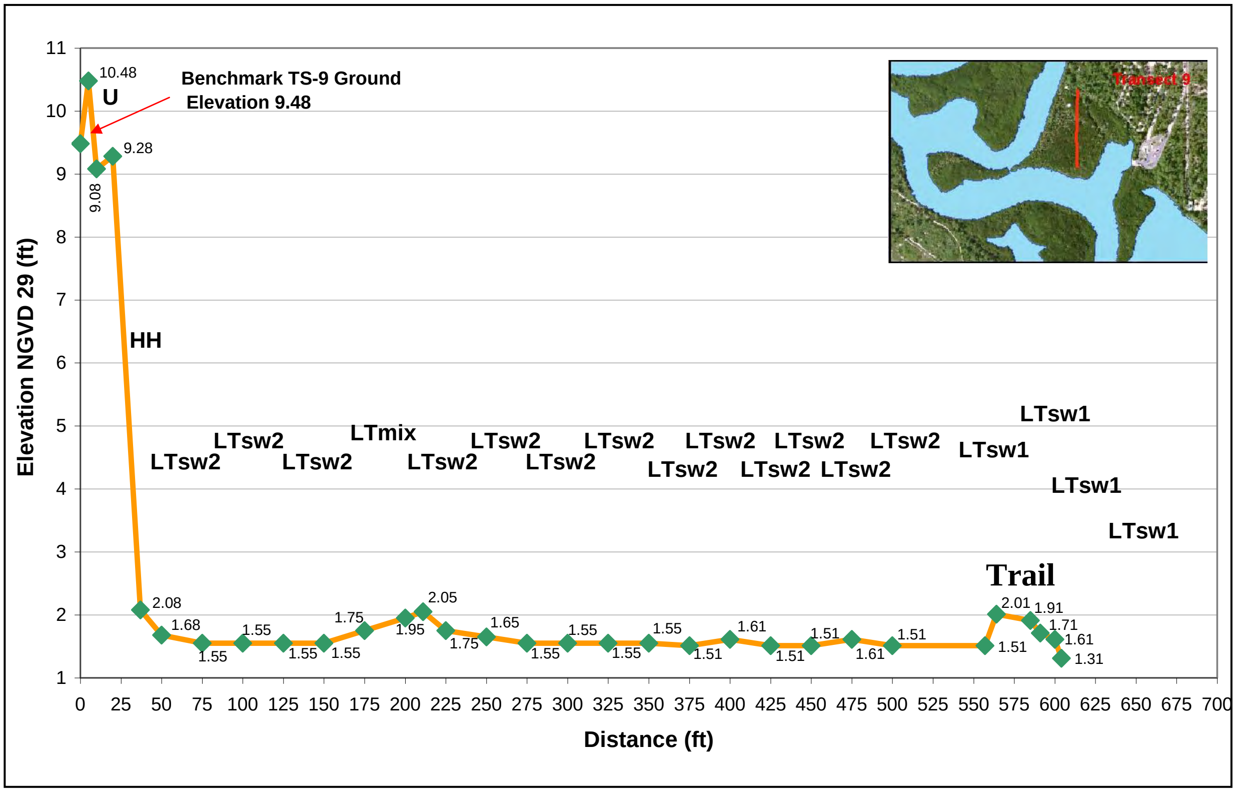


Figure77. Profile of Transect 9 (RM6.46).

slight rise in ground elevation and change in forest type (i.e. LTsw2 (white mangrove) to LTmix (hammock and swamp).

Of the twenty plots on this transect, seventeen were lower tidal swamp (LTsw1 and LTsw2), (**Figure 77**). **Figures 78 and 79** are photographs of LTsw1 and LTsw2 forest types at Transect 9. The other three were upland, hammock, and LTmixed. The most prevalent species in the canopy, shrub and groundcover layers were red and white mangroves in the swamp areas and cabbage palm in the hammock and mixed areas (**Figure 80**).

Figure 78. LTsw2 forest type (white mangrove) with a dead bald cypress in the background on Transect 9.

Figure 79. LTsw1 forest type (red mangrove) on Transect 9.

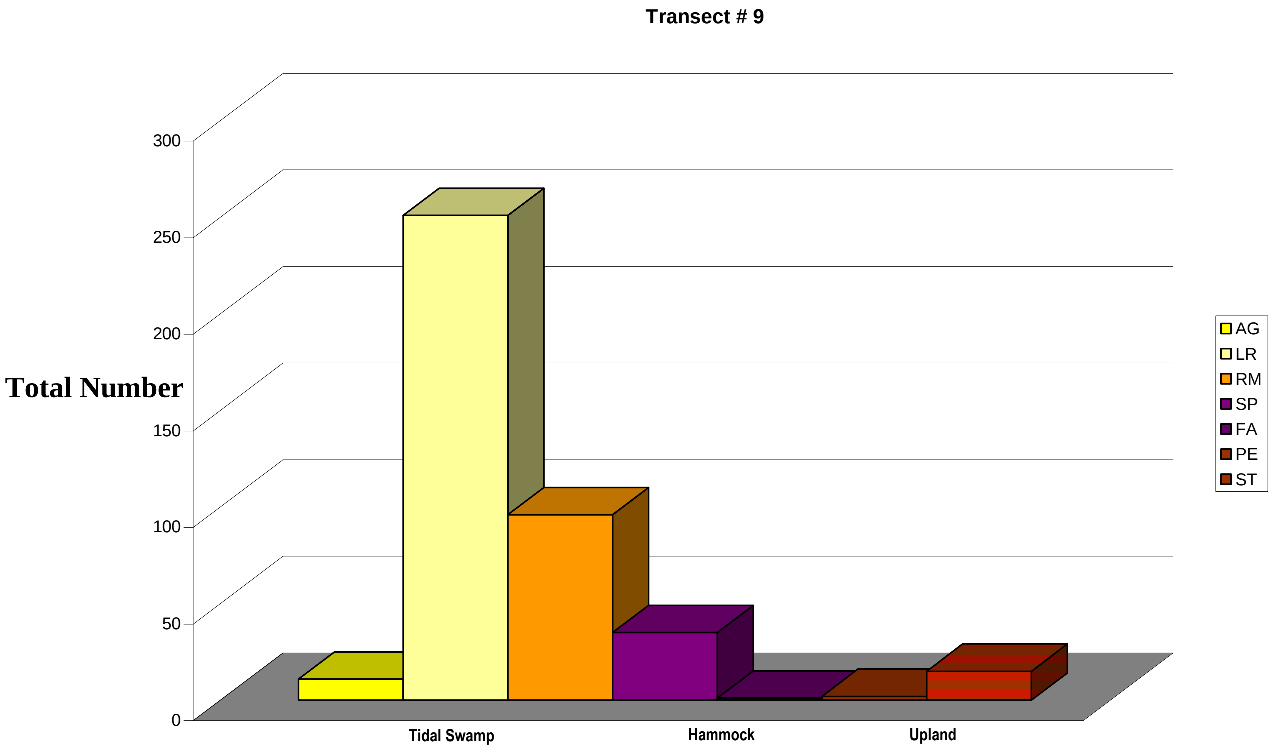


Figure 80. Canopy species abundance (density) on Transect 9.

Pond apple in the canopy was rare. They were found predominately in the deeper swamp area at the back of the floodplain and had an average dbh of only 7.2 cm. There is a noticeable difference between the distribution of red and white mangroves on Transect 9. White mangroves were dominant from the toe of the slope out to approximately 160 m. The remaining four plots (160 m to 200 m) were dominated by red mangrove. White mangroves were present in two size classes (5-20 cm and 21-40 cm) while red mangroves were present only in the 5-20 cm class (**Figure 81**), which may be a factor of their periodic die-back during prolonged freezes. Leather fern dominated the shrub layer while water hyssop, leather fern and rubber vine dominated the groundcover. During a visit in August 2004, it was noted that the majority of the cabbage palms that had been recorded as alive in 2003 were now dead. The only cabbage palms remaining alive were associated with the trail and the hammock areas.

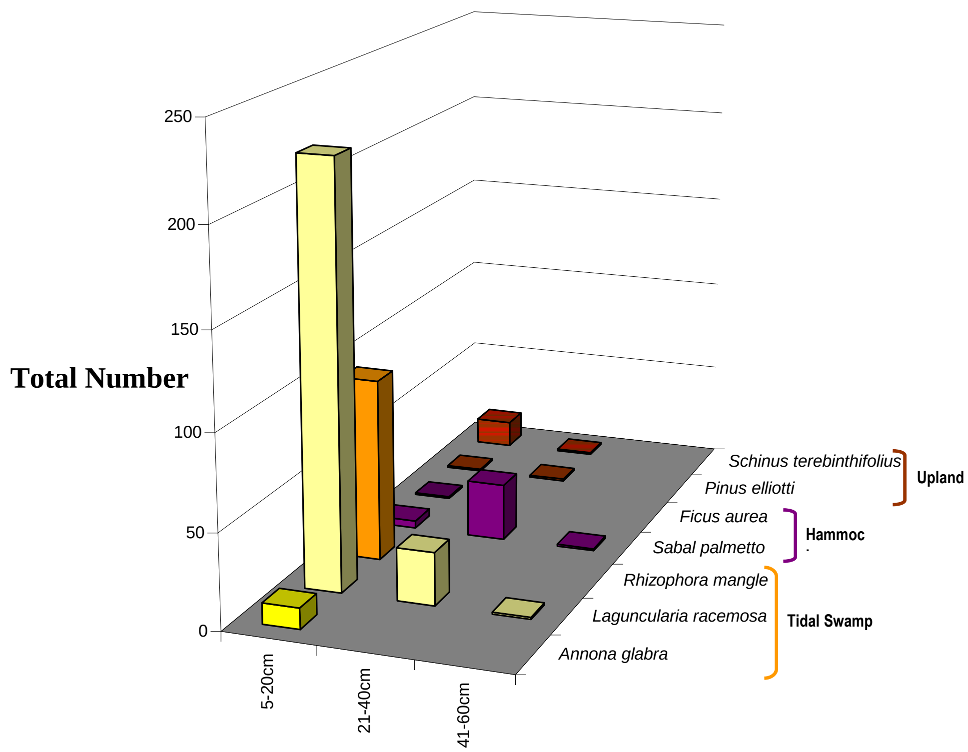


Figure 81. DBH size classes on Transect 9.

Tree heights were measured on 6 canopy species on Transect 9. The heights of eighty-seven white mangroves were measured and averaged 12.93 m and ten red mangroves averaged 9.42 m. Four pond apples averaged 7.78 m while 7 cabbage palm averaged 8.19 m. In the upland plot, one live oak was measured at 5.8 m and two slash pines averaged 16.18 m.

The North Fork tributary of the Loxahatchee River where Transect 10 (8 plots) is located meets the Central Embayment area of the Loxahatchee River at approximately RM 2.0 (**Figures 4 and 17**) while its headwaters reach far to the north to the Atlantic Coastal Ridge and coastal savannah systems of southern Martin County. The North Fork has been called the "Eastern Slough" of the Loxahatchee River because of its general north/south flowway character from above Bridge Road to the Loxahatchee River and because of its location east of Kitching Creek. In a 1952 black and white aerial of coastal Martin County (**Figure 82**), a bridge spans the floodplain area of the North Fork in the vicinity of Banner Lake. Just north of Bridge Road, the North Fork tributary appears as a savannah system running parallel to the back of the Atlantic Coastal Ridge. Bridge Road was constructed during the 1930s and acts as a barrier to sheet flow from the Atlantic Ridge area. South of Bridge Road the wetland system changes to a forested wetland system at first dominated by bald cypress but transitions for awhile into freshwater marsh. The freshwater marsh system (light blue, **Figure 83**) branches off to the east and then southward while the bald cypress strand picks up again and continues southward as it enters JDSP. The two wetland systems at this point are separated by an area of higher elevation scrub habitat in the middle that is further surrounded on both sides by pine flatwood and wet prairie systems. This scrub is habitat for the threatened Florida scrub jay, *Aphelocoma coerulescens*. The bald cypress strand continues southward through JDSP and into the property currently leased by the Palm Glades Girl Scout Council (Camp Welaka) while the freshwater marsh system continues southward to what is today Park Drive. Today, there are three small culverts that convey North Fork surface water flow beneath Park Drive. The area just east of the railroad tracks was impacted originally by agricultural activities and later Camp Murphy, which was established in 1942 as a U.S. Signal Corps radar training base. The camp was decommissioned in the fall of 1944. In 1947, the Florida Board of Forestry and Parks officially obtained title of a 7,871 acre parcel that was to be named Jupiter State Park. The park was renamed in 1955 in honor of Jonathan Dickinson who was shipwrecked on Jupiter Island in 1696 and wrote about his survival in the area. Additional parcels totaling over 3,600 acres were purchased over the years by the state and the South Florida Water Management District.

The tidal segment of the North Fork tributary begins in an area of mixed hardwoods (stream swamp), bald cypress strand, and cabbage palm hammock south of Park Drive (**Figure 83**). Both the bald cypress strand and mixed forested wetland systems converge again as floodplain elevations fall and a recognizable channel appears and grows wider as the tributary approaches the main branch of the river. Mangroves appear in the area north of County Line Road in the 1952 black and white aerial photograph; however, their distribution has expanded northward since that period.

Some of the problems associated with the North Fork include lowering of the groundwater table, decreasing freshwater flow, sediment deposition (muck) in the lower tributary, saltwater intrusion, and an invasion of mangroves into the freshwater floodplain community. Urban development to the north and installation of culverts under Bridge Road has contributed to the diminishing groundwater table and surface water flow. Currently there are 15 culverts (two on the North Fork) under Bridge Road, which affect the North Fork or Kitching Creek. These culverts do not appear to be adequate for transporting water to the south side of Bridge Road for the two tributaries. Lack of freshwater flow has resulted in a diminishing of the bald cypress strands, freshwater marsh, and wet prairie communities and the continuing spread of mangroves throughout the upper tidal North Fork floodplain.

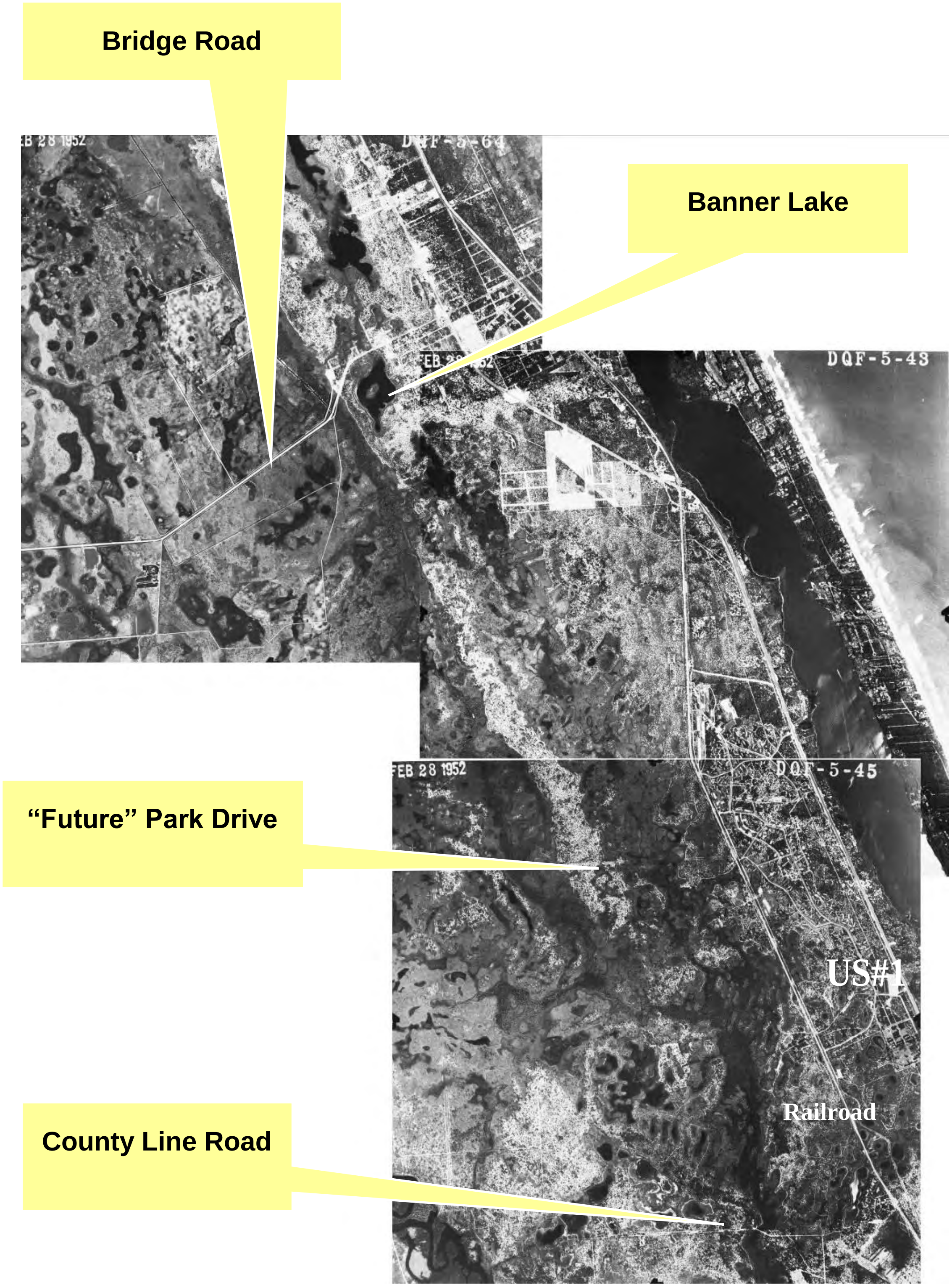


Figure 82. Black and white aerial photograph of the North Fork in 1952.

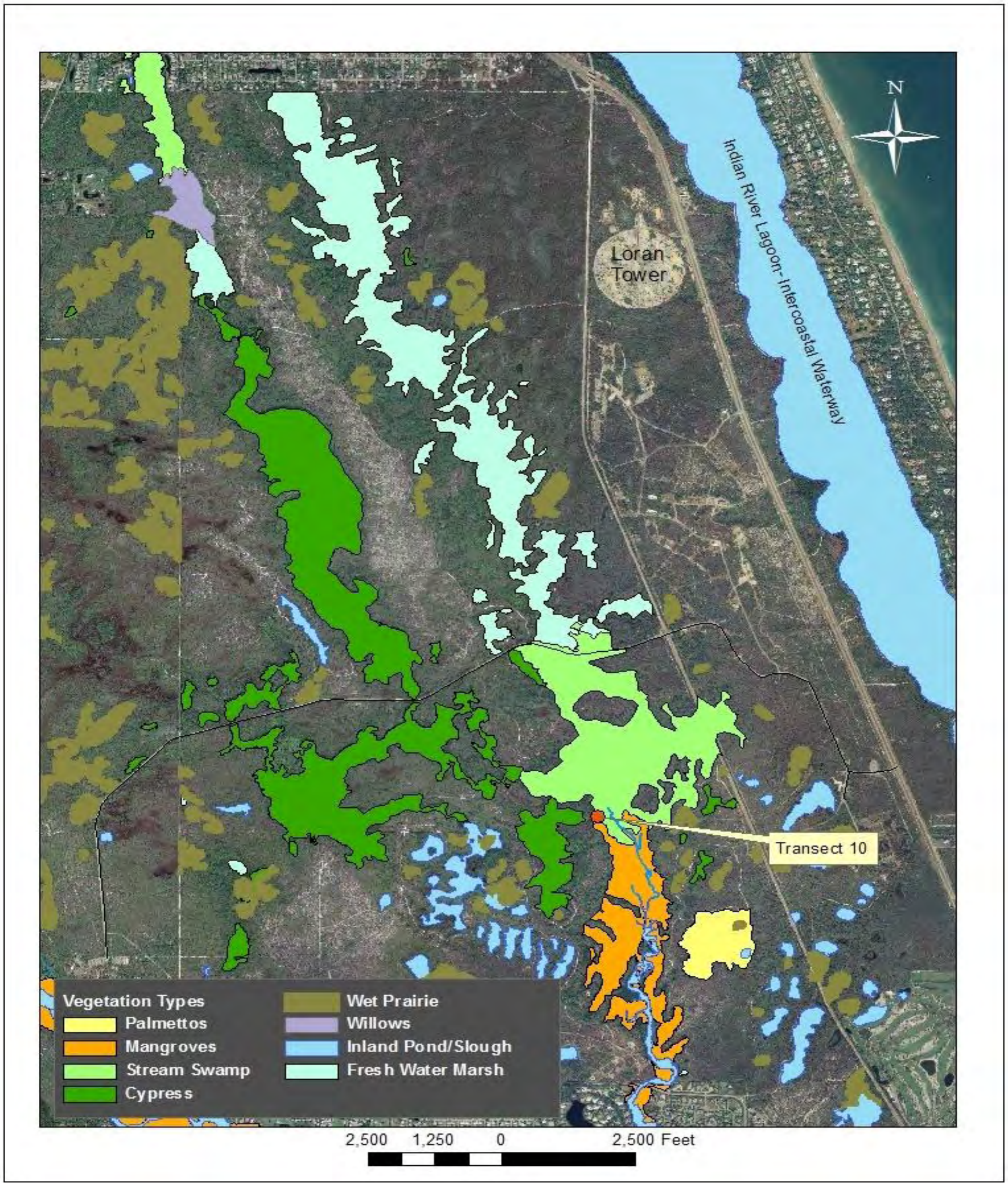


Figure 83. North Fork wetland systems.

During the original field trip in 2003 to establish a vegetative transect on the floodplain of the North Fork, FPS and SFWMD staff investigated three potential locations starting just north of Camp Welaka on the west side of the channel. The first two locations were primarily dominated by white mangrove. At the third location there was a prevalence of freshwater species along a young sub-canopy of mangrove and pond apple. Although it was quite a distance from the fire road for access, the SFWMD survey team established a bench mark adjacent to a fire road and proceeded to measure elevations through the slash pine/ saw palmetto/oak upland system down to the floodplain of the North Fork (not shown in **Figure 84**). Starting from the fire road and benchmark (7.73 ft), elevations within the upland community dropped towards the floodplain. About midway to T10, the topography suddenly flattened and there was a noticeable change in groundcover vegetation. The dominant groundcover became cutthroat grass. Whereas the upland community had been dry and hilly, this area, which was approximately 20 feet in width, was flat, frequently wet, and was dominated by cutthroat grass. This area appears to be a hydric seepage slope in which ground and surface water runoff from the higher elevated upland communities is captured in surface soils and perhaps hits an impermeable layer of soil. Beyond the seepage slope, the upland communities continue their descent to the floodplain.

The drop from uplands into the edge of the floodplain is quite dramatic on Transect 10 on the North Fork. Vegetation changes are immediate. **Figure 84** shows a profile taken from the edge of the floodplain out to the main channel of the North Fork. A narrow band of hydric hammock (7.83 ft) drops down into a marsh system with an average elevation of 6.80 ft. Elevations then rose to 7.03 and 7.83 ft for a UTsw2 plot and a UTmix plot. This was followed by two plots of hydric hammock at an average elevation of 7.13 ft. The last two plots (UTsw2) adjacent to the tributary channel had an average elevation of 7.03 ft. No logging activities had been noted on the floodplain of the North Fork.

Soils in the upland and adjacent hammock community were represented by Waveland sand depressional. In the lower elevations of the transect UTsw2 and UTmix were Okeelanta muck while the two hydric hammock plots were Sanibel muck (**Appendix D)**. The last two plots were Aquents.

Transect 10 is a short transect of 75 meters in length with eight plots. Cabbage palm, pond apple and wax myrtle were the most abundant of the eleven canopy species present (**Figures 85** and **86**). Brazilian pepper and white mangrove were present in small numbers as canopy trees. The largest trees on Transect 10 were cabbage palm, which were found at three dbh size classes (5-60 cm, **Figure 86**). Pond apple was found in the 5-20 cm and 21-40 cm size classes. Most of which were in the smaller class. Ten of the eleven canopy species were present in the 5-20 cm dbh size class. Laurel oak was only found in the 21-40 cm class.

Shrub and groundcover layers consisted mainly of swamp fern, myrsine, saltbush, white mangrove, and pond apple. Bald cypress were recorded in the ground cover layer and were noted as very young trees adjacent to the transect plots. Saw grass was present in the marsh and UTsw2 habitats.

From the young size classes displayed by the canopy on Transect 10, it is concluded that this upper tidal area of the North Fork tributary represents a wetland system in transition due to saltwater intrusion. It appears that it is transitioning from a freshwater coastal marsh and hammock system to a young forested wetland dominated by pond apple and white mangrove.

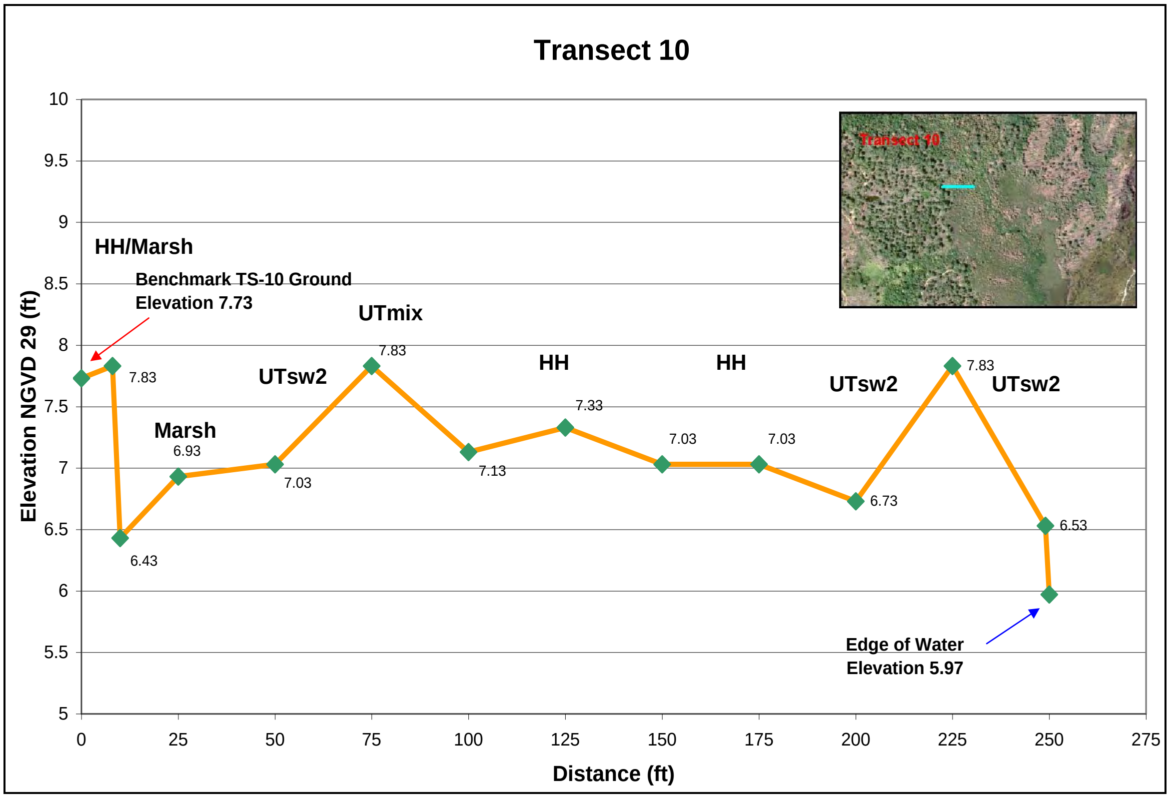


Figure 84. Profile of Transect 10 (North Fork, RM2.44 of NW Fork).

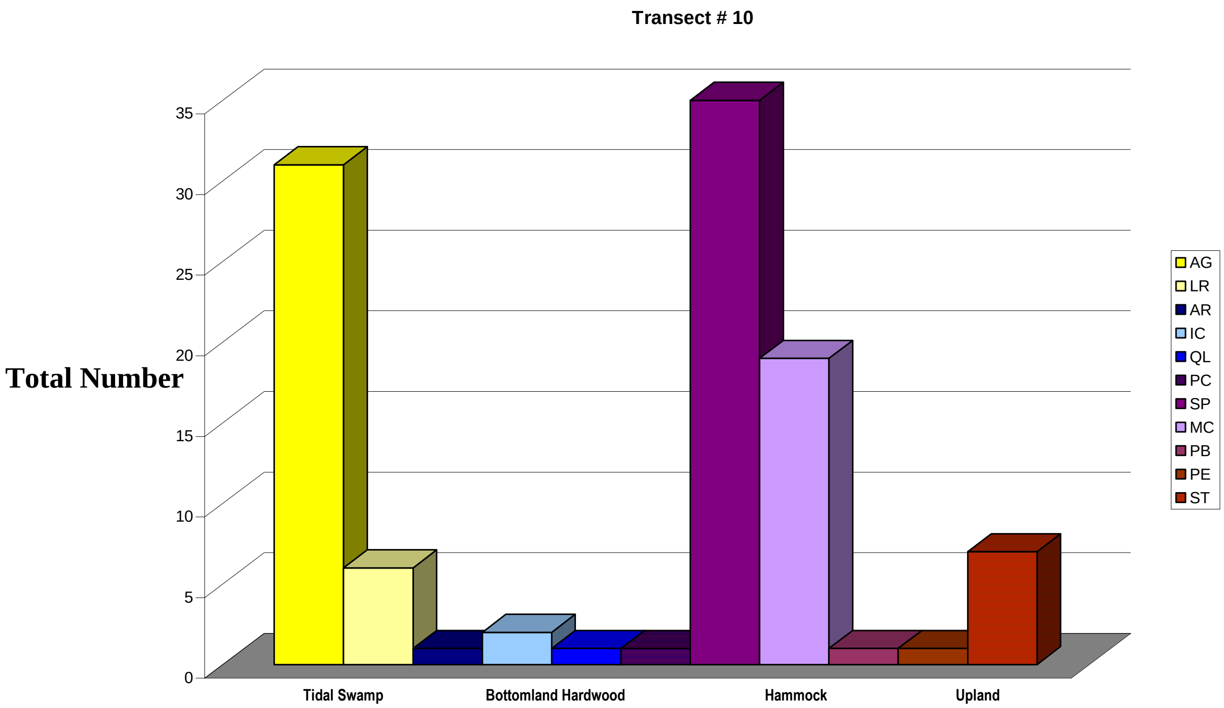


Figure 85. Canopy abundance on Transect 10 (North Fork).

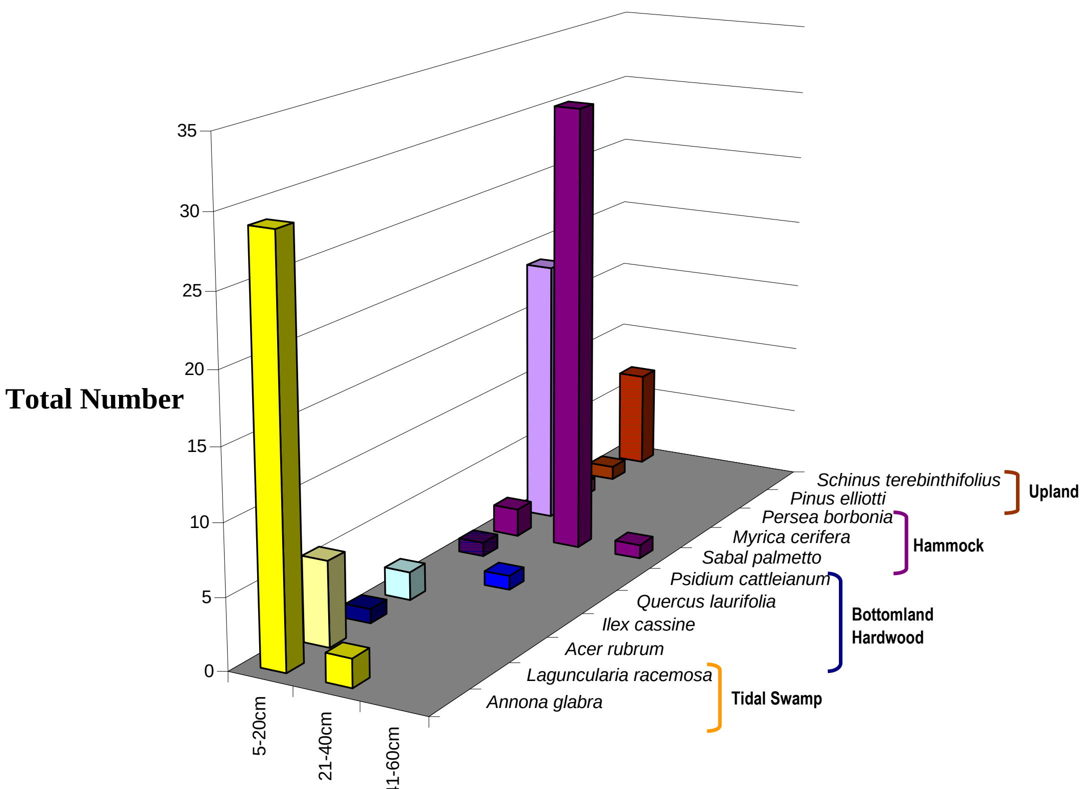


Figure 86. DBH size classes on Transect 10.

SHRUB-LAYER AND GROUNDCOVER COMMUNITIES

Introduction

Shrub-layer and groundcover communities have been used as short term indicators of health in plant communities. Shrub-layer plants show a more intermediate response between the tree canopy and the groundcover while groundcover communities are subject to quick changes compared with canopy and shrub components. 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 (Perry and Hershner, 1999). These species can be used as indicators of subtle hydrological changes in the floodplain that can occur as a result of flow reduction from changes in duration of inundation and saturation, flood depths and changes in salinity (Darst, et. al, 2002). Hydrology was identified as one of the most important factors in maintaining the Loxahatchee River's forest types (SFWMD, 2006). Thus, forest types can shift in plant composition and density, ultimately changing to different forest types due to, for example, the invasion of upland species and exotic pest plants.

Davis (1943) implied that typical shrubs and herbs for south Florida swamps were buttonbush, swamp dogwood, lizard's tail along with some marsh rushes and grasses such as the horned-rush. In addition, he found some plants such as wax-myrtle, red bay, sweet bay, hackberry, sweet-gum, mulberry, and strangler fig that were common in mixed swamps. He identified the typical ferns in the swamp as leather fern, swamp fern and the royal or cinnamon ferns.

Shrub and groundcover communities on the Loxahatchee River and its major tributaries were examined along with canopy communities during the Loxahatchee River 2003 Vegetation Study. The main purpose of this section of our report was to describe the shrub and groundcover communities in more detail and provide background information on known habitat preferences of the species that were present. Complete listings of the shrub and groundcover species by family with known habitat preference are given in **Appendices E-3 and E-4**, respectively. The complete 2003 datasets for shrub and groundcover are given in **Appendices E-5** and **E-19**. Ten of the 138 plots contained no shrubs. They were identified as plots 5, 6, 7 and 15 on T1; plots 17 and 26 on T2; plots 30, 36, and 37 on T3; and Plot 59 on T5. All 138 plots contained some groundcover vegetation, although Plot 99 on T8 contained only the exotic Old World climbing fern at 87.5 percent cover.

In the 2003 survey of shrub and groundcover species, there were 45 shrubs and 103 groundcover plants identified (**Appendices E-3 and E-4**). Of these species, 65 were limited in distribution to a wetland environment, either obligate (OBL, always found in wetlands) or facultative wet (FACW, i.e. more frequently found in wetlands). Additionally, there were 28 species that were classified as facultative (FAC, i.e. found equally in non-wetlands as in wetlands) and 9 species that were upland (UPL, seldom found in wetlands).

When comparing the shrub and groundcover species richness (**Figure 29**), there were no shrub species found that were not also located in the groundcover layers. The upper tidal reach plots had the most shrub species (35), with the riverine next at 24 and lower tidal at 11. However, the lower tidal plots only had 20 forest type plots as compared to riverine at 67 and upper tidal at 51 plots. There was only one shrub species, swamp fern, common to all 10 transects (**Figure 87**). Swamp fern is classified as a native FACW. The groundcover list contained 77 riverine species, with upper tidal next at 60 and lower tidal at 17. There was no groundcover species common to all 10 transects. In the Suwannee River Study (Darst, e. al, 2002), the riverine reach was also found to have a similar pattern of the highest groundcover species richness. As conspicuous as riverine and lower tidal transects are in outward appearances, there were some species similarity in both the shrub and groundcover layers. Within the shrubs, the following were found in both areas: leather fern, pond apple, swamp fern, cocoplum, laurel oak, cabbage palm, Brazilian pepper and saw palmetto. In the groundcover comparisons, those species found in both the riverine and lower tidal areas were: rosary pea, leather fern, pond apple, swamp fern, cabbage palm and muscadine grapevine.

The distribution of the combined shrub and groundcover inventories greatly expands the comparison of the canopy primary selection by both species and forest type. Excluding upland and exotic plants, **Table 13** presents a list of shrub-layer and groundcover plants that were only collected in one particular reach. Sixteen species were only collected in the riverine reach while 10 species were only collected in the upper tidal and one species (coin vine) was collected only in the lower tidal reach.

Appendices E-6 through **E-16** and **E-20** through **E-30** present shrub and groundcover data frequency of occurrence by forest types. With regards to forest type, pop ash was only one of the five primary riverine canopy species (22.6 percent) that was exclusively found within the riverine reach; however, it was also located in three shrub and groundcover forest types (Rblh2, Rsw2 and Rsw1). Conversely, red bay was not a primary canopy species in either the riverine or upper tidal reach, but was exclusively located in one forest type in the shrub and groundcover list (Rmix and UTmix in two reaches). In the riverine reach, one plant (ground nut) was just found in RHH. Three plants (hop sedge, water hickory, and Downy shield fern) were located in Rsw1. In the upper tidal reach species for characteristic shrub and groundcover, one plant (bamboo vine) was found solely in UTMH, and two plants (sawgrass and red bay) were restricted to the UT mix type. One species, lax hornpod, was detected only in UTsw2, and two plants (Carolina willow and pineland pimpernel) were observed nowhere else except in UTsw1. As for the lower tidal reach, the single characteristic shrub and groundcover was one vine, coin vine. Some of the above obligate species, such as golden canna, sawgrass, baby tears, and pickerelweed were found in forest types considered more in keeping with facultative wetland species.

Table 13. Characteristic shrub-layer and groundcover species (i.e. occurring in one particular reach) for each of the three reaches.

Riverine Reach

- *Apios americana*, Ground nut
- *Canna flaccida*, Golden canna
- *Carex lupuliformis*, Hop sedge
- *Carya aquatica*, Water hickory
- *Dichanthelium commutatum*, Witchgrass
- *Fraxinus caroliniana*, Pop ash
- *Ipomoea indica*, Blue morning glory
- *Micranthemum glomeratum*, baby tears/mudflower
- *Panicum rigidulum*, Redtop panicum
- *Parthenocissus quinquefolia*, Virginia creeper
- *Pontederia cordata*, Pickerel weed
- *Psychotria sulzneri*, Wild coffee
- *Rhynchospora rariflora*, Beak sedge
- *Thelypteris dentata*, Downy shield fern
- *Thelypteris serrata*, Meniscium fern
- *Tripsacum dactyloides*, Gamma grass

Upper Tidal Reach

- *Amorpha fruticosa*, False indigo
- *Cladium jamaicense*, sawgrass
- *Cyperus haspan*, Flat sedge
- *Mitreola petiolata*, Lax hornpod
- *Osmunda cinnamomea*, Cinnamon fern
- *Persea borbonia*, Red bay
- *Polygonum hydropiperoides*, Swamp smart weed
- *Salix caroliniana*, Carolina willow

Samolus valesandi, Pineland pimpernel
Smilax laurifolia, Bamboo vine

Lower Tidal Reach
Dalbergia ecastaphyllum, Coin vine

Figure 87. The most common shrub was swamp fern, which was present within all transects and all forest types throughout the year.

Plants of Special Interest

Of the 180 exotic plant species that are found within Jonathan Dickinson State Park (Roberts, et. al., 2006), those that are the most problematic to the floodplain of the Northwest Fork of the Loxahatchee River are Old World climbing fern, nephthytes, wild taro, Brazilian pepper, java plum and strawberry guava. In our research which included non-native shrubs, groundcovers and vines, the primary concern to the existing floodplain was Old World climbing fern. Species that are designated as Endangered, Threatened or Commercially Exploited by the Florida Department of Agriculture and Consumer Services that are found in the floodplain are noted in **Appendices E3 and E-4**.

The Shrub Community

The complete 2003 shrub field dataset is shown in **Appendix E-5** with transect number, plot number, distance from uplands, species code, percent cover, and forest type of the plot. The shrub communities on the Loxahatchee River floodplain consisted of 45 species from 34 different families (**Appendix E-3**). While most of these species were native, 13 percent were non-native. Non-native shrub species consisted of Old World climbing fern, Brazilian pepper, Caesar weed, Indian laurel, strawberry guava, and java plum**.** Most species were classified as facultative or facultative wet (able to live under a variety of conditions). Only 11 percent were strictly classified as obligate wetland species. The following shrub-layer species were found in both riverine and tidal areas: leather fern, pond apple, swamp fern, cocoplum, laurel oak, cabbage palm, Brazilian pepper and saw palmetto. With regards to bald cypress recruitment, no bald cypress trees were found in the shrub-layer in the riverine or tidal reaches during the 2003 study although a few were noted adjacent to some transects.

Table 14 presents the frequency of occurrence of shrub-layer species by transect and **Appendices E-6** through **E-15** present the same information by forest type. Of the 138 plots, the most common shrub species were leather fern (71 plots, 51 percent), swamp fern (37 plots, 27 percent), pondapple (24 plots, 17.3 percent), dahoon holly (24 plots, 17.3 percent), button bush (23 plots, 16.6 percent), Brazilian pepper (21 plots, 15.2 percent), and tri-veined fern (16 plots, 11.6 percent).

With the exception of some fern species, the frequency of occurrence of shrub-layer species in the riverine Transects 1, 2, 3, 4, and 5 (**Table 14**, green columns and **Appendices E-6 through E-10**) was low presumably due to the thick canopy cover and low levels of light reaching the floor of the floodplain in this reach. The most frequently occurring species in the riverine reach were swamp fern, leather fern (**Figure 88**), maiden fern and Virginia willow. In the riverine reach, leather fern, Virginia willow, and tri-veined fern were found in hydric hammock, bottomland hardwood, but primarily in swamp forest types. Swamp fern was found in similar forest types with the addition of mesic hammock. With regards to shrub-size canopy species, the most common in the riverine reach were cabbage palm (T1, 2 and 5) and red maple, (T1, 2 and 4). Cabbage palm was observed in several forest types including upland, mesic and hydric hammock, and bottomland hardwood. Red maple was observed only in the bottomland hardwood and swamp forest types. Pond apple was present on T1 and 4 in bottomland hardwood and swamp forest types. Pop ash was only present on T4 in the swamp.

Figure 88. Note the extensive distribution of shrub and groundcover (mostly leather fern) in the swamp at T1 and the shading provided by the canopy prior to the hurricanes. Both of these conditions may have prevented the recruitment of new canopy trees and indicates shorter flood durations in the swamp community.

Table 14. All Transects: Shrub-layer Frequency of Occurrence

Shrub Layer Species: Occurrence	Transects and Number of Plots ( )									
	1 (15)	2 (13)	3 (13)	4 (12)	5 (14)	6 (16)	7 (15)	8 (12)	9 (20)	10 (8)
Red maple		1		3				1		
Leather fern	4	3	5	4		13	13	10	16	3
False indigo							2	1		
Pond apple	2			1		4	7	6	2	5
Marlberry	2	3			2			1		
Salt bush							3	3		
Swamp fern	3	2	1	4	8	2	6	5	1	5
False nettle								2		
Beautyberry	2	3								
Button bush	1	1	1	1		5	7	4		3
Coco plum		1						1	3	
Saw grass										5
Indian laurel ficus									1	
Pop ash				2		2	6			
Dahoon holly										1
Blue morning glory	1									
Virginia willow		4		6				1		
White mangrove						3		3	2	1
Old World climbing fern								1		
Staggerbush							1			
Wax myrtle						2	7	7		8
Boston fern							1			
Cinnamon fern							1			
Royal fern						1	4	1		
Red bay										1
Marsh fleabane								3		
Strawberry guava						1		4		2
Wild coffee (*nervosa*)	1		1	2	1					
Wild coffee (*sulzneri*)			1		1					
Laurel oak					1				1	
Live oak						1				
Myrsine			1			1	2			2
Rubber vine									1	
Red mangrove						6	1	1	5	
Cabbage palm	3	1			2		2	1	1	1
Brazilian pepper				1		3	1	4	7	5

Transects	1	2	3	4	5	6	7	8	9	10
Saw palmetto		1		1	2	1	1	1		
Java plum							5			
Downy shield fern								1		
Marsh fern						1				
Tri-veined fern	2	1	4	6	1			2		
Meniscium fern		2	4	1						
Poison ivy								1		
Fakahatchee grass			1							
Caesar weed		1	1		1					
Muscadine grape vine			1							

In the upper tidal reach (Transects 6, 7, 8, and 10, yellow columns), the most frequently occurring shrub-layer species were leather fern, wax myrtle, pond apple, button bush, and swamp fern (**Table 14** and **Appendices E-11 to E-13 and E15**). Leather fern and wax myrtle were found in hydric hammock, mixed (UTmix), swamp and marsh forest types while pond apple was found in mixed, swamp, and marsh forest types. Swamp fern was found in upland, hydric hammock, mixed, swamp, and marsh forest types. Wunderlin and Hansen (2003) indicated that it was common in swamps, marshes, wet prairies, and hammocks throughout the Florida peninsula all year.

In the lower tidal reach (T9, tan column), the most frequently occurring shrub-layer species were leather fern, Brazilian pepper, and red mangrove. There were very few occurrences of shrub-size white mangrove, pond apple, and cabbage palm. Only 11 shrub-layer species were present in the lower tidal probably due to higher tidal inundation and higher salinity levels.

Appendices E-17 and **E-18** illustrates the percent cover of shrub-layer species by plot. Leather fern occurred in 51 percent (71) of the plots and primarily (78 percent) in the swamp forest type while swamp fern occurred in 37 percent of the plots but occurred just as frequently in the swamp (11.5 percent) and hammock (11.0 percent) forest types. Pond apple occurred in 19.6 percent of the plots and was present primarily in the swamp forest type (66.6 percent). Wax myrtle occurred in 17.3 percent of the plots and were present primarily (41.6 percent) in mixed forest types. Wax myrtle occurred on every plot of T10 with percent cover ranging from 7 to 43 percent. Buttonbush occurred on 16.7 percent of the plots and were present primarily (41.6

percent) in swamp forest types. The exotic, Brazilian pepper was present on 15.2 percent of the plots with 66.6 percent found in swamp forest types. Shrub-size cabbage palms were only found on 7.97 percent of the plots but they were found in all most every forest type from upland to swamp. Tri-veined fern were present on 11.6 percent of the plots and were primarily (62.5 percent) found in the swamp.

Also, **Appendices E-17 and 18** present the dataset for percent cover of shrub-layer species by plot and by reach. Percent cover of shrub-layer species was low in the riverine reach due to the heavy canopy. Leather fern occurred as high as 45 percent on T1, 65 percent on T2, 48 percent on T6, 99 percent on T7, and 56 percent on T8. On Transect 2, leather fern was observed at 45 percent while saw palmetto and Virginia willow were observed as high as 37 and 32 percent, respectively. Transect 3 was dominated by leather fern present as high as 65 percent and to a lesser degree myrsine (27 percent) and wild coffee (19 percent). Cabbage palm had the highest percent cover on Transect 1 at 25 percent followed by swamp fern with 17 percent and leather fern and swamp lily at 14 percent. The percent cover of shrub-size red and white mangrove was highest on T6 with percentages as high as 82 percent for red mangrove and 73 percent for white mangrove.

The Groundcover Community

Appendix E-4 presents the groundcover species by family with native or exotic and wetland designations. The entire 2003 groundcover dataset is shown in **Appendix E-19**. **Appendices E-20** through **E-29** displays frequency of occurrence of species by transect and forest type while **Appendix E-30** illustrates percent frequency of occurrence of each groundcover species by forest type within all 138 vegetative plots combined. The groundcover communities on the floodplain of the Loxahatchee River consisted of 103 species from 36 different families. Fourteen percent of the species were non-native and one species, baby tears/mudflower, was endemic to Florida (**Appendix E-4**). Most species were facultative wet or facultative. Twenty species were strictly classified as obligate. As facultative implies many species were found in a variety of floodplain forest types (**Appendices E-20 through E-30**). Only swamp fern was found in all 11 forest types while tri-veined fern and poison ivy were found in 9 forest types (**Appendix E-30**). Wild coffee (*P. nervosa*) and lizard's tail were found in 8 forest types. Several uncharacteristic occurrences in the swamp were noted particularly of bottomland hardwood species such as red maple, water hickory, button bush, and cabbage palm, a hammock species. This may be another indication that hydroperiods particularly in the riverine reach are too short in duration.

The groundcover list contains 77 riverine species, with upper tidal next at 60 and lower tidal at 17**(Table 15**). There were no species common to all 10 transects except swamp fern. In the Suwannee River Study (Darst, et al., 2002), the riverine reach was also found to have a similar pattern of the highest groundcover species richness. As conspicuously different as riverine and lower tidal transects are in outward appearances, there were some species similarity in both the shrub and groundcover layers. In the groundcover comparisons, those species found in both the riverine and lower tidal areas were: rosary pea, leather fern, pond apple, swamp fern, cabbage palm, and muscadine grape vine. The most frequently encountered groundcover species in the riverine reach were swamp fern, pennywort, wild coffee, cabbage palm, lizard's tail, tri-veined fern, and Caesar weed while the most frequently encountered species in the tidal reaches were pond apple, water hyssop, swamp fern, and white mangrove. The lower tidal reach groundcover community was dominated by white mangrove, pond apple, and rubber vine.

Table 15. All Transects: Groundcover Frequency of Occurrence.

Groundcover Species: Occurrence	Transects and Number of Plots ( )									
	1 (15)	**2 (13)**	**3 (13)**	**4 (12)**	**5 (14)**	**6 (16)**	**7 (15)**	**8 (12)**	**9 (20)**	**10 (8)**
Rosary pea	1								2	
Red maple	2		2	4	5					
Leather fern	2	1				8	5	2	5	
Alligator weed	1									
Joy weed	3									
False indigo							2			
Pond apple	3		2			11	2	6	13	7
Ground nut			1							
Marlberry	1	3			1					
Groundsel					1		1	3		1
Water hyssop						4	2	8	4	4
Tar flower						1				
Beggar ticks					1					
Bishop wood					1					
Swamp fern	4	8	4	6	12	11	6	6	1	7
False nettle	2		2	2	6		2	3		
Beautyberry	1	3								
Golden canna	2		1							
Hop sedge	2				3					
Water hickory		3		2	7					
Buttonbush						1	4	1		
Partridge pea			1							
Cocoplum									3	
Sawgrass										1
Dayflower	4	5	2		8					
Swamp lily	9	5	5	5		4	7	5		2
Flat sedge										2
False sawgrass									1	
Flat sedge		1								
Coin vine									1	
3 flower beggar weed									1	
Witch grass	1				6					
Witch grass spp.		4	5	10	4	1	2			
Road grass						1				
Fire weed			1							
Jack-in-the-bush					1					
Pop ash			3		1					
Milkpea sp.										
Pennywort spp.	5	4	2	1	1	1	2	5		1
E. Indian swamp weed					1					
St. John’s wort spp.			2							
Musky mint			1				1			
Ink berry							1			
Blue morning glory		1	4	1	2	1				
Virginia willow		4	2	3	3		2			
White mangrove						6	4	7	16	5

Transects	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Marsh weed				1						
Primrose willow								1		
Creeping primrose willow			1	2			5	5		1
Primrose seedling	1		3		1		1	3		
Old World climbing fern			1	2		2		2		1
Fetterbush						2	1			
Baby tears/mudflower			1							
Hemp vine		2	1				2	5		2
Sensitive brier			1						1	
Wax myrtle					1	1		1		1
Wild Boston fern								1		
Cinnamon fern							2			
Royal fern	1	1		1		1	4	5		
Redtop panicum			1	1				1		
Switch grass										1
Virginia creeper	3			2						
Red bay								1		
Resurrection fern										1
Swamp smart weed										4
Dotted smart weed							1	3		
Strawberry guava										1
Whisk-fern						2				1
Wild coffee (*nervosa*)	4	4	1	1	3		2			
Wild coffee (*sulzneri)*	1	1	6	2	5					
Myrtle oak									1	
Oak seedling	2		1		3	1	1			
Live oak	1		1	1		1				
Myrsine					1	1	1	1		
Rubber vine						6	2		9	2
Red mangrove						11	3	1	7	
Beak Sedge (*inundata*)			1					2		
Beak sedge (*rariflora*)			1							
Blackberry			1							
Cabbage palm	5	3	1	1	1		1		7	1
Broadleaf arrow head			1					1		
Carolina willow							1			
Pineland pimpernel						1		1		
White vine						5	10			4
Lizard's tail	7	6	10	8	2		8	10		
Brazilian pepper			3			3				4
Climbing cassia	1									
Saw palmetto				1	1	1			1	1
Wire weed					1					
Greenbrier	1		3	1	3	1	1			
Greenbrier seedling				2						
Nephthytes	2									
Java plum							3			
Bald cypress								1		
Downy shield fern	2	1		1	1					
Tri-veined fern	7	7	10	11	11	5	2	2		
Marsh fern			1			1	1			

Transects	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Meniscium fern	1	5	5	1						
Cardinal airplant					1					
Needle leaf airplant					1					
Poison ivy	2		2	2	3	4	13	6		2
Unid. Cyperaceae			2	1	1					1
Unid. Poaceae			1	2	6		1	3	2	2
Unidentified seedling	12	8	7	6	8	4	6	1		
Unidentified spp.	2				2		1	1		
Unidentified Xyris				1						
Caesar weed	4	2	4	2	2					
Muscadine grape vine	2	1	3				1		1	
Creeping oxeye	1									
Wild taro	1									

Stem Counts

Stem counts were examined to identify and quantify current groundcover communities and to examine future recruitment into the shrub and canopy layers within the Loxahatchee River floodplain. In general, the total stem counts (**Table 16**) were not as expected. The upper tidal area is the reach undergoing the most disturbances, with the riverine presumably being the most stable reach. Basically, the lower tidal regions have already completed the transition from a freshwater to a saltwater community. However, in the number of species, the riverine and upper tidal reaches were almost equal (with 68 to 60 respectively) and the lower tidal reach with only 17 species. Even more important, the comparison of the total stem counts revealed the riverine reach with 4106 stems and the upper tidal reach with 1632 stems, or the opposite of what was expected. In looking at the number of stems per plot, the riverine reach had twice as many stems (61) as the upper tida1 reach (32) and almost 4 times as many as the lower reach (18). Most stems in the riverine reach were swamp fern (632) and marsh fern (923). The upper tidal reach was dominated by *Ludwigia* seedlings (395), water hyssop (327), and swamp fern (227) while the lower tidal reach was dominated by marsh weed (121), water hyssop (100), and pond apple (97). In the tidal reaches, white mangrove seedlings (251) were more abundant than red mangrove seedlings (104). Only two bald cypress seedlings were observed on the ten transects (T2 and T8), which supports our theory that bald cypress recruitment is poor on the Loxahatchee River floodplain. Very young bald cypress seedlings were observed in the vicinity of T6 and T7 in late fall 2003; but, either cold weather, salt water, and or prolonged flooding caused their mortality. Bald cypress seed sources were also reduced by the three 2004-2005 hurricanes that impacted the area. There also appears to be poor recruitment of red maple and water hickory within the transects. Only 35 seedlings of red maple were observed and they were all reported from the riverine reach. Similarly, there were only 44 seedlings of water hickory observed and they were all reported from the riverine reach. Of the 17 pop ash seedlings observed within the transects, 16 were reported from T3 and one was from T5 in the riverine reach. With regards to pond apple seedlings, there were only 8 in the riverine and 95 in the upper tidal and 97 in the lower tidal, which leads us to believe that the riverine floodplain swamp is too dry to support them. They were only observed on the bank of the river channel or in the river in the riverine reach. Forty five seedlings of cabbage palm were observed. There were primarily found in the riverine (19) and lower tidal (24) reaches.

Table 16. Groundcover stem counts by reach and transect.

Groundcover Species: Stem Count	Reach			Transects										
Species	**Riverine**	**U. Tidal**	**L. Tidal**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Rosary pea	1		39	1								39		40
Red maple	35			2		22	5	6						35
Leather fern	7	46	37	4	3				31	12	3	37		90
Alligator weed	6			6										6
Joyweed	11			11										11
False indigo		3								3				3
Pond apple	8	95	97	6		2			29	3	32	97	31	200
Ground nut	2					2								2
Marlberry	36			2	33			1						36
Groundsel	1	15						1		4	6		5	16
Salt bush	1					1								1
Water hyssop		327	100						83	2	191	100	51	427
Tar flower		2							2					2
Beggar ticks	2							2						2
Bishop wood	6							6						6
Swamp fern	632	227	1	121	185	51	54	221	70	43	46	1	68	860
False nettle	59	8		4		4	3	48		3	5			67
Beautyberry	8			2	6									8
Golden canna	1					1								1
Hop sedge	9			3				6						9
Water hickory	44				11		3	30						44
Buttonbush		7							2	4	1			7
Partridge pea	3					3								3
Jack-in-the-bush	1							1						1
Cocoplum			42									42		42
Sawgrass		2											2	2
Wild taro	3			3										3
Dayflower	269			81	59	6		123						269
Swamp lily	121	89		52	21	18	30		23	17	37		12	210
Flat sedge		2											2	2
False sawgrass			1									1		1
Flat sedge	5				5									5
Flat sedge seedling	1						1							1
Coin vine			1									1		1
3 flower beggar weed			3									3		3
Witchgrass	99			7				92						99
Witchgrass spp.	134	7			17	24	11	46	2	5				141
Road grass		5							5					5
Fire weed	3					3								3
Fern juvenile (JUVFER)	4	1		2	2					1				5
Pop ash	17					16		1						17

Species	Riverine	U.Tidal	L.Tidal	1	2	3	4	5	6	7	8	9	10	Total
Pennywort spp.	238	135		44	173	6	11	4	2	11	105		17	373
E. Indian swamp weed	3							3						3
St. John's wort spp.	3					3								3
Musky mint	5	1				5				1				6
Ink berry		8								8				8
Blue morning glory	6	3			1	27	1	5	3					28
Virginia willow	44	2			13	6	11	14		2				44
White mangrove		130	121						22	4	64	121	40	251
Marsh weed	5						5							5
Primrose willow		1									1			1
Creeping primrose willow	4	395				1	3			24	359		12	399
Primrose seedling	6	31		1		4		1		2	29			37
Old World climbing fern	59	47				1	58		9		36		2	106
Fetterbush		23							10	13				23
Baby tears/mudflower	35					35								35
Hempvine	6	18			5	1				4	11		3	24
Sensitive brier	1		2			1						2		3
Lax hornpod		4								4				4
Wax myrtle	1	5						1	3		1		1	6
Wild Boston fern	5	1			5						1			6
Cinnamon fern		16								16				16
Royal fern	23	61		6	8		9		1	38	22			84
Redtop panicium	2	3				1	1				3			5
Switch grass		3											3	3
Virginia creeper	10			7	1		2							10
Red bay		1									1			1
Resurrection fern		1											1	1
Swamp smart weed		21											21	21
Dotted smart weed		6								3	3			6
Strawberry guava		1											1	1
Whisk fern		10							9				1	10
Wild coffee (*nervosa*)	90	2		62	9	7	1	11		2				92
Wild coffee (*sulzneri*)	94			3	4	48	9	30						94
Myrtle oak			4									4		4
Live oak	3	19		1		1	1		19					22
Myrsine	1	3						1	1	1	1			4
Rubber vine		30	19						22	3		19	5	49
Red mangrove		63	41						58	4	1	41		104
Beak sedge (*inundata*)	6	17				6					17			22
Beak sedge (*rariflora*)	1					1								1
Blackberry	3					3								3
Cabbage palm	19	2	24	12	4	1	1	1		1		24	1	45
Broadleaf arrow head	1	1												2
Carolina willow		2								2				2
Pineland pimpernel		7							1		6			2
White vine		41							8	28			5	41
Lizard's tail	308	214		46	109	105	44	4		74	140			522

Species	Riverine	U.Tidal	L.Tidal	1	2	3	4	5	6	7	8	9	10	Total
Brazilian pepper	3	23				3			5				18	26
Climbing cassia	3			3										3
Saw palmetto	5	3	2				1	4	2			2	1	10
Wire weed	1							1						1
Greenbrier	26	7		1		8	4	13	1	6				33
Greenbrier seedling	2						2							2
Creeping oxeye	1			1										1
Nephthytes	2			2										2
Java plum		10								10				10
Bald cypress	1	1			1						1			2
Downy shield fern	68			34	3		27	4						68
Tri-veined fern	923	60		177	200	243	199	104	48	5	7			983
Marsh fern	8	16				8	1		8	8				24
Meniscum fern	235			2	83	137	13							235
Cardinal airplant	1							1						1
Needle leaf airplant	1							1						1
Poison ivy	23	79		3		2	9	9	6	43	25		5	102
Unidentified Poaceae	87	18	21			27	2	58		2	14	21	2	126
Unidentified seedling	466	19		319	54	52	14	27	9	8	2			485
Unidentified spp.	35	4		29				6		1	3			39
Unidentified Xyris	1						1							1
Caesar weed	162			6	14	116	14	12						162
Muscadine grapevine	12	3	6	3	1	8				3		6		21
Total Number of Stems	**4106**	**1632**	**362**	**521**	**551**	**469**	**426**	**852**	**363**	**243**	**412**	**362**	**174**	**7588**
Total Stems/#Plots	**61**	**32**	**18**	**35**	**42**	**36**	**36**	**61**	**23**	**16**	**34**	**18**	**22**	**55**
Number of Species*	**68**	**57**	**17**	**32**	**24**	**36**	**26**	**31**	**26**	**33**	**27**	**17**	**23**	**100**

*includes only those species identified to genus and species.

Shrub and Groundcover Communities and Hydrology

Climate and hydrology are two of the most important factors in maintaining the river's forest types (SFWMD, 2006). The field work for this study was done between July and November 2003, which was a year when rainfall and water levels were variable by month. Leading up to the 2003 study, rainfall was low and subsequently flows over Lainhart Dam were low in the last quarter of 2002. Mean monthly rainfall values from January to March 2003 at the JDWX weather station were an inch or less (**Figure 7**, Rainfall and Hydrology Section). Thirteen inches of rain were recorded between April and June 2003. July 2003 was dry for the wet season with only 3 inches of rain recorded. During the late wet season (August), almost 10 inches of rain were recorded.

Mean monthly flows over Lainhart Dam (**Table 3**, Rainfall and Hydrology Section) reflected rainfall amounts received at the JDWX weather station. Flows of about 90 cfs represent a top of bank condition at T1 while flows of about 110 cfs represent inundation of the swamp community (SFWMD, 2006). Between January and April 2003, flows over Lainhart Dam were estimated at 22, 14, 62, and 46 cfs, respectively. May 2003 was estimated at 119 cfs while June, July and August were estimated at 137, 48, and 149 cfs. Most of the preceding year's dry and wet seasons (2002) had been extremely dry with only three months (February, June and July) of the year with mean monthly flows greater than 100 cfs.

The shrub and groundcover communities of the Loxahatchee River floodplain reflect both the landscape position and hydrology of the period of data collection. Many species observed in all reaches grow in varied microtopographical elevations. These variations can include mounds from uprooted trees, fallen logs or cypress knees. These areas of higher elevation can result in better seedling germination and less potential for harm by flooding. Conversely, they can be more impacted by prolonged drought and years of extremely short hydroperiods. Within the average topographical gradient, a prolonged period without adequate hydroperiod and soil moisture would facilitate upland species (facultative and facultative upland) to germinate in areas otherwise too inundated with water for most of the year. Without higher inundation, these species would also have time to develop.

DISCUSSION AND CONCLUSION

COMPARISONS BETWEEN 1985, 1995, 2003, AND 2006 STUDIES

McCune and Grace (2002) defined species richness as an inequality in relative abundance expressed as a component of diversity in the number of species in a sample unit or other specified area. Also, they pointed out that species richness is very sensitive to the sampling unit area and the skill of the observer (e.g. error is greater with taxonomically difficult organisms). In the 2002 MFL document for the Northwest Fork of the Loxahatchee River , Figures 24 and 25 illustrated a linear relationship (R^2= 0.9317 and R^2= 0.9728) between the number of vascular plant species and miles from the inlet/river mile (RM 8 to 10.5). We wanted to see if that would still hold true in multiple-year studies and in a longer river mile span of the Loxahatchee River and its major tributaries.

Figure 89 provides a comparison of species richness by transect for each of four Loxahatchee vegetation studies (1985, 1995, 2003, and 2006). There was a very poor relationship between species richness and river mile over this river span that included segments of the riverine and tidal reaches (RM 6.46 to 14.5 on the NW Fork). Our results typically showed that species richness increased during dry years and was higher in areas that had been disturbed by lumbering and/or hurricane events. The high winds of hurricane events can spread plant seeds over wide areas. With regards to multi-year studies, the 1995 Study (a wet year) and 2006 Observations (a dry year), species richness for T1 through T6 (RM 14.7 to RM 8.43) showed very similar patterns. Part of this observation can be explained by the fact that the actual plant surveys were more extensive in 1995 and 2006. In addition, the 2006 Observations which had some of the highest values for species richness (T3 and T5) were conducted after three hurricanes had impacted the area. On the other hand, the 1985 and 2003 studies consistently possessed lower species richness. 1985 species richness values may have been low due to apparent freezes that occurred during the winter months (**Appendix B**).

Figure 89. A comparison of species richness for the four studies.

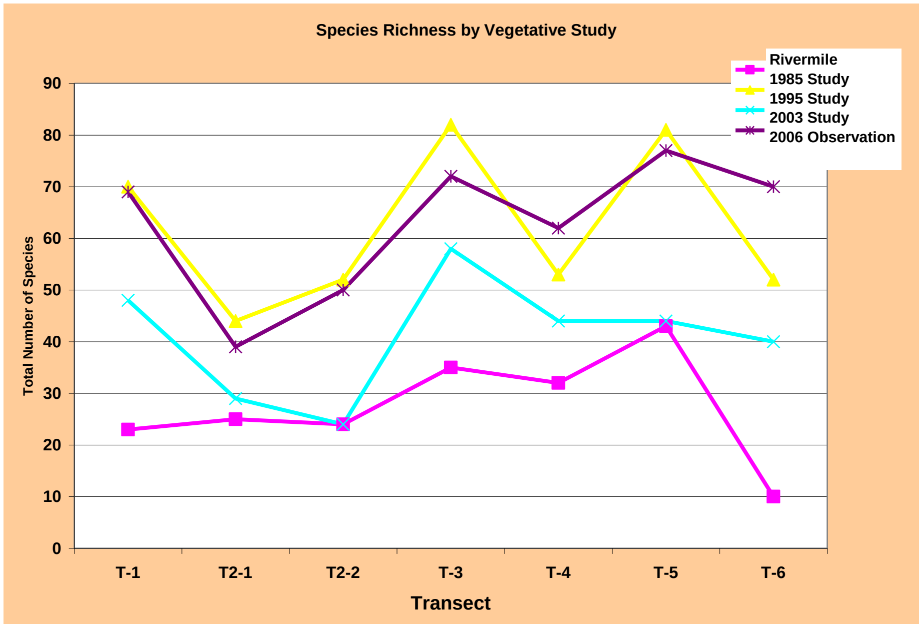


Figure 90. A comparison of species richness per plot for the 2003 and 2006 studies.

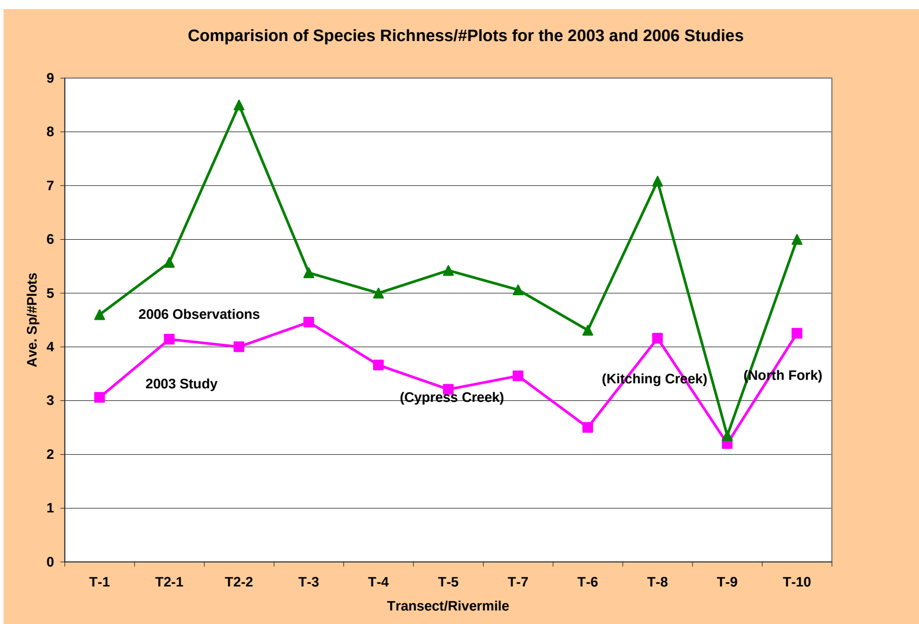


Figure 90 illustrates the same concept except number of plots within a transect is added to the equation to obtain an average number of species per plot for each of the 10 transects examined in 2003 and 2006. Again 2006 had the more extensive plant survey so species per plot were higher than 2003. The greatest change between 2003 and 2006 occurred on T2-2, which is a mature cabbage palm hammock with two additional swamp plots adjacent to the river channel. The additional 20 species documented in 2006 might be attributed to the combined impact of increased light levels as a result of the hurricanes and feral hog disturbance at this site. The low species richness values at T2-1 might be a factor of Masten Dam acting as a semi-impoundment. T6 and T9 (the furthest downstream locations) had the lowest values of species per plot most likely due to higher salinities and higher and longer periods of tidal inundation. Transect 8 (Kitching Creek), which has an understory of mangroves mixed with the freshwater canopy, had the second highest species richness in 2006. From its location on Kitching Creek, Transect 8 has also experienced probably lower salinity values over time than the other tidal transects located on the Northwest Fork. As with the other upper tidal transects on the Northwest Fork, past lumbering activities is a factor in increasing species richness, which was also a factor on Transect 8. Transect 3 also had displayed impacts of lumbering activities. Overall, 2006 had greater species richness on all 10 transects. In our opinion, this is a direct result of a combination of hurricane impacts (i.e. increases in light availability as a result of the damaged canopy) and the extremely dry conditions of 2006.

Appendix I contains a summary table of the plant species observed in the 1985 SFWMD Study (Z, Dewey Worth), 1995 Ward and Roberts Study (**X**), the 2003 Study (**0**), and the 2006 Observations (**Y**) by transect. The plant lists for these tables include all three layers of the floodplain community (canopy, shrub, and ground cover). The 1985 and 1995 studies did not include T7, T8, T9 and T10, which were established in the 2003 Study. On T1 in the riverine reach, the number of species increased from 23 and 27 in 1985 and 1995 to 72 species in 2006. On T6 in the tidal reach, there is also a trend of more species present from 10 species in 1985 to 37 in 1995 and 40 in 2003 and 70 in 2006.

Most exotic species appear to have increased during the study periods. Brazilian pepper was totally absent from T5 in all years and was not found until 1994-1995 on T1, T2, and T3 and not until 2003 on T4 (**Appendix I**). It was also not found on T1 and T2 in 2003 and 2006. Java plum was only found on T1 (1985, and 1995), T5 and T6 (2006 only), and T7 (2003 and 2006) Strawberry guava was only found on T1 and T2 in 1995 and on all of the tidal transects. Old

World climbing fern was found on all transects; however only recently (2006) on T1. It was first observed on T3, T4 and T5 in 1985.

We also looked at the dbh size class frequency of various canopy species from the 1985, 1995 and 2003 abundance datasets. As Darst (2008) noted the size of trees roughly correlates to their comparative age, because dbh increases with age. By comparing the dbh size class frequencies between the three decades we can observe growth, maturation, death and recruitment in the floodplain forest. The first species that we wanted to look at was cabbage palm, which were found on all transects. **Figure 91A-E** shows the dbh size frequencies for cabbage palm on T1, T2, T3, T4 and T5. All 5 transects showed very little new recruitment into the first canopy size class (5-20cm). T1, T2, T3 and T4 exhibited loss of trees between 1985 and 2003. The largest loss (39 percent) was in the 21-40 cm size class on T1. T2, which has an extensive cabbage palm hammock, showed only one recruit in 1985, no recruits in 1995 and 2003 and a gradual loss of trees in the 21-40cm size class between the three decades (10 percent in 1995 and 28 percent in 2003).

Red maple also declined in numbers particularly on T3 and T5 between 1985 and 2003 (**Figure 92A-D**). On T3 there was about a 45 percent loss between 1985 and 1995 and a 55 percent between 1985 and 2003 in the 5-20 cm size class. On T5 there was a 71 percent drop between 1985 and 1995 and an 87 percent drop between 1985 and 2003. Red maple was present on T2-2 in 1985 and 1995 but absent in 2003 and 2006 (**Appendix I**). There were only 35 total red maple seedlings reported in the 2003 groundcover stem count dataset from the ten transects. From our field observations, we believe that large red maple and water hickory are particularly susceptible to injury (mainly tipovers) and have shallower root systems than bald cypress and cabbage palm.

Water hickory may have been impacted by the hurricanes in 2004 and 2005; but, they were in trouble prior to those events. They were present at T2, T4 and T5 in 1985 and 1995, but were not present at T1, T2-2 and T-3 in 2003 and not present at either T2-1 or T2-2 in 2006 (**Appendix I**). However, water hickory did appear in 2006 at T6 in the tidal reach, which is probably a good sign that surface and groundwater salinities were fresher. The dbh size class frequency 5-20 cm remained about the same on T2 through the three decades; however, they showed signs of decline on T4 and T5 in the 5-20 and 21-40cm size class frequencies (**Figure 93 A-C**). There was some apparent growth of trees on T5 in the 41-60 cm and 61-80cm between the three decades.

Figure 91. Dbh size classes of cabbage palm.

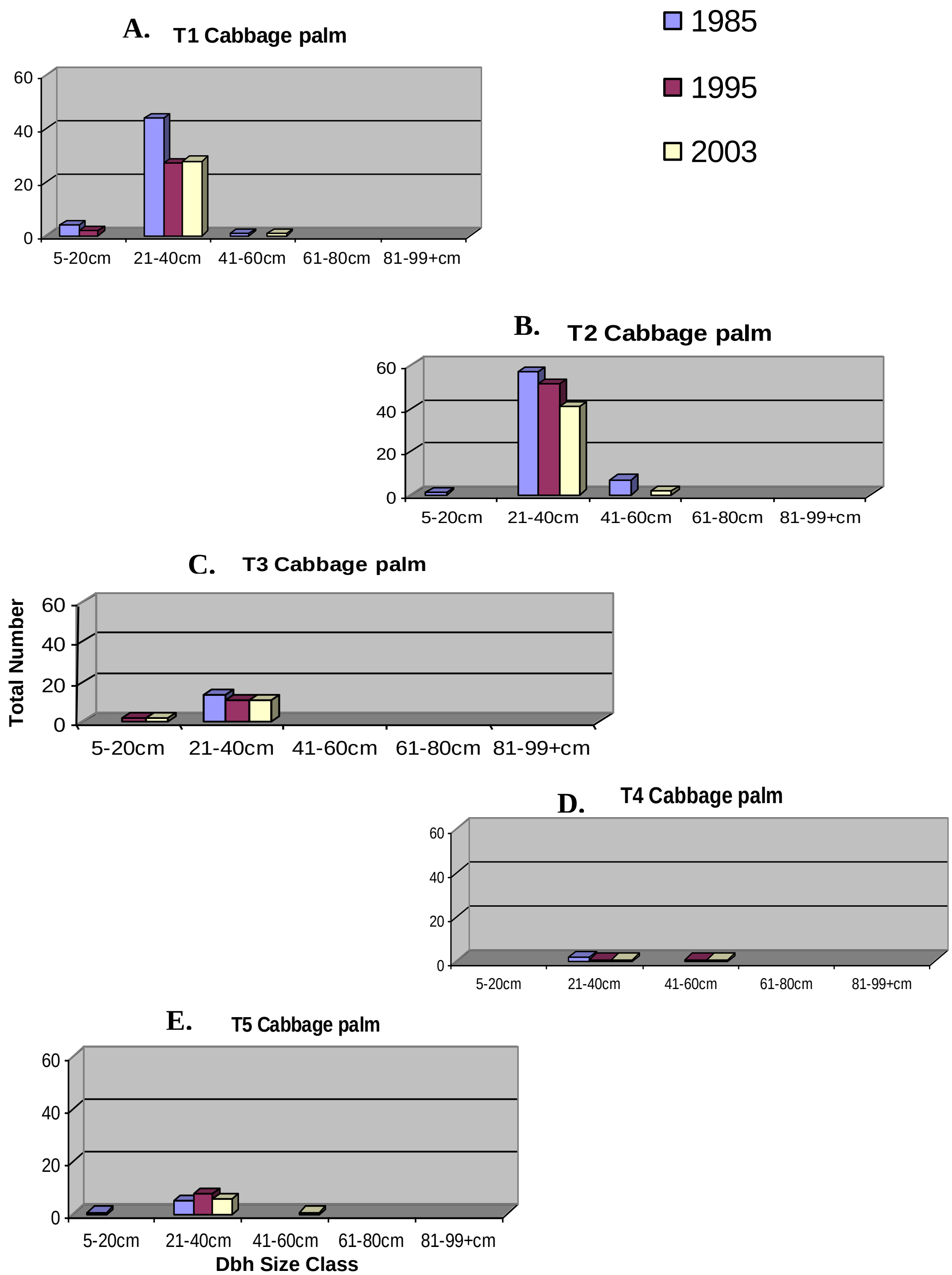


Figure 92. Dbh size class frequencies for red maple.

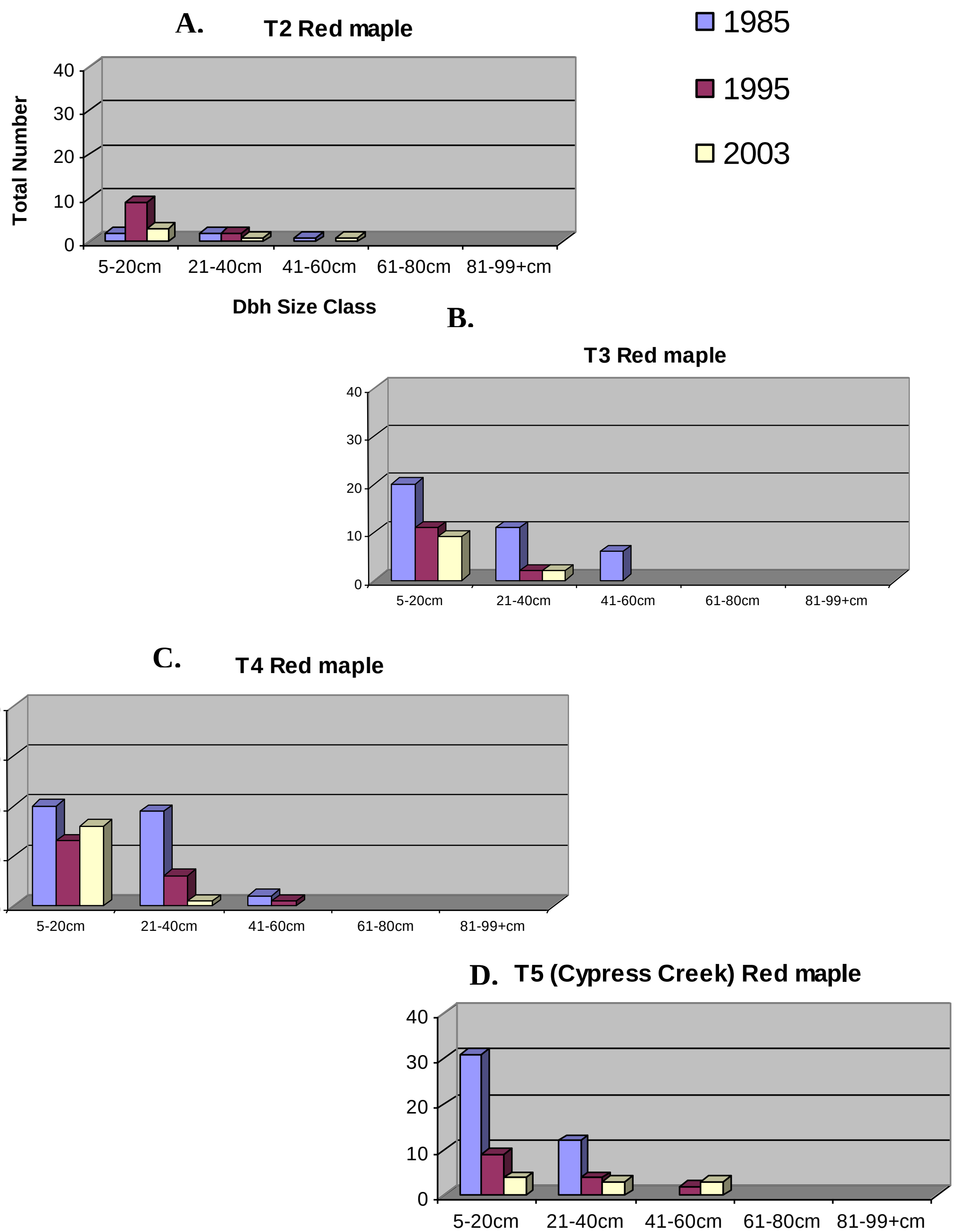
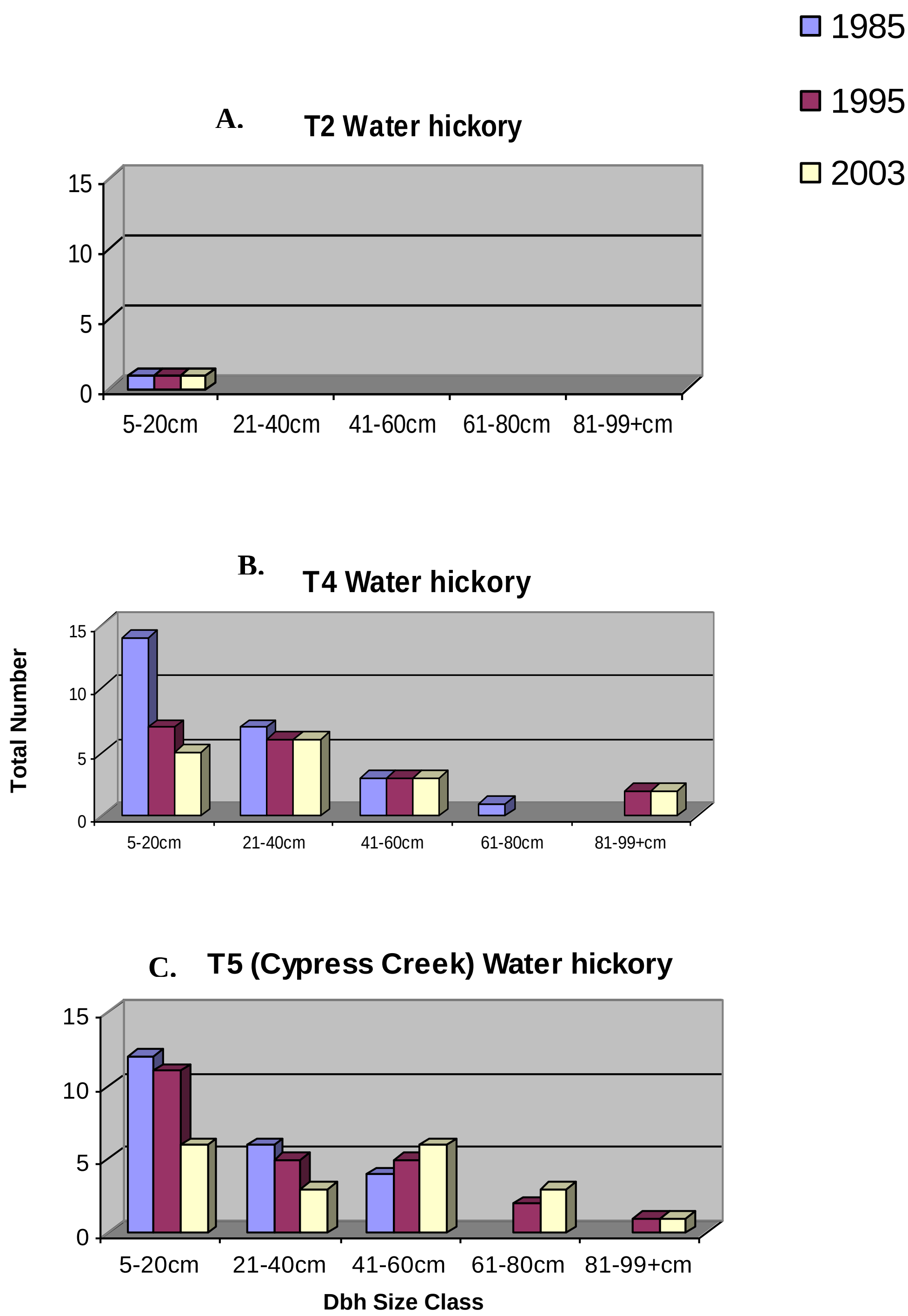
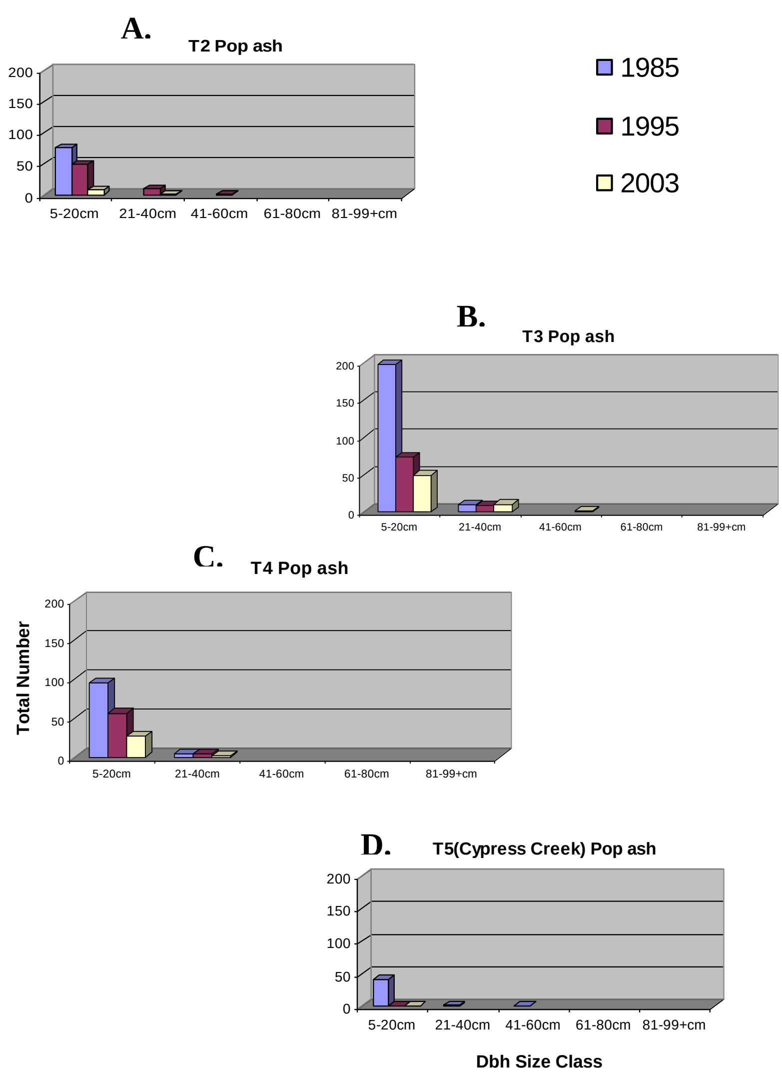


Figure 93A-C. Dbh Size class frequencies for water hickory.



Pop ash appeared for the first time at T1 in 2006 (**Appendix I**). It was not present at T6 in 1995, but showed up at T6, T7, and T8 (tidal transects) in 2003 and 2006. Pop ash showed declines in number on T2, T3, T4 and T5 between the three decades (**Figure 94 A-D**). On T2, pop ash decreased by 36 percent between 1985 and 1995 and by 89 percent between 1985 and 2003 in the size class frequency 5-20 cm. Although the 21-40 cm size class remained about the same on T3, young pop ash trees (5-20 cm) declined by 63 percent between 1985 and 1995 and by 75 percent between 1985 and 2003 with a 33 percent decline between 1995 and 2003. T3 has the largest population of pop ash in any of the ten transects. On T4, there was a 41 percent and a 72 percent decline in the 5-20 cm size class frequencies between 1985 and 2003. Of the 42 5-20 cm pop ash trees observed in 1985 on T5, only one was found in 1995 and 2003.

Figure 94A-D. Dbh size class frequencies for pop ash.



Bald cypress were present on all ten transects in all years except for T10 (**Appendix I**). The 300+ year old bald cypress in the floodplain of the Northwest Fork is the oldest vegetative representative of one of the last remaining communities of its type in southeast Florida (hence the designation as Florida's first National Wild and Scenic River). Pre-development flows down the Northwest Fork must have been sufficient to sustain this community for several centuries. However in examining the 2003 dbh canopy data for bald cypress (**Figures 95 and 96**), we observed that new recruitment (i.e. new trees of last several decades or less than 20 cm dbh, light green) was lowest on the upper Northwest Fork (T1, T2, T3) where floodplain elevations are the highest and inundation is less frequent. The dip in bald cypress abundance and density at T2 and T3 was probably a factor of past lumbering activities. Bald cypress recruitment was highest in the upper tidal areas of T8, T7 and T6, which receives daily tidal inundation. From the literature we know that bald cypress seed germination is dependent upon the presence of moisture in the soils and this may account for the poor status of bald cypress recruitment in the riverine reach. In addition, there is virtually no recruitment visible in the lower tidal reach of the Northwest Fork and mid-North Fork presumably due to the impact of higher salinity and higher tidal amplitude on bald cypress seedlings, although a few young trees were near the elevated trail of the peninsula of T9 and just off of the transect on T10. **Figure 96** also illustrates the loss of the larger mature bald cypress (darker greens) between 1985 and 1995 in the riverine reach and tidal reaches. In particular it shows the affect that salt water intrusion has had on portions of the upper and lower tidal reaches.

Figure 95. An examination of bald cypress recruitment and loss of larger mature trees using dbh size class frequencies.

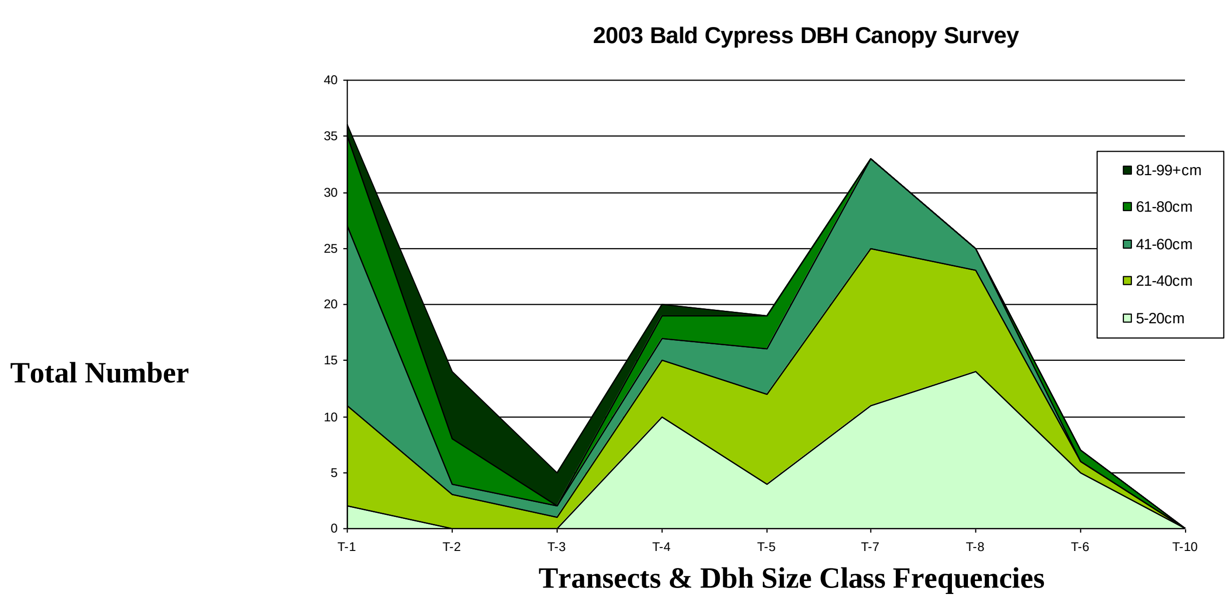
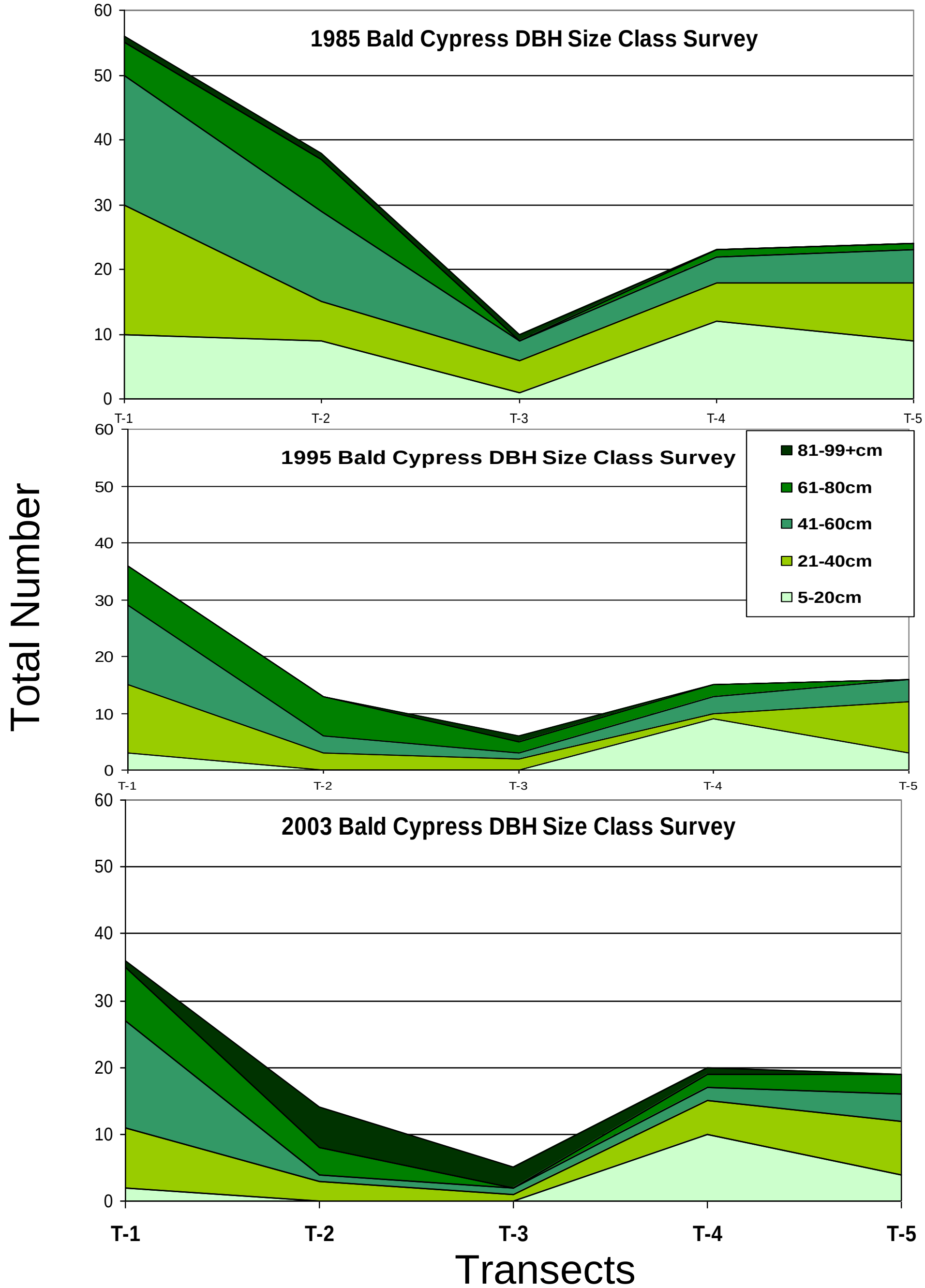


Figure 96A-C. Dbh Size class frequencies for bald cypress.

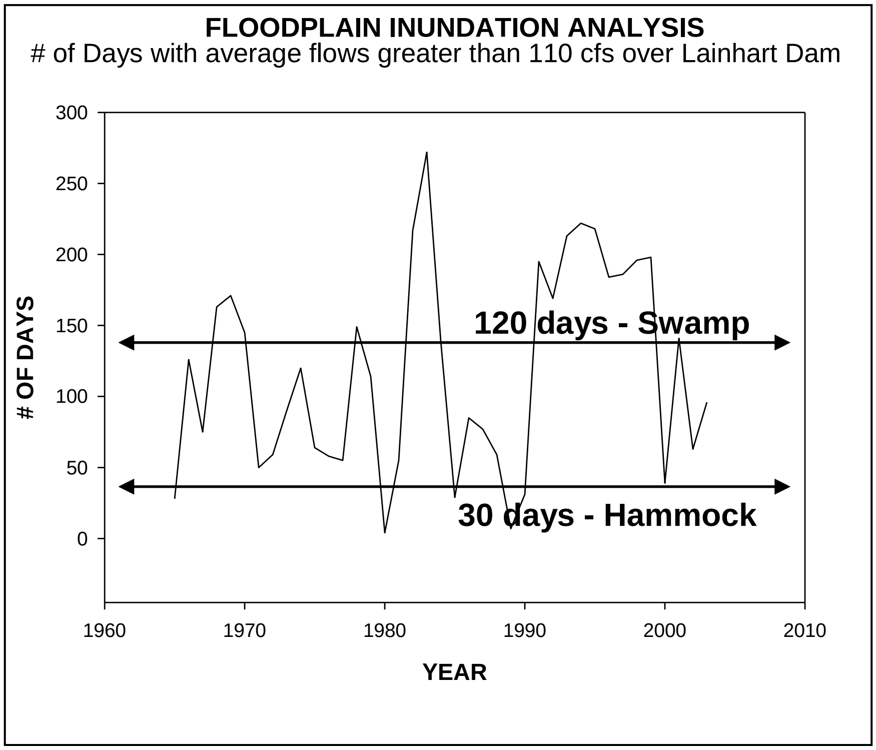


Looking at the three decade period of 1985, 1995 and 2003, bald cypress exhibited losses, new recruitment and growth (**Figure 96A-C**). New recruitment was highest in 1985 on T1, T2, T4 and T5 and lowest on T3.

Rainfall and hydrological data indicated that the 2003 and 2006 study periods were very dry, while the 1995 study period of Ward and Roberts was wet. The Ward and Roberts Study was conducted in a season impacted by the heavy rainfall of Tropical Storm Irene, in addition to the previously wet year of 1994. Between the 2003 study period and the 2006 study period, three major hurricanes heavily impacted the floodplain communities on the Loxahatchee River and resulted in raising seasonal totals for rainfall and freshwater flow. Flows at Lainhart Dam peaked at just over 603 cfs for Hurricane Frances and peaked again at over 868 cfs less than 30 days later for Hurricane Jeanne. With the exception of October 5-8, 2004, flows remained over 100 cfs from September 2nd to November 4, 2004. In 2005, flows at Lainhart Dam peaked at about 550 cfs for Hurricane Wilma on October 25th. Shortly thereafter the stage gage went out and was not repaired and running again until November 6th. By this time flows were back down to 200cfs and remained above 100 cfs until December 29th. The extent of physical damage to the floodplain canopy within the study area is summarized for Hurricanes Frances and Jeanne (2004) in **Appendix K**. Severe damage and mortality were most apparent in areas with the tallest canopy tree species (bald cypress, red maple, and water hickory). Forty-eight percent of the canopy examined in the riverine reach was damaged, 39 percent of the upper tidal, and 54 percent of the lower tidal. An assessment of the impacts of Hurricane Wilma in 2005 has not been conducted; however, new breaks, tipovers, and deaths within canopy communities were observed during the 2006 observations.

Post development stage and flow relationships were examined using a combination of field collected and modeled data (**Figure 96**). Approximately 110 cfs over Lainhart Dam is needed for inundation of the floodplain swamp at T1 (SFWMD, 2006). Average mean monthly flow for the 1965-2003 study period revealed that complete inundation of the floodplain swamp area occurred on average for only three months (September, October and November) per year while a monthly median flow averaged only one month (October) per year of inundation. Because the river is so rainfall driven now, water levels along the floodplain fall back within the banks of the river channel within a short period of time after most rainfall events. This can be true of both dry and wet season stage levels.

Figure 97. Base condition floodplain swamp inundation analysis of number of days in a month with 20-Day Moving average flows greater than 110 cfs over Lainhart Dam.



Generally in dry years, upland and transitional species increase their distribution within floodplain systems as a result of shortened hydroperiods. Canopy species may take hold in areas where they don't normally grow, while shrub and groundcover species may change seasonally with the change in hydrology. In the riverine reach, groundcover in the swamp communities died back dramatically after prolonged periods of inundation following the hurricanes of 2004 while during extended dry periods groundcover species flourished after the flooding from the hurricanes was gone. This was probably due to the increase in nutrients and increase in available light as a result of the damaged canopy. Total annual rainfall amounts for 2004 and 2005 were higher than 2003 primarily due to the hurricanes while the dry season of 2003 may have been dryer than the 2004 and 2005 dry seasons.

There have been a number of community ecology studies of floodplain forests in the southeastern United States. Ward (1987) examined light, elevation, soil pH, soil organic content and fire history of the Wekiva River riparian plant communities using TWINSPAN (two-way indicator analysis) and CCA (canonical correspondence analysis). Burke et al., (2003) concluded that flooding is the major factor affecting community structure but soils may play a factor in a study of the Coosawhatchie River in South Carolina. They observed a flooding gradient from the lowest forests of water tupelo to swamp tupelo to laurel oak to mixed oak communities in the highest elevations of the floodplain. Using Detrended Correspondence Analysis (DCA) with species distribution fit with a Gaussian regression, they were able to explain 67 percent of the variation in community structure with the changes or differences in elevation and soil characteristics (thus affecting rooting volume and cation nutrient availability). Melanie Darst and Helen Light conducted extensive work in North Florida on the Suwannee River which is partly a blackwater stream (Light et al., 2002; Darst et al., 2002). In the Suwannee River study, USGS examined the riparian vegetation community using species importance and richness, relative density and relative basal area. The Southwest Florida Water Management District (SWFWMD) conducted studies on the Upper Peace River (2002). The Upper Peace River study concentrated more exclusively on understanding the hydrological characteristics and needs of floodplain vegetation zones (i.e. upland, hammock, berm, seepage slope, river terrace, marsh, swamp, stream and riverbank). Most of these studies, including the Loxahatchee River Study, have come about as a result of the need to study these systems for Florida’s Minimum Flows and Levels and Water Reservation legislations. Within these studies most of the work has concentrated on baseline identification and enumeration of forest communities and trying to understand historical and current flow and stage relationships for analysis of inundation trends.

As reported in Davis (1943) South Florida studies, mixed groups of forest types were prevalent on the floodplain of the Loxahatchee River and its tributaries. In a PCA multivariate analysis of the 2003 canopy frequency of occurrence dataset, the resulting algorithum identified 2 major canopy groups (upland/hammock, and bottomland hardwood/swamp) with 6 sub-groups consisting of mesic and hydric hammock, upland/hammock mix, riverine swamp, riverine bottomland hardwood and swamp mix, tidal swamp, and tidal hammock mix. The largest group identified as the mixed swamp and bottomland hardwoods group also had overlap with the upland and hammock groups. Additional ordination results also suggested that, particularly in the riverine reach, hydroperiods are not adequate in depth and duration which may account for the intrusion of non-hydric and exotic plant species, and landscape displacement of the hydric species.

Evidence of plant species intrusion and displacement (i.e. a shift in plant species over time with primarily drier species into swamp areas) can be found throughout all of the riverine transects on the Northwest Fork of the Loxahatchee River. On Transects 1 and 2, slash pine can now be found in hammock areas while cabbage palm has shifted into swamp areas. Young red maple had been forced from bottomland hardwood areas into wetter swamp areas. Transect 3, also had cabbage palm re-established into bottomland hardwood and swamp areas along with wild coffee and myrtle oak. Brazilian pepper, normally an upland species, had invaded bottomland hardwood and swamp communities of Transects 3 and 4.

If hydroperiods in the floodplain are not adequate in depth and duration then these conditions allow for intrusion of non-hydric species and displacement of different hydric species into floodplain forest community types. Light et al. (2002) noted that with the anticipated growth and development in the Florida/Georgia basin of the Suwannee River, there would be reductions in ground water resources and river flow that would change the composition of the forest floodplain in that system. Both decreases in duration of inundation and saturation, as well as, flood frequency flows would be affected. They predicted that 47 to 50 percent of the forest type Rsw1/sw2 (swamp) community would be expected to convert toward the hydrology of Rblh1 forest (bottomland hardwood) from a reduction in flow of $56m^3/s$ (2000 cfs). The lowest flow period of record (1933-1999) for the upper Suwannee River was $61.7m^{3/}s$ or 2,200 cfs and inundated only 17.4 hectares of the 18,600 hectare forest. Median flow at the confluence of the Suwannee and the Santa Fe Rivers was approximately $181m^3/s$ or 6480 cfs over the same period of record. As a further note, they predicted that the loss of saturated area in the riverine reach could result in an increase in oxidation of organic soils which in turn could result indirectly to reduce water-holding capacity of the soils. In the tidal reaches, they predicted that if flows were reduced, flood depths that currently limit the establishment of tidal species would occur further upstream. As a result, tidal species would invade upstream of existing reach boundaries creating new boundary locations between riverine, upper tidal and lower tidal reaches. Finally, they predicted that if the forest were to become drier and more saline the floodplain plant communities would be more vulnerable to invasion by exotic plants as we have observed on the Loxahatchee River floodplain.

Darst et al. (2008) noted that forest of the Apalachicola River floodplain changed between 1976 and 2004-06 to a drier mix of plant species. The Apalachicola River has the largest river floodplain in the state of Florida. In swamps, they observed a 17 percent decline in the number of trees and an overall 37 percent decline in tree density. They attributed the declines to erosion of the river channel after 1954 and decreased flows in spring and summer months due to increases in demand for water from urban areas of Florida, Georgia and Alabama. The spring and summer months are the critical time of year for wetland tree growth, fish production, and other riparian biological processes. Darst et al. (2008) predicted that the Apalachicola River floodplain forest would be at least 38 percent drier in species composition by 2085. The year 2085 corresponds to the year in which the surviving 2004 subcanopy trees will reach the median age of the 2004 large canopy trees. The most important species in the nontidal floodplain were pop ash, Ogeechee tupelo, water tupelo and bald cypress.

With the results, discussion and conclusions presented within the 2003 Loxahatchee River Vegetation Study, our goals of establishing the composition and structure of floodplain plant communities and their associated hydrological characteristics have been analyzed. In addition, major problems associated with diminishing freshwater flow to the river system, reduced hydroperiods in the riverine reach, and increasing saltwater intrusion and tidal inundation associated with stabilization of Jupiter Inlet and sea level rise were identified. With the guidelines created for forest type identification and relative basal area databases, a factor called Floodplain Index (FI, Darst et al., 2008) will be calculated to track changes in relative dryness in our current and future forest plot databases. With regards to the increase or decrease of species diversity within floodplain plant communities, high values may not be a good indicator when it comes to sustaining historical community structure. In our 2003 study, most increases in diversity were associated with impacted sites, increases in distribution of exotics, and the movement of dryer species into and within the floodplain. Decreases in species diversity were associated with the increasing presences of more salt tolerant species in the lower tidal reach. Examining the impacts of Hurricanes Frances and Jeanne provided insight into the physical impacts of severe weather and a baseline for determining the amount of time needed for the floodplain plant community to recover. As demonstrated, hurricanes have the capability of opening the canopy of a forest and compounding hydrological complications within the river system by reducing soil moisture and providing more light to encourage the growth of groundcover species. They also caused structural displacement of site locations for epiphytic plants and nesting wildlife. As the various restoration projects are completed and operational and seasonal restorative freshwater flows become the norm, it will be essential to document how the Loxahatchee River floodplain community responds at canopy, shrub, and ground cover levels as restorations within the Loxahatchee River Watershed are implemented.

RESTORATION CONSIDERATIONS WITH REGARD TO VEGETATION, FISH, AND WILDLIFE UTILIZATION

Since the 1930s, the Loxahatchee River has experienced considerable hydrologic change. Significant changes were made to the watershed that resulted in minimal post development inundation of the floodplain swamp community; insufficient inundation to discourage the intrusion of transitional, upland, and exotic plant species; and insufficient inundation for aquatic organisms to utilize floodplain swamp communities. After the diversion of freshwater flow to the Southwest Fork (1957-58) with the construction of C-18 Canal and the S-46 Structure, bald cypress tree deaths were noted in the tidal reaches but not in the riverine reach of the Northwest Fork; however, they were probably stressed during very dry years. In the riverine reach, biologist and local residents reported that the river channel would dry up for long stretches during the 1960s and 1970s, which was also probably the most stressful period for bald cypress and other freshwater species in the tidal floodplain. Lainhart and Masten Dams may have provided some protection by impounding the freshwater from local rainfall upstream of the Florida Turnpike. Rainfall averages increased during the 1980s and 1990s and water was redirected back to the Northwest Fork via the G-92 Structure (1975). This is probably why we are not seeing significant canopy tree deaths today caused by saltwater intrusion. However, the death of most of the remaining cabbage palms within the swamp and mixed plots of T9 in the lower tidal reach was of great significance. Orem et al., (2006) identified high conductivity and high sulfides on portions of T9 and T6 probably due to poor flushing conditions at the back of the floodplain.

Recommendations for future floodplain vegetation monitoring on the Loxahatchee River consists of examining canopy communities every 6 years and shrub and groundcover communities every 3 years. This schedule was presented in the Restoration Plan for the Northwest Fork of the Loxahatchee River as a means to best utilize staff and allow the sites to recover from impacts created during the sampling events. The dbhs of canopies species were re-measured in 2005 during the hurricane assessment investigation while shrub and groundcover communities were re-examined in 2007. A report is being prepared with comparisons between the 2003 and 2007 groundcover communities. The canopy community was re-examined in 2009 and the results will be included in the 2011Addendum to the Restoration Plan.

While perpetuation of the floodplain plant communities is the primary focus of this study, we concluded that bald cypress should be the primary species of concern for restoration and enhancement in this riverine swamp, while red maple and water hickory should be the primary species of concern for bottomland hardwoods communities and cabbage palm for hydric hammock. Recommendations for hydroperiods and depths in floodplain swamp and hydric hammock communities are presented in Chapter 4 of the Restoration Plan (SFWMD, 2006). For hydric hammock, the performance measure was inundation of at least 30-60 days/year with 2-6 inches of water. For floodplain swamp, the performance measure was 4-8 months of inundation (100-300 days) with 18-30 inches of water.

Recent river restoration studies have emphasized the importance of reestablishing natural flow regimes including natural variations in flow timing, duration and water quality, rather than just minimum flows in regulated systems such as the Loxahatchee River (Poff et al., 1997, Toth et al., 1998, and Benke, 2001). Benke stated that maintaining the connectivity between the river channel and floodplain is vital for diverse and productive invertebrate assemblages and the higher trophic levels that depend on them. Thus, enhancement and restoration of the riverine floodplain forest communities is warranted to provide additional freshwater flow to improve seasonal hydroperiod and depth and subsequently ecological community health. Light et al., (2002) noted that reductions in freshwater flow could reduce diversity and productivity of Suwannee River fishes because of the links to timing and extent of floodplain inundation.

Although field surveys of riverine fish and wildlife have not yet been completed, historical inundation analysis revealed that the riverine floodplain was unavailable for aquatic community utilization (i.e. lack of inundation and depth) about 75% of the time for most years (**Figure 97**). The need for baseline field monitoring and the plan for study are outlined in Chapter 10 of the Restoration Plan for the Northwest Fork of the Loxahatchee River. A more natural hydroperiod in the riverine floodplain would potentially increase food resource availability (i.e. invertebrates, amphibians, fish and birds) and provide a multitude of aquatic habitats. Amphibians in particular are important indicators of ecological health, because they require out of channel aquatic habitat to breed successfully. Amphibians need various lengths of continuous inundation to complete the metamorphosis from larvae to adult. Larval and juvenile riverine fishes utilize the out of channel experience to hide from larger predators. Depending upon water depth, fishes of all sizes migrate into the floodplain and use the vast plant and invertebrate food resources. Several recent publications have illustrated the significance of submerged snags as habitat to increase invertebrate populations, which in turn increases food resources for several other biological communities. Benke (2001) found that benthic invertebrate assemblages in the floodplains of the Ogeechee River (Georgia) were different from both snags and benthos of the main channel. Oligochaetes, isopods, and dipterans were the major groups in density and biomass on the floodplain. Oligochaete biomass was somewhat lower in the floodplain than in the main channel, while dipteran biomass was somewhat higher. Total biomass and density were much lower in the floodplain than observed on snags. Their floodplain inundation model illustrated that the biomass of invertebrates within the floodplain was extended over a period of time by retention of water by floodplain pools and inputs of rainfall and groundwater. High biomass and production of snag-dwelling insects is made possible by an abundant supply of microbially enriched amorphous detritus that primarily originates from floodplain forest.

On the Ogeechee River, Benke (2001) found that the regular exchange of water, nutrients, and other organic matter between the river channel and floodplain was a critical connection. Benke's observation points to the significant need to provide additional floodplain inundation and reduced salinity/conductivity levels on the Loxahatchee River floodplain. A more detailed list of concerns to be addressed would include inadequate hydroperiod (depth and duration), loss of canopy trees, displacement of native plant species, dispersion of exotic plant species, and loss of habitat for aquatic organisms within the riverine reach; and, increasing salinity in the surface water and soils and increasing tidal inundation in the two tidal reaches. By addressing the hydroperiod and saltwater intrusion issues on the Loxahatchee River, we may enhance and perhaps restore portions of this last remaining bald cypress swamp in southeast Florida.

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VOLUME II

RIVERINE AND TIDAL FLOODPLAIN VEGETATION OF THE LOXAHATCHEE RIVER AND ITS MAJOR TRIBUTARIES

Appendices

South Florida Water Management District
Coastal Ecosystem Division
Florida Department of Environmental Protection
Florida Park Service, District 5

DECEMBER 2009

APPENDICES (Volume II)

APPENDIX A

LOXAHATCHEE RIVER: TIME LINES OF CHANGE

APPENDIX A

Loxahatchee River: Time Lines of Change

Colonization/ Homestead Period	**3000-750BC** - Late Archaic Period: Early Indian encampments along the river **750BC-1750AD** - East Okeechobee Periods I-IV: Villages and middens constructed near the river **1696** - Jonathan Dickinson is shipwrecked on Jupiter Island **1800s** - Seminoles name the river "Lowchow" for turtle and "Hatchee" for River **1838**- Battle of Loxahatchee (January 24,1838), Second Seminole War **1850s** - Loxahatchee River known to locals as Jupiter River **1855-1860** - Jupiter Lighthouse constructed **1860s** - Early settlers arrive in Martin and Palm Beach County areas **1870s** - Ft Jupiter established on Jupiter Island/ developer Henry Flagler begins to fill in natural slough areas **1886** - The family of Walter Kitching purchases land for $1.25/acre and establishes trade boat business **Late 1800s - 1912** - Atlantic Intracoastal Waterway channelized between Jacksonville and Miami Construction of St. Lucie and Lake Worth Inlets further diverted flow away from Jupiter Inlet
Drainage Period	**Early 1900s** - Construction of the Florida East Coast Railroad (FECRR) trestle bridge with filling of surrounding submerged lands **1928** - Small agricultural ditch dredged to divert water from the Loxahatchee Marsh to the Southwest Fork of the Loxahatchee River **1930s** - The Lainhart and Masten Dams were privately constructed by local families on the Northwest Fork **Mid 1930s-1942** - U.S. Army Corps of Engineers dredged lower estuary **1940s** - Bridge Road constructed and sod farms established, reducing sheet flow to the northern portion of Kitching Creek **1940-41** - Cypress trees were cut for lumber along Kitching Creek **1947** - Jupiter Inlet permanently stabilized for navigation **1947** - US. Army Base Camp Murphy deactivated and state acquires the property to create Jonathan Dickinson State Park **1957-58** - Southwest Fork of the Loxahatchee River heavily altered, dredged and drained by the construction of the C-18 Canal to divert water from the Northwest Fork to the Southwest Fork **1968** - The state acquired land purchased by Trapper Nelson during the 1930s and established his home and grounds as an Interpretive Site **1970-71**- Severe drought throughout the watershed further reducing freshwater flows **1970** - Loxahatchee River-Lake Worth Creek Aquatic Preserve established **1974** - C-14 Canal allowed water to be re-diverted from C-18 to the Northwest Fork G-92 Structure constructed at the intersection of C-18 and the Northwest Fork allowing a flow of 50 cubic feet per second (cfs) and a maximum flow of 100 cfs to be redirected to the NW Fork **1975** - Alexander and Crook documented the historical migration of mangroves in formerly cypress areas **1976-77** - U.S. Army Corps of Engineers dredged the lower estuary, which increased saltwater intrusion **1977-78** - Oyster bars dredged at the FECRR Bridge to improve navigation and flushing in the embayment area **1978** - Loxahatchee River Environmental Control District began operation of a sewage treatment plant that discharged from 0 to 2.0 million gallons per hour (mg/h) to the Northwest Fork
Urbanization Period	**1980s** - Lainhart and Masten Dams are reconstructed to maintain higher water levels **1980** - Operation of S-46 Structure on C-18 Canal altered to provide more storage in the canal. Discharge occurred to the Southwest Fork when water levels were greater than 15 feet above mean sea level **1980** - Three channels were dredged in the embayment area to improve navigation **1981** - In August, Hurricane Dennis hit the area and caused prolonged heavy flows of freshwater **1984** - Florida Department of Natural Resources reported that the majority of the cypress trees downstream of Kitching Creek (River mile 7.8) were dead **1985** - Pristine portions of the Northwest Fork of the Loxahatchee River designated as a Federal and State Wild and Scenic River **1987** - G-92 is replaced by a gated control structure capable of passing up to 400 cfs via remote telemetry from the SFWMD Operations Control Room **2000** - Projects are underway to restore hydrology in the Loxahatchee Slough and enhance flow to the Northwest Fork

APPENDIX B

VEGETATION DISTRIBUTION ALONG THE NORTHWEST FORK OF THE LOXAHATCHEE RIVER AS DETERMINED BY AERIAL PHOTOGRAPHY

APPENDIX B

Vegetation Distribution along the Northwest Fork of the Loxahatchee River as Determined by Aerial Photography

Introduction

Changes in the balance of fresh and salt water appear to have resulted in significant changes in the distribution of freshwater and saltwater vegetation along the floodplain of the Northwest Fork of the Loxahatchee River. While cypress and other freshwater communities can still be found in the upper reaches of the Northwest Fork of the Loxahatchee River, the lower undeveloped portions of the floodplain are now dominated by mangrove forest and subject to daily tidal fluctuations. Anthropogenic alterations throughout the 1900s within the Loxahatchee River Watershed that have altered freshwater flows in the Loxahatchee River have been well documented.

Historical Aerial Photography Studies

Alexander and Crook (1975) utilized aerial photographs and groundtruthing to examine plant communities along the Northwest Fork of the Loxahatchee River and Kitching Creek. Plant species lists were compiled for Site 13 (RMs 7-8), Site 14 (RMs 7.0-7.5), and Site 15 (RMs 6.0-6.5) on the Northwest Fork and Site 10 on Kitching Creek. Upon identifying the signature of the most abundant community types, they were able to use photo-interpretation to identify major vegetative communities from a 1940 aerial photograph. Areas of dead and living cypress canopy within a mangrove understory were noted in 1970. They concluded that since 1940, wet prairie and swamp hardwoods had lost ground to pineland and mangrove communities due to a lowering of the groundwater table and invasion of saltwater between RMs 6 and 8. They were able to identify areas of active logging in the aerial photographs, which could explain the loss of mature trees within portions of the watershed. Also, they mentioned the impact of fire, hurricanes and heavy frost on the major plant communities. At RM 6.5, they collected freshwater peat at a depth of 24 inches below the surface. Based on this information, they further concluded that there was no evidence that cypress forest had extended much further downstream than about RM 6. Wanless (written communication, 1982) suggested that RM 6 has experienced brackish conditions for at least the last 4,500 years. Finally, Alexander and Crook (1975) predicted that the mangrove invasion would accelerate, if anthropogenic activities in the upper floodplain of the river further reduced the freshwater head.

Hohner (1994) used aerial photography and satellite imagery to examine vegetative changes in the Loxahatchee Slough between 1940 and 1989. The Loxahatchee Slough is part of the headwaters of the Loxahatchee River. In a comparison of the vegetative classes Forest Land (hammock), Non-forested Wetland (wet prairie), Forested Wetland (cypress), and Non-forested Wetland (marsh), she concluded that with geographic information system (GIS) analysis there was a general trend toward dryer hydroperiod vegetation. A portion of the study area, in which water levels were raised to pre-channelization levels in 1979, exhibited a recovery to vegetation communities more characteristic of longer hydroperiods.

Aerial Photographic Study of the Northwest Fork of the Loxahatchee River

This study examines the displacement of cypress and stream swamp by mangrove forest along the Northwest Fork of the Loxahatchee River and Kitching Creek using historical black and white and color infrared aerial photographs taken over a 55-year period. Color infrared photographs were used for more recent periods. The purpose of this study was to document the changes in vegetative coverage and correlate those changes to major events in the watershed. To obtain a more detailed look at changes in freshwater and saltwater communities between 1940 (**Figure B-1**) and 1995, District staff divided the river into six segments (Lower Northwest, Mid Northwest, Upper Northwest, Wilson Creek, Kitching Creek, and Ketter Creek) (**Figure B-2**). For a more intensive look at the last six decades, District staff examined vegetative changes between RMs 6.6 and 8.9 from 1953, 1964 and 1979 black and white aerial photographs in addition to the 1940, 1985, and 1995 photographs. This study also re-examined Loxahatchee River vegetative sampling sites originally established by Alexander and Crook (1975) during their investigation of long term vegetation changes in South Florida.

Similar historical aerial photographic interpretation studies have been done on Northern Biscayne Bay, Florida. Harlem (1979) conducted aerial photographic surveys from 1925 and 1976 aerial photographs of the Bay. His work was supplemented with field studies to examine the effects of urban development and natural stresses over time. Maps were created to delineate long term changes in developed land, dredged and spoil areas, decreases in vegetative cover, and increases in bulkheaded shorelines. The major changes observed included the expansion of land areas as a result of filling of swamps, the creation of new islands from dredged spoil material, and changes in circulation patterns as a result of inlet and causeway construction.

Methods

This study of the Northwest Fork of the Loxahatchee River utilized black and white aerial photographs from 1940, 1953, 1964, and 1979 and color infrared photographs from 1985 and 1995. Aerials were obtained from the National Archives, the U.S. Department of Agriculture, Consolidated Farms Service Agency, and the National Aerial Photography Program. The 1985 color infrared photographs were obtained from a special flight conducted for SFWMD over Lake Okeechobee and portions of the Loxahatchee River Watershed. The 1940 aerial photographs (Accession Numbers CJF 3-51,17-53, 17-54) were taken on August 21, 1940 at a scale of 1:40,000, while the 1995 aerial photographs (Accession Number NAPP 6966-089) were taken on January 26, 1995 at a scale of 1:40,000. The 1985 photographs were taken by Abrams Aerial Survey Corporation on April 27, 1985 at a scale of 1:400. The 1995 photographs were Digital Ortho Quads (DOQQs).

Figure B-1. 1940 Loxahatchee River Watershed

Eight photographs from the 1985 survey were scanned to produce the floodplain coverage. The 1940 photographs were scanned at a scale of 3ft per pixel and georeferenced to the 1995 DOQQ's. The 1995 aerials for the DOQQ's were scanned at a 1 meter-pixel resolution and rectified to meet a 1:12,000 scale accuracy for the quarter quadrangles. All imagery was produced in the State Plane Coordinate System, Florida East Zone, 1983 Datum. Black and white photographs from 1953, 1964 and 1979 were examined in addition to the analysis of 1940, 1985 and 1995 in floodplain areas between RMs 6.6 and 8.9. Total vegetative community coverage by type and by year was compared over time to quantify changes in vegetative types. The 1940 and 1995 coverages were further broken down by river segments corresponding to Segment 1 (Lower Northwest), Segment 2 (Mid-Northwest), Segment 3 (Upper Northwest), Segment 4 (Wilson Creek), Segment 5 (Kitching Creek) and Segment 99 (Ketter Creek). The locations of these river segments are shown in **Figure B-2**.

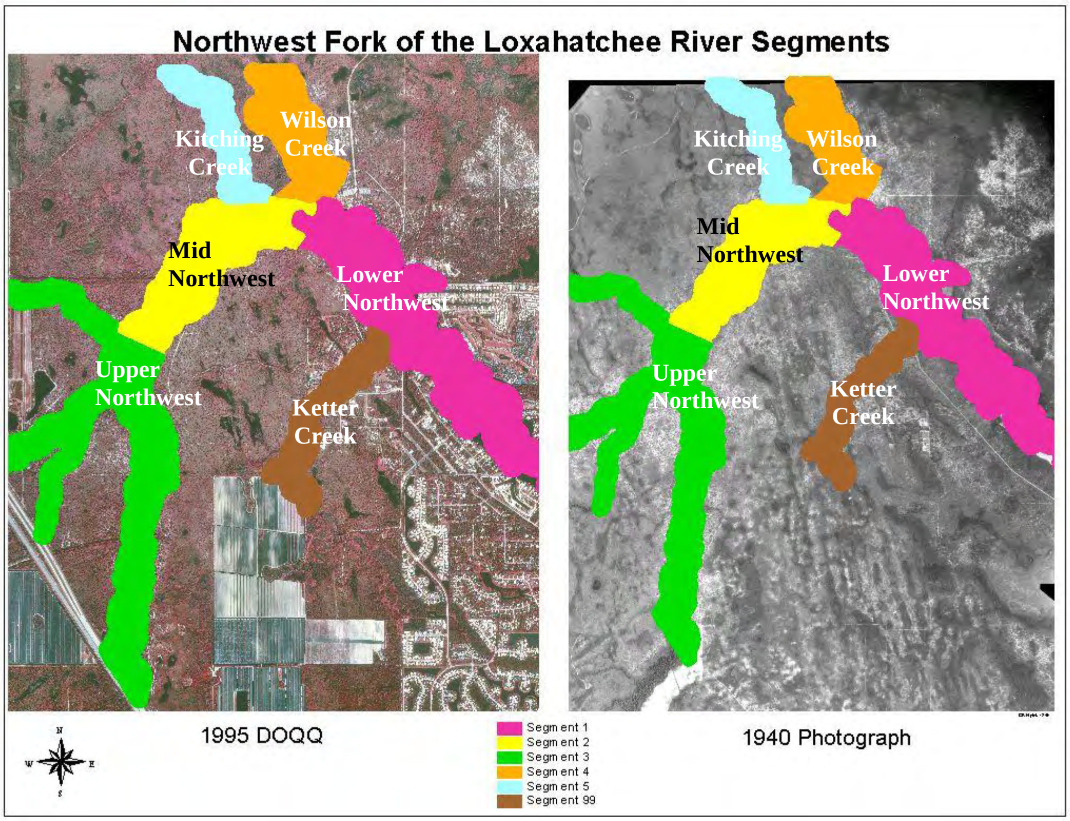


Figure B-2. Location of River Segments

Dominant species of plants in the canopy were noted on hard copies of the photographs. To verify signatures produced of major plant community-types in the floodplains and associated upland communities. Field observations were conducted from a helicopter on October 19, 2000 and November 1, 2000 and ground surveys were conducted on November 14 and 29, and December 12, 2000.

Plant community signatures utilized in this study were adopted from the Florida Land Use, Cover and Forms Classification System (FLUCCS), Florida Department of Transportation, 1985 (**Table B-1**). Color and texture descriptions listed in the reference document were compared with known vegetation from the 1995 aerial to establish the following list of observed classifications:

Vegetative Coverages

243 Ornamental Garden
300 Rangeland
- 321 Palmetto Prairies

400 Upland Forests
- 427 Live Oak
- 428 Cabbage Palm
- 437 Australian Pine

500 Water
- 510 Streams and Waterways

600 Wetlands
- 612 Mangrove Swamp
- 615 Stream & Lake Swamp
- 616 Inland Pond and Slough
- 621 Cypress

700 Barren Land
- 740 Disturbed Land

Using these categories, major plant communities were delineated into distinct aerial units characterized by specific tones and textures. Image tones refer to the brightness of an area of background as portrayed by the film in a given spectral region (or in three spectral regions for color or color infrared). Image texture refers to the apparent roughness or smoothness of an image region. Texture is produced by the pattern of highlighted and shadowed areas as an irregular surface is illuminated from an oblique angle. Mature forest appears as rough texture, while agricultural fields appear as smooth texture. Categories such as cypress may be recognized by the distinctive shape of the pin-like crowns of some trees (Campbell, 1987).

Results

Comparison of Vegetation Coverages along the Northwest Fork of the Loxahatchee River

The Loxahatchee River Watershed landscape is topographically divided into two landforms, the Atlantic Coastal Ridge and Eastern Flatlands. Vegetative communities consist primarily of coastal hammock, pine flatwood, seasonal ponds and prairies, freshwater swamp hardwood, and mangrove.

Much of the region remains unurbanized today due to earlier military and agricultural uses. Subsequently, land use changed to large tracts of public conservation and recreation and agricultural lands, and low density 5 to10 acre ranchettes. The Northwest Fork has been provided with additional protection as portions of this water body have been designated as a federal wild and scenic river. The oldest municipality is the Town of Jupiter, which was incorporated in 1925. Neighboring municipalities Juno Beach, Jupiter Inlet Colony, Jupiter Island, Palm Beach Gardens, and Tequesta were all incorporated during the 1950s.

1940 Vegetative Communities

The Loxahatchee River Watershed was largely undeveloped in 1940 (**Figure B-1**). According to the 1940 U.S. Census, the Town of Jupiter contained 215 residents (**Table B-2**). Interstate 95 and the Florida Turnpike had not been constructed. The major roads in the area were Center Street, State Road 706 (Indiantown Road), State Road 710 (Beeline Highway), U.S. Federal Highway 1, State Road 708 (Bridge Road) and Northlake Boulevard. Also, the C-18 Canal had not yet been constructed, although evidence has been found of ditching southward to the Loxahatchee and Hungryland Sloughs. The Jupiter Inlet was open in the 1940 photograph, but the presence of sandbars probably reduced the amount of saltwater coming in during high tides. The inlet was not permanently stabilized for navigation until 1947. On the Northwest Fork, incoming tides may have reached upstream past the mouth of Kitching Creek frequently enough to produce a fringe of mangroves along the river ending at RM 7.8 on the northern bank.

The most obvious features of the 1940 aerial photographs are the abundance of wetlands associated with creeks, sloughs and wet prairies and the lack of urban development throughout most of the watershed (**Figure B-1**). There are extensive wetlands (prairies and four major sloughs) between Kitching Creek, the North Fork of the river, and Bridge Road in Martin County. Two of the sloughs appear to have been connected to the North and Northwest Forks in the past. These areas would have provided a source of freshwater to the river and estuary that is not present today. Only Wilson Creek remains connected to the river today (**Figure B-2**).

Other visible hydrologic characteristics in the 1940 photographs included:

- On the Northwest Fork, Hobe Grove Ditch did not exist but Moonshine Creek was apparent and drained a wetland slough to the north
- No citrus was grown near the river as it is today, but there was extensive land clearing north of SR# 706 on the east side of the Northwest Fork (perhaps for agriculture) and in the vicinity of the Park's boundary (i.e. location of power lines today)
- A wetland slough connected Jones Creek to Lake Worth Creek (in the vicinity of what is today Frenchmen's Creek)
- Jones and Sims Creeks were lined with mangroves south of SR# 706
- A ditch was dredged from Loxahatchee Marsh (northern Loxahatchee Slough) to Limestone Creek, which is the headwaters of the SW Fork. Limestone Creek was later channelized by the dredging of the C-18 Canal in 1957-58. Since 1994, SFWMD has worked to restore upland and floodplain vegetation along the right-of-way downstream of S-46.

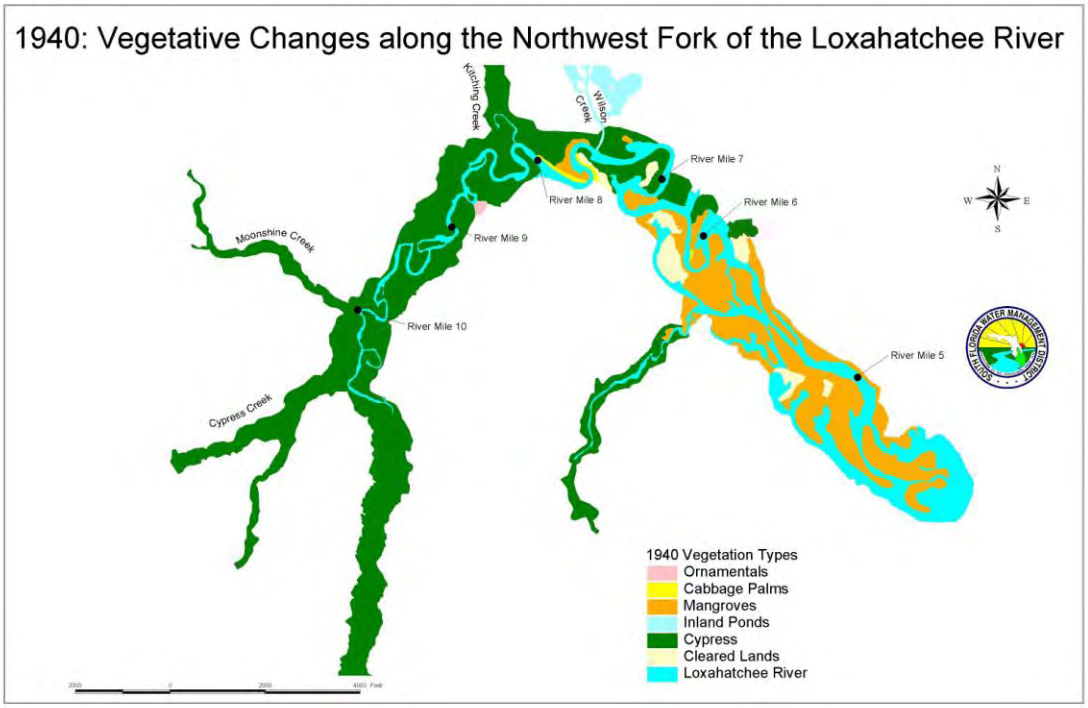


Figure B-3. 1940 Loxahatchee River Watershed

- Mangroves bordered the North Fork and transitioned into freshwater vegetation in the vicinity of today's park boundary (north of County Line Road). The floodplain was very narrow in the mangrove areas
- There were very few mangrove islands in the embayment area
- Spoil mounds were evident along Lake Worth Creek and the lower Indian River Lagoon from the dredging of the Atlantic Intracoastal Waterway channel

Table B-1, provides a summary of the major vegetation communities found along the Northwest Fork of the river in 1940 and **Figure B-3** illustrates the location of the major vegetation communities. **Figure B-4** comparisons of the 1940 and 1995 distributions of vegetation communities in the floodplain of the Northwest Fork are provided by river segment. An estimate of the location of Interstate 95 and the Florida Turnpike was made to define the southern boundary of the study area in the 1940 photograph. Unlike the clarity of later black and white and infrared photography, it was difficult to identify plant species other than cypress and cabbage palm within the freshwater communities. In addition, the 1940 photography was taken during the month of August, when all trees would have possessed full canopies, whereas most aerial photography is taken during the winter months when trees, like cypress, are dormant and more easily distinguished. Therefore, in **Table B-2**, total acreage of cypress was combined with stream swamp to compare 1940 with the 1985 and 1995 coverages. The category of cypress represents a community dominated by cypress but also may contain red maple, pond apple, pop ash, water hickory, laurel oaks, and bays, whereas the category of stream swamp represents a freshwater community of primarily mixed hardwoods with cypress, present but not dominant. Cabbage palms, which are normally associated with hammock communities, are found in tidally inundated to rarely inundated areas of the floodplain along the Northwest Fork of the Loxahatchee River. During the 2000 field observations, it was noted that those cabbage palm still surviving in inundated areas did not appear as healthy as those did at higher elevations.

Table B-2 and Figure B-3 show that in 1940, there were about 163 acres of mangroves and 467 acres of cypress dominated freshwater communities, 58 acres of inland ponds and sloughs, 3 acres of cabbage palm, 4 acres of ornamental vegetation and 27 acres of cleared land within the floodplain. Of the total 720 acres of vegetation identified in the 1940 aerial photography, more than 64 percent was represented by cypress communities while mangroves represented about 22 percent of the vegetative cover. Disturbed or cleared land represented 27 acres or about 4 percent of this coverage. Mangroves dominated the floodplain between RMs 4.5 and 6.0 and were present up to RM 7.8. Freshwater communities were present from about RM 6.5 and were dominant upstream above RM 8.0. As mentioned in the book "**Loxahatchee Lament"** (1978)**,** the area of ornamental vegetation includes an exotic ornamental plant garden (1.4 acres) established by Mrs. Alice De Lamar prior to 1940. Segments 1 and 2 (Lower and Mid Northwest Fork) were the most impacted areas in 1940.

Table B-2. Vegetative Communities in1940 in the Northwest Fork of the Loxahatchee River

1940 VEGETATION	**COVERAGE (acres)**	**PERCENT TOTAL**
Freshwater Plant Communities		
Cypress	467.21	64.04%
Inland Ponds and Sloughs	58.55	8.02%
Cabbage Palm	3.08	0.42%
Ornamental	1.44	0.20%
Sub-total	530.28	72.68%
Salt Tolerant Plant Communities		
Mangrove	163.06	22.35%
Other		
Disturbed or Cleared Lands	26.82	3.68%
TOTAL	**720.16**	**100%**

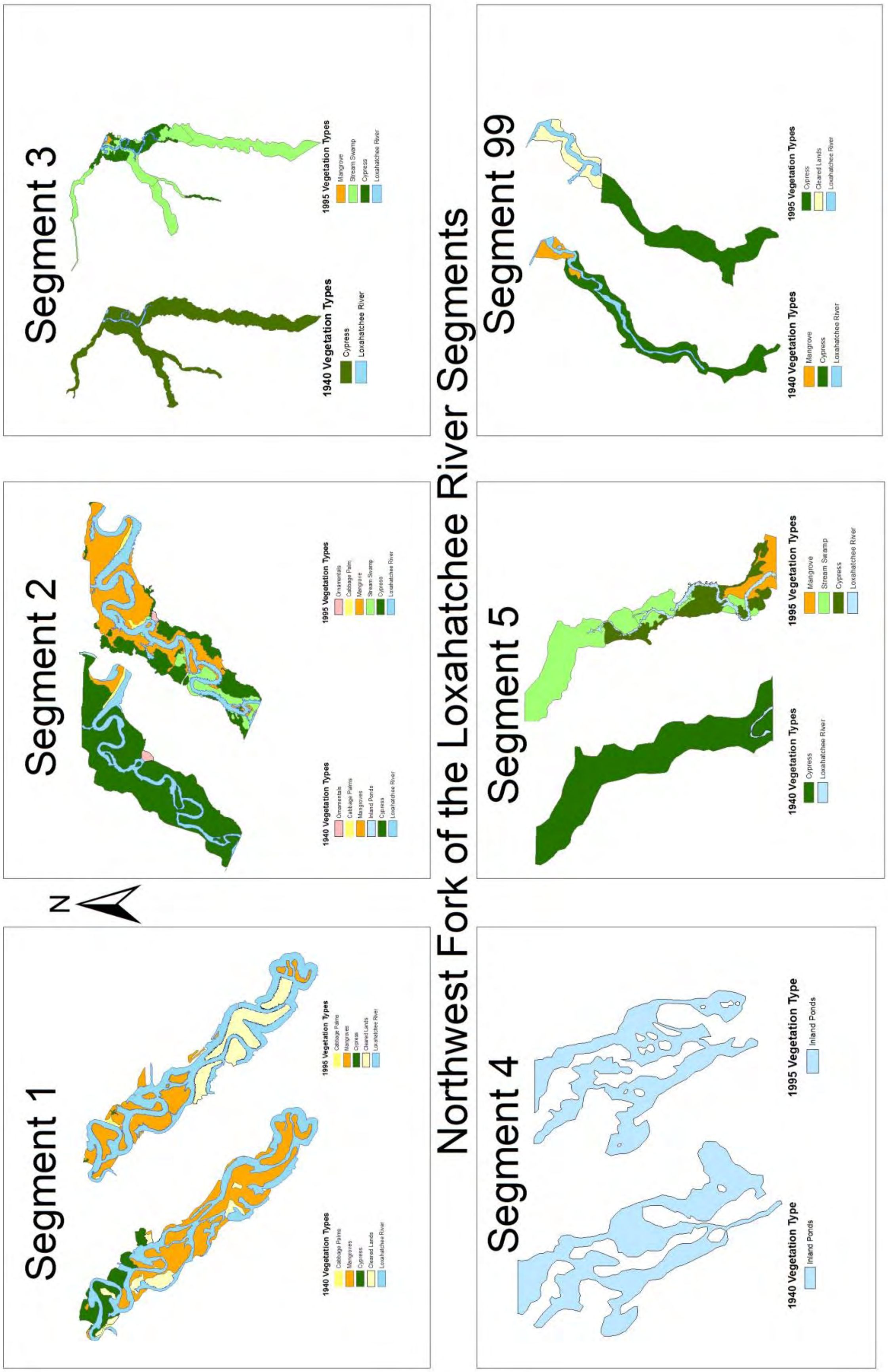


Figure B-4. Comparisons between 1940 and 1995 Coverages by River Segment

1985 and 1995 Vegetative Communities

The 1985 distribution of vegetative communities within the floodplain are shown in **Figure B-5. Table B-3** summarizes the areas of each community. Color infrared photography allowed for the identification of a greater number of plant categories and better observation of vegetative changes. In 1985, the floodplain of the Northwest Fork consisted of 61 percent (390 acres) freshwater communities and 25 percent (161 acres) mangroves. Freshwater communities were dominated by stream swamp (205 acres), cypress (139 acres), inland ponds and sloughs (39 acres) and cabbage palm (7 acres) (**Table B-3**). Mangroves were dominant between RMs 5.5 and 8.7 and present up to RM 10.4. Freshwater communities were present in the upper elevations of the floodplain from about RM 8.5 and inside all of the creeks. Stream swamp, which represents a mixed hardwood community of less than 50 percent cypress, was present upstream of RM 9.3 and within Kitching Creek. Only a few dead cypress trees were noted between RMs 4.5 and 5.5; however, the frequency of dead cypress trees increased between RM 6.8 and 10 with a peak between RMs 8.4 and 8.8.

Figure B-5. 1985 Vegetation map

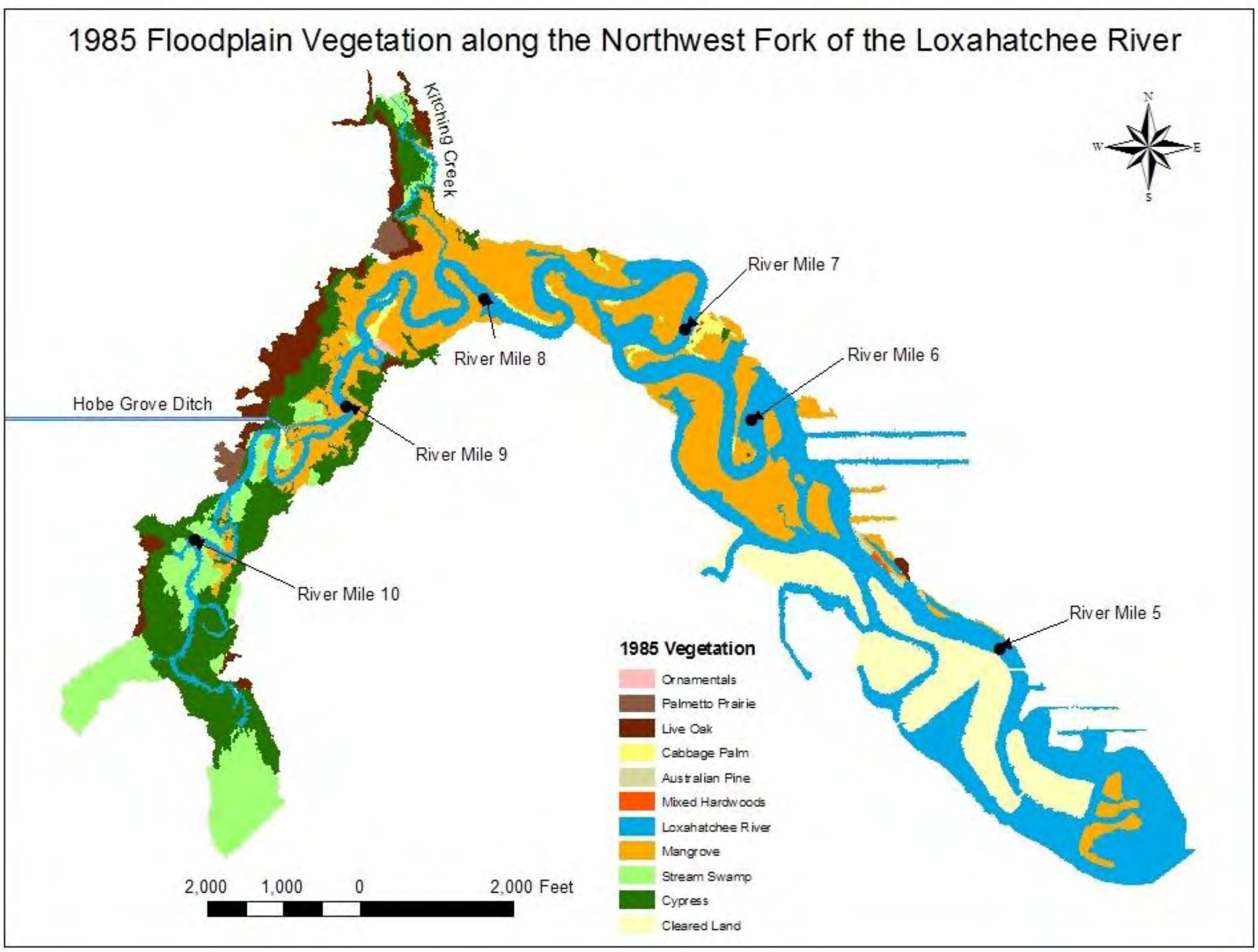


Table B-3. Vegetative Coverage for 1985 on the floodplain of the Loxahatchee River

1985 VEGETATION*	COVERAGE (acres)	PERCENT TOTAL
Freshwater Plant Communities		
Cypress	139.18	21.90%
Stream Swamp	204.77	32.22%
Inland Ponds & Sloughs	38.63	6.10%
Mixed Hardwood	0.15	0.02%
Cabbage Palm	7.38	1.16%
Ornamental	0.70	0.11%
Sub-total	390.81	61.49%
Saltwater Tolerant Plant Communities		
Mangrove	160.94	25.32%
Other		
Disturbed or Cleared Lands	83.77	13.18%
Live Oak*	31.04**	-
Australian Pine*	*0.13***	-
Palmetto*	*6.73***	-
TOTAL	**635.52**	**100%**

*Coverages of Cypress, Inland Ponds and Sloughs and Stream Swamps in portions of Kitching and Moonshine, and Ketter Creeks, and a segment of the river below Trapper Nelson’s were estimated from the 1995 photograph; because, these areas were not flown and photographed during the 1985 aerial survey. These coverages were validated through the examination of a 1984 black and white photograph.

** These categories were not included in the total coverages because they were above the river floodplain.

Figure B-6 illustrates the 1995 distribution of vegetation within the floodplain of the Northwest Fork by river segment, while **Table B-4** summarizes the aerial coverages. In 1995, the vegetation consisted of 61 percent (371 acres) freshwater vegetation and 25 percent (152 acres) mangrove. Freshwater vegetation consisted of stream swamp (199 acres), cypress (129 acres), cabbage palm (4.3 acres), and inland ponds and sloughs (39 acres). In 1940, mangroves were dominant between RMs 4.5 and 6.5 and were present up to RM 7.8, while mangroves by 1995 had progressed upstream as the dominant vegetation in the floodplain between RMs 5.5 and 8.7. Near the mouth of Kitching Creek, mangroves appeared as forests whereas further upstream they appeared as understory to a cypress/cabbage palm canopy. Just downstream of the mouth of Moonshine Creek (RM 9.8), mangroves expanded slightly along the shoreline since 1985. Also, stream swamp in this area contained scattered red mangroves growing concurrently with pond apple, while exotic java plum trees (*Syzygium cumini*) were growing concurrently with pop ash and dahoon holly. Trapper Nelson, a former land owner, supposedly introduced java trees along the river.

Figure B-6. 1995 Vegetation map.

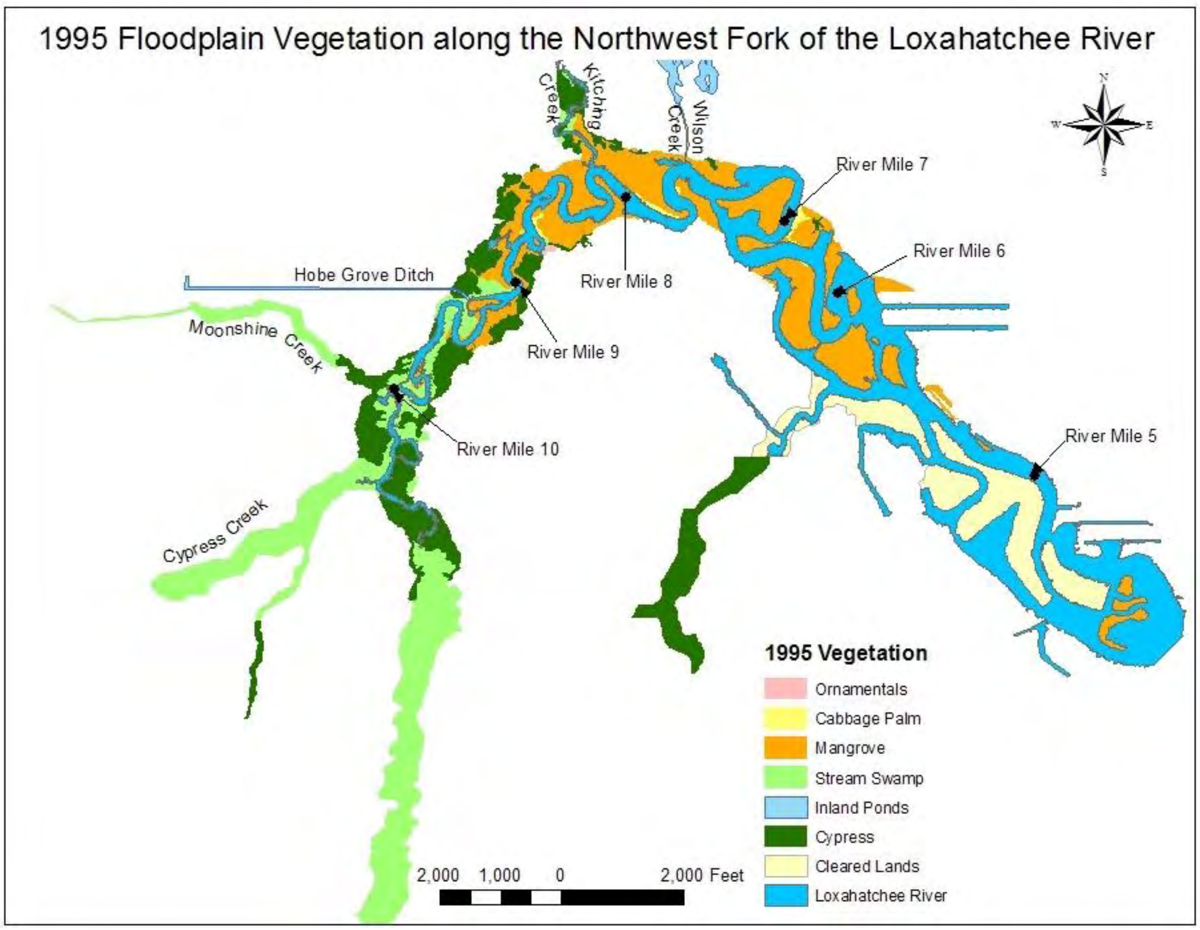


Table B-4. Vegetative Coverage for the 1995 floodplain of the Loxahatchee River.

1995 VEGETATION	COVERAGE (acres)	PERCENT TOTAL
Freshwater Plant Communities		
Cypress	128.65	21.20%
Stream Swamp	198.90	32.78%
Inland Ponds & Sloughs	38.63	6.37%
Cabbage Palm	4.30	0.71%
Ornamental	0.64	0.12%
Sub-total	*371.12*	*61.17%*
Saltwater Tolerant Plant Communities		
Mangrove	152.00	25.05%
Other		
Disturbed or Cleared Lands	83.61	13.78%
TOTAL	**606.73**	**100%**

Overall, there were no major changes in vegetation between 1985 and 1995. Between 1940 and 1995, most of the observed changes were within the Lower Northwest and Mid Northwest segments. Freshwater communities were present in all segments, but primarily in the Upper Northwest segment. Disturbed and/or Cleared Lands were present primarily in the Lower Northwest segment. Those Disturbed Lands that were not developed eventually became mangrove communities after first becoming brackish water marsh according to local knowledge of the area.

The most striking features noted in comparing the 1940 with 1985 and 1995 was the dredge and filling of mangrove islands between RMs 4.5 and 5.5 and the loss of floodplain adjacent to the Northwest Fork. Invasion of upland species (i.e. saw palmetto, slash pine, etc.) and development, including the construction of bulkheads along both shorelines of the estuary and lower Northwest Fork of the river, and heavy scouring of the land and oxbows are some factors contributing to the overall loss (113 acres) of floodplain between 1940 and 1995 (**Figures B-3 and 6**).

Between 1940 and 1995, mangroves exhibited losses and gains in total coverage (**Tables B-2, 3 and 4**). Approximately 84 acres of mangroves were lost due to development of former mangrove islands between RMs 4.5 and 5.5. Mangroves gained another 149 acres from re-establishing in cleared lands (6 percent) and from invading freshwater communities (32%). The gains in coverage occurred primarily between RMs 6.0 and 8.5. And, it appears that mangroves had taken over areas that were formerly brackish water marsh. Approximately 165 acres of mangroves remained unchanged over the 55-year period.

There were no overall gains in freshwater vegetation over the study period. Freshwater marshes associated with the wider floodplain areas were identified using infrared photographs. It was also noted in the field that many of the remaining freshwater marsh areas and Wilson and Moonshine Creeks have been invaded by the exotic old-world climbing fern, *Lygodium microphyllum*. There were net losses of 149 acres of freshwater habitat (i.e. mangroves gained), primarily between RMs 6.5 and 7.8. Within the remaining freshwater communities along the open river (RMs 9.0 to 10.5) there were changes in the signature of the canopy. Whereas the 1940 black and white photographs had exhibited a very uniform canopy among swamp hardwood areas, the 1985 and 1995 photographs exhibited a canopy of more varying heights, colors and textures. Field observations and aerial photography revealed that while there were remaining areas of greater than 50 percent cypress, other areas consisted of a mixture of water-tolerant hardwoods including red maple (*Acer rubrum)*, water hickory (*Carya aquatica)*, laurel oak (*Quercus laurifolia)*, pond apple (*Annona glabra)*, pop ash (*Fraxinus caroliniana)*, dahoon holly (*Ilex cassine)*, and swamp bay (*Persea palustris)*. These areas were designated as "Stream Swamp" in the 1985 and 1995 coverages.

Analysis of the 1985 and 1995 distribution of mangroves and freshwater wetlands in the Hobe Grove Ditch and Cypress Creek areas showed that freshwater communities dominated by cypress appear to be more closely associated with wider floodplain areas suggesting that there may be less species competition and less water stress associated with these areas due to greater levels of freshwater groundwater input and greater distance from the river channel.

Other alterations seen in the 1995 photographs include:

- The Southwest Fork which was channelized between 1957 and 1958 to create the C-18 Canal. The canal redirects water from the Northwest Fork to the Southwest Fork. Discharges to the river are controlled at the S-46 Structure.
- C-14 and the G-92 Structure that were constructed in 1974 to redirect water from the Southwest Fork back to the Northwest Fork.
- Over 3,000 acres of citrus groves that have been planted west of the Northwest Fork in the 1970s.
- Hobe Grove Ditch, which in the 1960s was dug through uplands to provide flood control for citrus groves. Surface water flowing from this area during dry periods is now retained to maintain the water table for irrigation wells.
- Most of the remaining inland ponds and sloughs appear to be much smaller in size than in the 1940 photographs denoting corresponding change in vegetative type from wetlands to transitional or upland types.

A Six-Decade Vegetation Analysis of the Northwest Fork of the Loxahatchee River

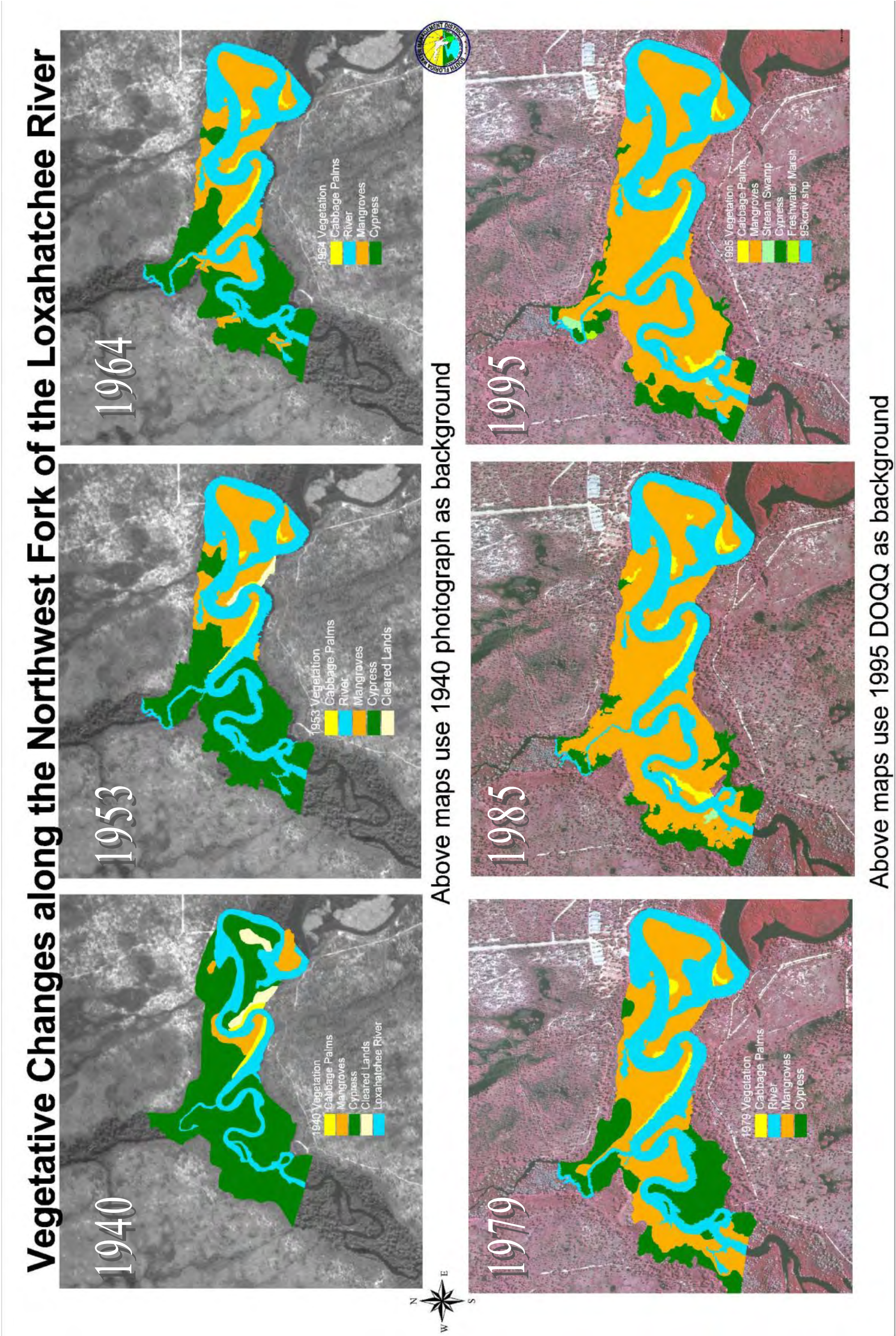
During the years 1940, 1953, 1964 and 1979, District staff analyzed black and white aerial photographs taken of the river between river miles 6.6 and 8.9. These early vegetation coverages were also compared to more recent infrared Digital Ortho Quad photographs taken from the watershed in 1985 and 1995. River miles 6.6 to 8.9 is that area of the river where the majority of vegetative changes have taken place over the past 55 years.

1940 Vegetation Coverage: In **Figure B-7**, the 1940's distribution of the freshwater communities that were dominated by cypress is color-coded green, while mangroves are color- coded as orange. This coverage represents the earliest photographic record of the distribution of cypress communities prior to permanent opening of the Jupiter Inlet in 1947. Cypress communities extended downstream as far as RM 5.8. Mangroves are also present in 1940 photography extending upstream to RM 7.8. The presence of mangroves along the Lower Northwest Fork of the river at this point in the river's history may be the result of several factors. Prior to 1947, the inlet opened and closed periodically. During periods when the inlet was open, saltwater may have had the opportunity to penetrate the lower portion of the river allowing mangroves to become established. Other factors that may have contributed to increased salinity levels within the estuary and lower Northwest Fork prior to 1940 include: (a) construction of the Intracoastal Waterway in 1928 that linked the St. Lucie Inlet with the North Lake Worth Inlet, (b) USCOE dredging of the inlet and lower estuary in the 1930's, and (c) construction of a small agricultural ditch that diverted water from the Loxahatchee Slough marsh to the SW Fork of the river (See Figure B-1, 1940 Map of the Loxahatchee River Watershed).

1953 Vegetation Coverage: In 1953, mangrove increased substantially in comparison to the extent in 1940, while cypress communities decreased. These major changes in river vegetation correspond to the opening of the Jupiter Inlet in 1947, which permanently changed the lower estuary from a freshwater/brackish water system to a salinity regime more characteristic of estuarine conditions. In addition, back-to-back hurricanes in the late 1940's and their associated storm surges may have increased mangrove seed distribution and accounted for some of the mangrove colonization shown in the 1953 photography.

1964 Vegetation Coverage: The 1964 photography shows additional losses of cypress communities in favor of mangroves (**Figure B-7**). By 1964, mangroves had colonized the Northwest Fork of the river as far as RM 8.7 and into the mouth of Kitching Creek. These losses of floodplain swamp and increases in mangroves correspond with two major drainage and development projects within the watershed. In 1957-58, the C-18 canal was constructed to drain the central portion of the Loxahatchee Slough. This project diverted flow away from the Northwest Fork to the SW Fork, thereby reducing the freshwater head that could prevent saltwater intrusion during low rainfall periods (McPherson et al. 1982). In addition, during the early 1960's a developer also dredged and filled a number of mangrove islands within the lower portion of the river and cut a channel (10-15 ft deep) through the sandbar ("S-bar") that historically provided a natural saltwater barrier to upper reaches of the river (***Loxahatchee Lament***, 1978). As a result of these two projects, saltwater could now more freely penetrate the Northwest Fork of the river during low flow periods.

1979 Vegetation Coverage: The 1979 photography shows the continued decline of the cypress community and increases in mangrove in response to past drainage and development projects within the watershed (**Figure B-7**). These declines correspond with


Vegetative Changes along the Northwest Fork of the Loxahatchee River
1940
1940 Vegetation
Cabbage Palms
Mangroves
Cypress
Cleared Lands
Loxahatchee River
1953
1953 Vegetation
Cabbage Palms
River
Mangroves
Cypress
Cleared Lands
1964
1964 Vegetation
Cabbage Palms
River
Mangroves
Cypress
Above maps use 1940 photograph as background
1979
1979 Vegetation
Cabbage Palms
River
Mangroves
Cypress
1985
1995
1995 Vegetation
Cabbage Palms
Mangroves
Stream Swamp
Cypress
Freshwater Marsh
95kcriv.shp
Above maps use 1995 DOQQ as background
N
E
S
W

The continued operation of the C-18 Canal which essentially eliminated freshwater flow from the Loxahatchee Slough to the Northwest Fork from the time the C-18 canal project became operational (early 1960's) until the construction of the G-92 structure in 1974. In addition, dredging of the central embayment area (McPherson 1982), combined with oyster bar removal projects (Chiu 1975), and replacement of the A1A Bridge over the Loxahatchee River are thought to have improved tidal flushing of the estuary. These projects may have also played a role in allowing saltwater to further penetrate the lower portion of the river during dry periods. Also during the 1970's, the region experienced a number of below normal rainfall years (1971, 1972, 1973, 1975, 1976, 1977 and 1979) which may have also contributed to the river's saltwater intrusion problems.

1985 Coverage: The 1985 photography represents the distribution of vegetation along the river at the time it was designated as Florida's first Wild and Scenic River. At this time mangroves were identified as far upriver as RM 10.4 although they were only dominant between RMs 5.5 and 8.7 (**Figure B-7**).

1995 Coverage: There was very little change between the 1985 coverage and the 1995 coverage. The 1995 coverage reflected the fact that above RM 9, mangroves expanded only from the areas that were occupied in 1985 (**Figure B-7**). This limited encroachment may be attributed to the fact that in 1987 additional culverts and operational criteria were added to G-92 to reconnect the Loxahatchee Slough with the Northwest Fork resulting in more water being added to the Northwest Fork.

Some hydrological modifications were constructed on the SW Fork of the Loxahatchee River in the late 1950s. Between 1957 and 1958, the District channelized the Southwest Fork and constructed the S46 Structure and C-18 Canal which diverted water from the Northwest Fork to the Southwest Fork for flood control. It is interesting to note that since the 1974 construction of the G-92 Structure and modifications to the Northwest Fork riverbed, vegetative communities appear to have stabilized (i.e. 1985 and 1995 vegetative coverages).

Sklar and Hutchinson (1993) noted similar effects on the growth of tidal freshwater cypress in South Carolina. They concluded that cypress tree growth was related to the cumulative influence of regional rainfall amounts, saltwater intrusion, and periods of low river discharge. Their results suggested that increasing river discharge would increase cypress growth by flushing and preventing tidally-driven saltwater intrusion. Their model predicted that cypress trees in tidally dominated freshwater marshes could die because of increased salt stress within 50 years if sea level rise were to exceed 4-5 millimeters per year.

Comparisons with 1970s River Vegetation Studies

The 1973 field observations of Alexander and Crook (1975) provide a historical record of the existing floodplain vegetation in several locations along the Northwest Fork and Kitching Creek. In Alexander and Crook's study, Site 10 was located on

Kitching Creek, while 3 sites (13, 14, and 15) were located on the Northwest Fork. Interpretation of the 1940 photography yielded conclusions similar to those similar from Alexander and Crook's 1940 interpreted drawings. Site 10 as a swamp hardwood dominated by water oak, maple, ash, and pond apple. Sites 13 and 14 were identified as mangrove river communities, and Site 15 was interpreted as a cypress canopy with a mangrove understory. In our interpretation of these same areas, Sites 10 and 15 were still swamp hardwoods, while Site 13 was predominately cypress with a small amount of mangrove at the southern tip. Site 14 was predominately mangrove with some cleared land. Therefore, there were some slight disagreements in the vegetative coverage of Site 13.

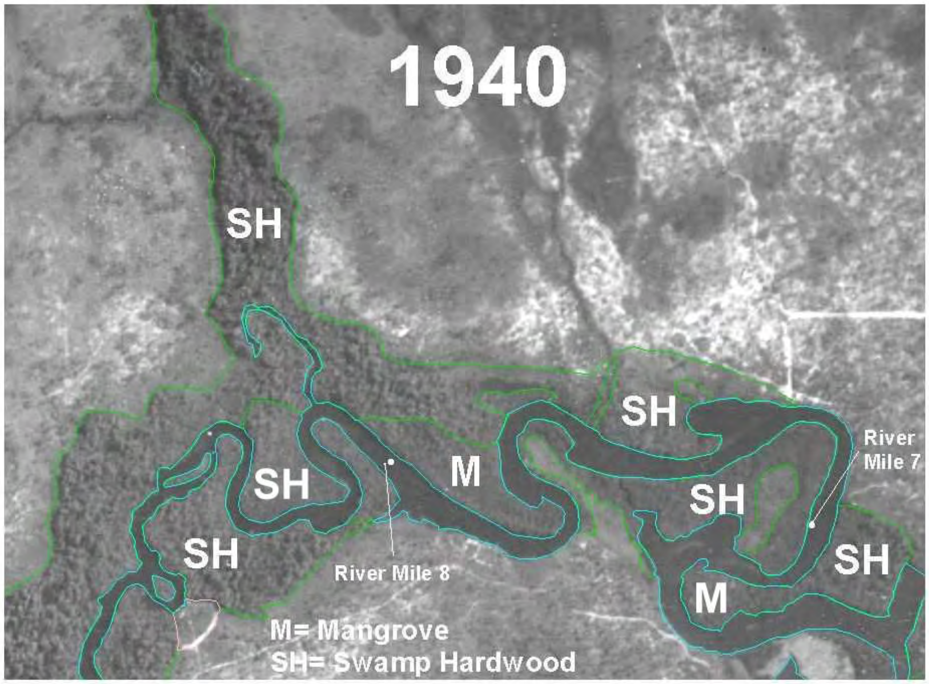
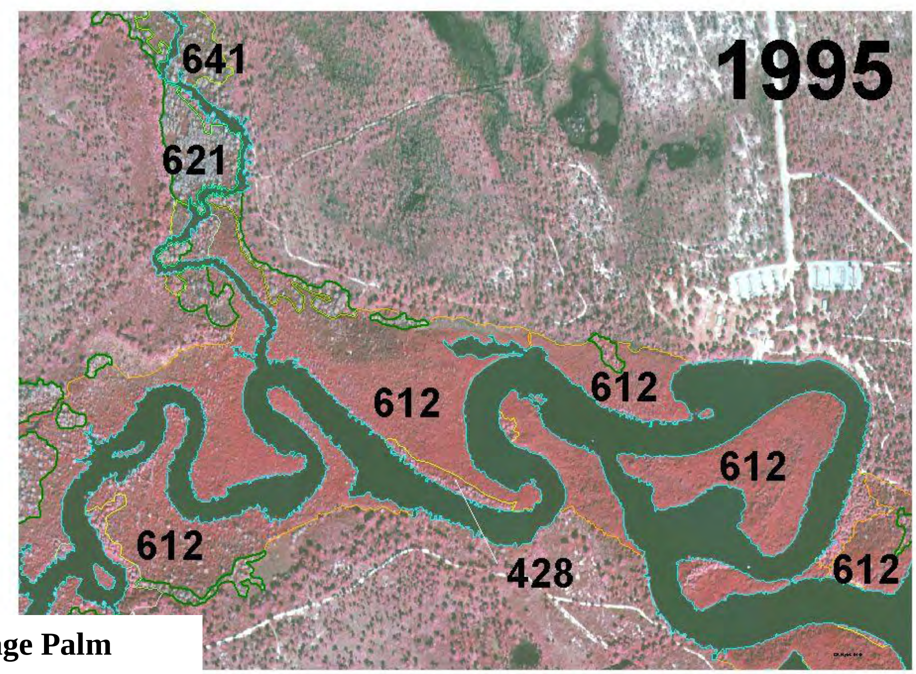


Figure B-6 and 7. Comparison with Alexander and Crook's 1975 Vegetation Study



428= Cabbage Palm
612= Mangrove
621= Cypress

A Discussion of the Impacts of Hydrological Alterations and 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. The examples that were given included the mangrove borders of Biscayne Bay and much of the Everglades. These forests have expanded inland since the 1940s in conjunction with man's alteration of surface and groundwater flows.

Red mangroves are particularly successful invaders. Their rod-shaped propagule is very efficiently transported by tide and has the lowest seedling mortality rate of mangrove species (Rabinowitz, 1978a). Davis (1940) noted that floating red mangrove propagules remain viable up to 12 months. In addition, Rabinowitz (1978b) observed that red mangrove seedlings can become established under an existing, dense canopy and due to their superior embryonic reserves, are able to wait as seedlings on the forest floor for months until a tree falls to open up the canopy and present opportunities for growth.

The opening and closing of Jupiter Inlet, the reduced inflows of surface water, and the subsequent drop in the groundwater table has promoted the distribution of red and white mangroves and taken its toll on the freshwater habitat of the Northwest Fork of the Loxahatchee River. In many areas, mangroves now dominate habitat that was formerly dominated by bald cypress. Urban development within the headwaters and the major tributaries will continue to modify historical freshwater flow and make any efforts towards preserving this historical flora more difficult.

Hurricanes have affected the watershed by producing storm surges, the opening and closing of the inlets, changes in land contours and by producing severe physical damage to vegetation. Hurricanes also spread plant propagules over long distances. Major hurricanes and tropical storms occurred in the vicinity of the Loxahatchee River in 1898, 1903, 1924, 1926, 1928, 1933, 1948, 1949, 1964, and 1979. The 1903 storm created an 8-foot storm surge in Jupiter, while Hurricane David in 1979 created a 5-foot surge with winds gusting at 85 miles per hour (mph). Winds of 153 mph were recorded at the Jupiter Lighthouse during the 1949 storm, which passed through Delray Beach (Barnes, 1998). The hurricane impacts of 2004 (Frances and Jeanne) are discussed in detail in Appendix D. Impacts from Hurricane Wilma (2005) have not been assessed.

Severe droughts were recorded in 1937/38, 1943/44, 1950/51, 1955/56, 1960/61, 1966/67, 1970/71, 1980/81, 1989/90, and 2000/01. Droughts effect vegetation through "water stress" and saltwater intrusion. Richardson (1977) stated that only isolated stands of cypress exist in places that at one time were extensive forests in Palm Beach County. Cypress seeds need moisture before germination may take place. Pezeshki et al. (1987) observed that flooding one-year-old bald cypress seedlings above 2ppt. with saline water reduced CO_2 fixation by 40%-65% and net photosynthesis by 51-70%. All saline treatments resulted in leaf injury with greater damages at higher salinities. Their study suggested that saline water produces an excess accumulation of sodium and chloride, which may affect different plant processes in bald cypress seedlings.

Historically cold winters were reported in 1939-40, 1957-58, 1962-63 and 1964-65 (Alexander and Crook, 1975) and in 1977, 1983, 1985 and 1989 (Florida Department of Environmental Protection, 2000). Evidence of a major meterological event was apparent from infrared aerial photographs taken during a special flight for South Florida Water Management District in April 1985. Mangroves along the Northwest Fork were defoliated and trees of 30 feet or more exhibited broken branches and trunks. The average monthly air temperatures for January and February 1985 were 46º and 52º F, respectively with temperatures ranging as low as 25°F (U.S. Department of Commerce, Climatological Data: Florida). Mangroves do not tolerate temperature fluctuations exceeding 18° F or temperatures below freezing (Odum et. al, 1982). Mangroves may defoliate after exposure to 45°F or less. Mangroves along the Northwest Fork of the Loxahatchee River have not yet reached the potential height of mature mangroves, which can range between 60 and 80 feet. Distance inland may be another factor in lower mangrove heights.

Although mangroves have colonized a considerable area formerly in freshwater vegetation along the Northwest Fork of the Loxahatchee River, the Wild and Scenic River segments of the waterway continue to be a valuable natural resource and tourist attraction with both mangrove and cypress habitats. As in coastal areas, mangroves provide shoreline stabilization, wildlife habitat, and aesthetic values.

Summary and Conclusions

Results of the examination of 1940, 1985, and 1995 aerial photographs showed the following:

- Reductions in total acreage of the river floodplain between 1940 and 1995 were attributed to severe scouring of the riverbed, bulkheading, and loss of the wetland vegetation to transitional and upland species. Most of the vegetative changes occurred in the lower and middle segments of the Northwest Fork (RMs 5 through 10).

- The 1940 aerial photography revealed an abundance of swamp, wetland prairies, inland ponds and sloughs, and mangroves along the river. Freshwater communities dominated the vegetative coverage of the Northwest Fork representing 72.68 percent of the coverage, while mangroves represented 22.35 percent and disturbed/cleared land 3.68 percent.

- By 1985, much of the watershed that was undeveloped in 1940 had been developed with the exception of Jonathan Dickinson State Park. Freshwater communities represented 61.49 percent of the total coverage while mangroves represented 25.32 percent and disturbed/cleared land represented 13.18 percent. Mangroves were present up to RM 10.4. Freshwater communities decreased by 11.19 percent since 1940.

- By 1995, freshwater communities had decreased by 11.5 percent since 1940. Mangroves increased by 2.7 percent. In a delayed response to the 1957-58 construction of the C-18 Canal and Structure S-46, vegetation within the floodplain of the Northwest Fork may have responded to increases in rainfall during the 1990s and the improvements to the G-92

Structure in 1986. These two factors may have stabilized the advance of mangroves and saltwater intrusion.

• Mapping of freshwater and salt tolerant communities showed an increase in species diversity (i.e. stream swamp versus cypress and mangrove communities) along the immediate river corridor upstream of RM 9. Areas dominated by cypress appear to receive groundwater flow from uplands and wider floodplains, which protect their roots from saltwater.

• An analysis of six decades of change revealed that most of the mangrove encroachment occurred between 1953 and 1979. The 1953-79 correlates to a period in which the inlet stabilized and freshwater flow was redirected from the Northwest Fork to the Southwest Fork of the river for flood control.

• Comparisons of Alexander and Crook's 1975 investigations and the current investigation revealed similar coverages for all but Site 13 for the 1940 vegetative coverage. Both studies observed a steady increase in the invasion of mangroves along the Northwest Fork and Kitching Creek.

Any future efforts to restore the freshwater hardwoods and cypress communities on the floodplain of the Northwest Fork of the Loxahatchee River must consider the many diverse resources and functions that need to be protected in the river and floodplain, the overall availability of freshwater throughout the watershed, and the potential for connecting this watershed to other basins and regional resources.

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Table B-1. Major Plant Communities and their Signatures for Color Infrared Photographs

Major Plant Communities	Signature	Vegetation	Hydrology/Soils
300 Rangeland 321 Palmetto Prairies	Bright pink, stippled appearance	Saw palmetto (*Serenoa repens)* is the dominant species. Other potential species: bluestems (*Andropogon spp.)*, panic grasses (*Panicium spp.*), fetterbush (*Lyonia sp.*), gallberry (*llex glabra*), and wax myrtle (*Myrica cerifera*)	Good drainage, seldom inundated
400 Upland Forest 428 Cabbage Palm	Dull, medium red color return with a predominantly fluffy and irregular crown texture with individual crowns discernable	cabbage palms with live oaks and vines	Rarely inundated/ fine sands well to somewhat poorly drained
500 Water 510 Streams and Waterways	black color for rivers streams, creeks, canals and other water bodies		
600 Wetlands 612 Mangrove Swamp	Smooth "cottony" red with generally even height* Areas of stress may appear as bright greenish color with a rough or stipple texture	Dominated by red, white or black mangroves (red towards the water's edge, blacks toward the landward side, whites more landward Other species Buttonwood, seagrape, palms, brazilian pepper, cocoplum	Permanently to tidally flooded/ very poorly drained organics or saline sands
615 Stream & Lake Swamps	Varying size canopies of irregularly shaped crowns from very pin-like (cypress) to mid-size fluffy and cottony overlapping crowns of broad leaf deciduous hardwoods. Cypress greyish green other hardwoods red color returns	Dominated by a mixture of water tolerant hardwoods including red maple, water oak, sweetgum, willows, water hickory, bays Cypress present but not dominant	Seasonal inundation depending upon weather cycles/ Soils mixture of sand, organics, and alluvial materials
616 Inland Ponds & Sloughs	Similar return as 615; however, these areas are found in depressions (ponds) and poorly drained defined drainages (sloughs) not associated with rivers or creeks	Dominated by cypress, red maples, willows with no single species dominating	Semi-permanent or permanent hydroperiods with a few inches of slowly moving water/ Soils highly organic sands or layered
621 Cypress	gray or gray-green color, narrow, densely packed crowns Tallest trees near the center with younger smaller trees along the edges	Dominated by cypress bald or pond Other species: red maple, pond apple, pop ash, water hickory In drier sites laurel oaks, sweet gum and bays	Semi-permanent or permanent hydroperiods/Poorly or very poorly drained, high in organics with peat layer of varying thickness on the surface
630 Mixed Wetland Forest	Gray or grey green, with canopy openings	Mixed cypress, pond apple and mangrove	Tidally and seasonally flooded

*We noted that darker tones of red within the mangrove community appeared to be taller/older trees that had not been as impacted by past freezes. These areas could be found generally in the interior of the communities and had perhaps been shielded from the colder temperatures and stronger wind.

APPENDIX C

Species and Code Lists

Species and Code Lists

Table C.1. Canopy Species List and Codes

Scientific Name	Common Name	Code
Acer rubrum	Red maple	AR
Annona glabra	Pond apple	AG
Carya aquatica	Water hickory	CA
Cephalanthus occidentalis	Buttonbush	CO
Chrysobalanus icaco	Cocoplum	CI
Citrus sp.	Citrus	CS
Ficus aurea	Strangler ficus	FA
Fraxinus caroliniana	Pop ash	FC
Ilex cassine	Dahoon holly	IC
Laguncularia racemosa	White mangrove	LR
Myrica cerifera	Wax myrtle	MC
Persea borbonia	Red bay	PB
Persea palustris	Swamp bay	PP
Pinus elliottii	Slash pine	PE
Psidium cattleianum	Strawberry guava	PC
Quercus laurifolia	Laurel oak	QL
Quercus myrtifolia	Myrtle oak	QM
Quercus virginiana	Live oak	QV
Rapanea punctata	Myrsine	RP
Rhizophora mangle	Red mangrove	RM
Roystonea regia	Royal Palm	RR
Sabal palmetto	Cabbage palm	SP
Salix caroliniana	Carolina willow	SaC
Schinus terebinthifolius	Brazilian pepper	ST
Serenoa repens	Saw palmetto	SR
Syzygium cumini	Java plum	SC
Taxodium districhum	Bald cypress	TD

Table C-2. Shrub Species and Codes

Scientific Name	Common Name	Code
Abrus precatorius	Rosary pea	ABRPRE
Acer rubrum	Red maple	ACERUB
Acrostichum danaefolium	Leather fern	ACRDAN
Alternanthera philoxeroides	Aligator weed	ALTPHI
Alternanthera sessilia	Joyweed	ALTSES
Amorpha fruticosa	False indigo	AMOFRU
Annona glabra	Pond apple	ANNGLA
Ardisia escallonioides	Marlberry	ARDESC
Baccharis halimifolia	Salt bush	BACHAL
Blechnum serrulatum	Swamp fern	BLESER
Boehmeria cylindrica	False nettle	BOECYL
Callicarpa americana	Beautyberry	CALAME
Canna flaccida	Golden Canna	CANFLA
Carex lupulina	Hop sedge	CARLUP
Carya aquatica	Water hickory	CARAQU
Cephalanthus occidentalis	Button bush	CEPOCC
Chrysobalanus icaco	Coco plum	CHRICA
Cladium jamaicense	Sawgrass	CLAJAM
Commelina diffusa	Dayflower	COMDIF
Crinum americanum	Swamp lily	CRIAME
Cyperus retrorsus	Flatsedge	CYPRET
Dichanthelium commutatum	Witchgtrass	DICCOM
Dichanthemlium spp		DICSPP
Fern seedling		JUVFER
Ficus microcarpa	Indian laurel ficus	FICMIC
Fraxinus caroliniana	Pop ash	FRACAR
Hydrocotyle spp	Pennywort	HYDSPP
Hypericum spp	St. John's wort	HYPSPP
Ilex cassine	Dahoon holly	ILECAS
Ipomoea indica	Blue morning glory	IMPIND
Itea virginica	Virginia willow	ITEVIR
Laguncularia racemosa	White mangrove	LAGRAC
Ludwigia octivalvus	Primrose willow	LUDOCT
Ludwigia peruviana	Primrose willow	LUDPER
Ludwigia seedling		LUDSEE
Lygodium microphyllum	Old world climbing fern	LYGMIC

Scientific Name	Common Name	Code
Lyonia fruiticosa	Staggerbush	LYOFRU
Mikania scandens	Hempvine	MIKSCA
Morus rubra	Mulberry	MORRUB
Moss species		MOSSSP
Myrica cerifera	Wax myrtle	MYRCER
Nephrolepis exaltata	Boston fern	NEPEXA
Osmunda cinnamomea	Cinnamon fern	OSMCIN
Osmunda regalis	Royal fern	OSMREG
Parthenocissus quinquefolia	Virginia creeper	PARQUI
Persea barbonia	Red bay	PERBAR
Pluchea odorata	Marsh fleabane	PLUODA
Psidium cattleianum	Strawberry guava	PSICAT
Psychotria nervosa	Wild coffee	PSYNER
Psychotria sulzneri	Wild coffee	PSYSUL
Quercus laurifolia	Laurel oak	QUELAU
Quercus seedling		QUESEE
Quercus virginiana	Live oak	QUEVIR
Rapenea punctata	Myrsine	RAPPUN
Rhabdadenia biflora	Rubber vine	RHABIF
Rhizophora mangle	Red mangrove	RHIMAN
Rhynchospora rariflora	Beak sedge	RHYRAR
Rubus trivialis	Blackberry	RUBTRI
Sabal palmetto	Cabbage palm	SABPAL
Sarcostemma clausum	White vine	SARCLA
Saururus cernuus	Lizard's tail	SAUCER
Schinus terebinthifolius	Brazilian pepper	SCHTER
Senna pendula	Climbing Cassia	SENPEN
Serenoa repens	Saw palmetto	SERREP
Smilax bona-nox	Greenbrier	SMIBON
Syngonium podophyllum	Nephthytes	SYNPOD
Syzygium cumini	Java plum	SYZCUM
Taxodium distichum	Bald cypress	TAXDIS
Thelypteris dentata	Downy shield fern	THEDEN
Thelypteris interrupta	Willdenow's maiden fern	THEINT
Thelypteris palustris	Marsh fern	THEPAL
Thelypteris serrata	Meniscium fern	THESER
Tillandria fasciculata	Cardinal airplant	TILFAS
Toxicodendron radicans	Poison ivy	TOXRAD

Scientific Name	Common Name	Code
Tripsacum dactyloides	Gamma grass	TRIDAC
Typha spp.	Cattail	TYPSPP
Unidentified Poaceae		UNIPOA
Unidentified seedling		UNISEE
Unidentified spp.		UNISPP
Urena lobata	Caesar weed	URELOB
Vitis rotundifolia	Grape vine	VITROT
Wedelia trilobata	Creeping oxeye	WEDTRI
Xanthosoma sagittifolium	Elephant ear	XANSAG

Table C-3. Groundcover Species and Code List

Scientific Name	Common Name	Code
Abrus precatorius	Rosary pea	ABRPRE
Acer rubrum	Red maple	ACERUB
Acrostichum danaefolium	Leather fern	ACRDAN
Alternanthera philoxeroides	Alligator weed	ALTPHI
Alternanthera sessilia	Joyweed	ALTSES
Amorpha fruticosa	False indigo	AMOFRU
Annona glabra	Pond apple	ANNGLA
Apios americana	Ground nut	APIAME
Ardisia escallonioides	Marlberry	ARDESC
Baccharis glomeruliflora	Groundsel	BACGLO
Baccharis spp		BACSPP
Bacopa monnieri	Water hyssop	BACMON
Bejaria racemosa	Tar flower	BEJRAC
Bidens alba	Beggar ticks	BIDALB
Bischofia javanica	Bishop wood	BISJAV
Blechnum serrulatum	Swamp fern	BLESER
Boehmeria cylindrica	False nettle	BOECYL
Callicarpa americana	Beautyberry	CALAME
Canna flaccida	Golden Canna	CANFLA
Carex lupuliformis	Hop sedge	CARLUP
Carya aquatica	Water hickory	CARAQU
Cephalanthus occidentalis	Button bush	CEPOCC
Chamaecrista fasciculata	Partridge pea	CHAFAS
Chrysobalanus icaco	Coco plum	CHRICA
Cladium jamaicense	Sawgrass	CLAJAM
Commelina diffusa	Dayflower	COMDIF
Crinum americanum	Swamp lily	CRIAME
Cynoglossum zeylanicum *	Hound's tongue / Wild comfrey	CYNZEY
Cyperus haspan	Flat sedge	CYPHAS
Cyperus ligularis	False saw grass	CYPLIG
Cyperus retrorsus	Flatsedge	CYPRET
Cypress seedling		CYPSEE
Dalbergia ecastaphyllam	Coin vine	DALECA
Desmodium triflorum	Three flower begger weed	DESTRI
Dichanthelium commutatum	Witch grass	DICCOM
Dichanthemlium spp		DICSPP
Eleocharis baldwinii	Road grass	ELEBAL

Scientific Name	Common Name	Code
Erechitites hieracifolia	Fire weed	EREHIE
Eupatorium mikanioides	Semaphore aster **	EUPMIK
Fern seedling		JUVFER
Fraxinus caroliniana	Pop ash	FRACAR
Galactia spp		GALSPP
Hydrocotyle spp	Pennywort	HYDSPP
Hygrophila polysperma	E. Indian swamp weed	HYGPOL
Hypericum spp	St. John's wort	HYPSPP
Hyptis alata	Musky mint	HYPALA
Ilex glabra	Ink berry	IGELA
Ipomoea indica	Blue morning glory	IMPIND
Itea virginica	Virginia willow	ITEVIR
Laguncularia racemosa	White mangrove	LAGRAC
Limnophilia sessiliflora	Marsh weed	LIMSES
Ludwigia octivalvus	Primrose willow	LUDOCT
Ludwigia repens	Creeping primrose willow	LUDREP
Ludwigia seedling		LUDSEE
Lygodium microphyllum	Old world climbing fern	LYGMIC
Lyonia lucida	Fetterbush	LYOLUC
Melanthera nivea	Square stem	MELNIV
Micranthemum glomeratum	Baby tears	MICGLO
Mikania scandens	Hempvine	MIKSCA
Mimosa quadrivalvis	Sensitive brier	MIMQUA
Myrica cerifera	Wax myrtle	MYRCER
Nephrolepis exaltata	Boston fern	NEPEXA
Osmunda cinnamomea	Cinnamon fern	OSMCIN
Osmunda regalis	Royal fern	OSMREG
Panicum rigidulum	Redtop Panicum	PANRIG
Panicum virgatum	Switch grass	PANVIR
Parthenocissus quinquefolia	Virginia creeper	PARQUI
Persea borbonia	Red bay	PERBAR
Pleopeltis polypodioides	Resurrection fern	PLEPOL
Poaceae seedling		POASEE
Polygonum hydropiperoides	Swamp smart weed	POLHYD
Polygonum punctatum	Dotted smart weed	POLPUN
Psidium cattleianum	Strawberry guava	PSICAT
Psilotum nudum	Whisk-fern	PSINUD
Psychotria nervosa	Wild coffee	PSYNER
Psychotria sulzneri	Wild coffee	PSYSUL
Quercus myrtifolia	Myrtle oak	QUEMYR

Scientific Name	Common Name	Code
Quercus seedling		QUESEE
Quercus virginiana	Live oak	QUEVIR
Rapenea punctata	Myrsine	RAPPUN
Rhabdadenia biflora	Rubber vine	RHABIF
Rhizophora mangle	Red mangrove	RHIMAN
Rhynchospora inundata	Beck sedge	RHYINU
Rhynchospora rariflora	Beak sedge	RHYRAR
Rubus trivialis	Blackberry	RUBTRI
Sabal palmetto	Cabbage palm	SABPAL
Sagittaria lancifolia	Arrow head	SAGLAN
Sagittaria latifolia	Broadleaf arrow head	SAGLAT
Salix caroliniana	Carolina willow	SALCAR
Samolus valerardi	Pineland pimpernel	SAMVAL
Sarcostemma clausum	White vine	SARCLA
Saururus cernuus	Lizard's tail	SAUCER
Schinus terebinthifolius	Brazilian pepper	SCHTER
Senna pendula	Climbing Cassia	SENPEN
Serenoa repens	Saw palmetto	SERREP
Sida acuta	Wire weed	SIDACU
Smilax bona-nox	Greenbrier	SMIBON
Smilax spp		SMISPP
Syngonium podophyllum	Nephthytes	SYNPOD
Syzygium cumini	Java plum	SYZCUM
Taxodium distichum	Bald cypress	TAXDIS
Thelypteris dentata	Downy shield fern	THEDEN
Thelypteris interrupta	Willdenow's maiden fern	THEINT
Thelypteris palustris	Marsh fern	THEPAL
Thelypteris serrata	Meniscium fern	THESER
Tillandria fasciculata	Cardinal airplant	TILFAS
Tillandria setacea	Needle leaf airplant	TILSET
Toxicodendron radicans	Poison ivy	TOXRAD
Unidentfied Cyperaceae		UNICYP
Unidentified Poaceae		UNIPOA
Unidentified seedling		UNISEE
Unidentified spp.		UNISPP
Unidentified Xyris		UNIXYR
Unidentifued cyperacea		UNICYP
Urena lobata	Caesar weed	URELOB
Vitis rotundifolia	Grape vine	VITROT
Wedelia trilobata	Creeping oxeye	WEDTRI

Scientific Name	Common Name	Code
Xanthosoma sagittifolium **	Elephant ear	XANSAG
** sent off for identification*		
*** could be Chromolaena odorata*	Jack-in-the-box	
**** could be Colocasia esculenta*	Wild Taro	

APPENDIX D

Soil Characteristics

APPENDIX D

Soil Characteristics

Table D- 1. Soil characteristics at Transect #1.

Appendix D: UF Soil Survey conducted May 2004 - Transect 1											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T1-1-20	0-20	25	N 26° 56.390'	W 80° 10.321'	Winder fine sand	Riviera Series	0-15cm:10YR3/1, fine sand with many uncoated sand grains; 15-20 see next entry	0-15: A horizon; 15-60: E1 horizon	>120	Cabbage Palm, slash pine, we are on the edge of the cypress.	
T1-1-40	20-40						15-60: 10YR5/1 fine sand	same			
T1-1-60	40-60						same	same			
T1-1-80	60-80						60-90: 10YR7/1 fine sand	60-90: E2			
T1-1-100	80-100						90-120: 10YR4/3 sandy clay loam	90-120:Bt layer			
T1-1-120	100-120						same	" "			
T1-2-20	0-20	65	N 26° 56.409'	W 80° 10.346'	Winder fine sand	Aquents	0-30: 5Y2.5/1 clay w/ C2D 10Y5/6 mottles	A	>120	Cypress, red maple, water hickory	
T1-2-40	20-40						same to 30; 30-50: 5Y3/1 Sandy Clay	C1			
T1-2-60	40-60						same to 50; 50-60: change to fine sand, 2.5Y5/2	C2			
T1-2-80	60-80						10YR8/1 fine sand	C3			
T1-2-100	80-100						10YR3/2 loamy sand	C4			
T1-2-120	100-120						same	" "			
T1-3-20	0-20	25 (?)	N 26° 56.428'	W 80° 10.365'	Winder fine sand	Aquents	0-22: 5Y3/1 sandy clay loam	A	100	Cypress, water hickory, red maple.	Waypoint 39
T1-3-40	20-40						22-45: white sand	C1			
T1-3-60	40-60						45-100+: change to grey loamy fine sand, 5Y3/1	C2			
T1-3-80	60-80						same	" "			
T1-3-100	80-100						same	" "			
T1-3-120	100-120										

T1-4-20	0-20	55(?)	N 26° 56.432'	W 80° 10.367'	Winder Series	Pineda	10YR4/1 fine sand	A	110		
T1-4-40	20-40						20-50:10YR5/3 fine sand	Bw			
T1-4-60	40-60						50: same getting loamier, sandy loam	Bt			
T1-4-80	60-80						same	" "			
T1-4-100	80-100						90-120: loamy sand w/ common shell fragments, 5Y7/1	IIC			
T1-4-120	100-120						same				

Table D- 2. Soil characteristics at Transect #2.

Appendix D: UF Soil Survey conducted May 2004 - Transect 2											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T2-1-20	0-20	0-5	N 26° 56.951'	W 80° 10.230'	Winder fine sand	Wabasso	0: 10YR3/1 fine sand with many uncoated sand grains; 10: 10YR2/2 fine sand	10:Bh (no E)	>120	Cabbage palm, red maple, cypress	Waypoint 43
T2-1-21	20-40						same to 30. 30: 10YR5/4 color change	30: E1 horizon			
T2-1-22	40-60						same.	E2 horizon			
T2-1-23	60-80						10YR6/3 fine sand	E3 horizon			
T2-1-24	80-100						80: 5Y5/1 sandy clay loam with few fine F1P 7.5YR5/8 mottles (red); 90:10YR5/2 loamy sand	Btg1			
T2-1-25	100-120						same to 110. 110-120: 10YR5/2 sandy loam	Btg2			
none	>120						10YR3/3 sand	IIC			
T2-2-20	0-20	55-65	N 26° 56.940'	W 80° 10.184'	Winder fine sand	Chobee	5Y2.5/1 Sapric Muck	0-30: Oa horizon	120		Masten Dam, impounded area
T2-2-40	20-40						same to 30. 30: 5Y4/1 sandy clay loam	Btg1			
T2-2-60	40-60						sandy clay loam, lighter in texture	Btg2			
T2-2-80	60-80						5Y5/1 sandy loam, sandier.	IIC1			
T2-2-100	80-100						5Y5/1sand	IIC2			
T2-2-120	100-120						same	""			
none	>120						sandy to 204 cm.	" "			
T2.2-1-20	0-20	5	N 26° 56.996'	W 80° 10.209'	Winder fine sand	Pineda	0: 10YR3/1 fine sand, many uncoated sand grains; 10: 10YR6/2 fine sand	AP horizon E1	>120	Pine tree, live oak, pop ash, cabbage palm, Cocoplum (*Chrysobalanus*	We are in a cabbage palm hammock. Waypoint
T2.2-1-40	20-40						same	" "			
T2.2-1-60	40-60						10YR6/3 fine sand	Bw			

Appendix D: UF Soil Survey conducted May 2004 - Transect 2											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
								horizon		*icaco*).	45
T2.2-1-80	60-80						same	" " horizon			
T2.2-1-100	80-100						same to 90; 90: 10YR6/3 sandy loam with M12D 10YR5/8 mottles and common C2D 10YR6/2 mottles	Bt			
T2.2-1-120	100-120										
none	>120						10YR5/3 sand to >120	IIC			
T2.2-2-20	0-20	35-45	N 26^o 56.994'	W 80^o 10.194'	Winder fine sand	Gator muck	5Y2.5/1 Sapric muck	Oa	100	cypress	Waypoint 46
T2.2-2-40	20-40						same				
T2.2-2-60	40-60						same				
T2.2-2-80	60-80						same				
T2.2-2-100	80-100						5Y2.5/1 Sandy loam	IIC1			
T2.2-2-120	100-120						same	" "			
none	160-160+						10YR6/2 sand	IIC2			

Table D- 3. Soil characteristics at Transect #3.

Appendix D: UF Soil Survey conducted May 2004 -Transect 3											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T3-1-20	0-20	0	N 26° 57.665'	W 80° 09.856'	Pompa no fine sand, occasionally flooded	Nettles	0:10YR2/1; 7.6: 10YR3/1 to 33cm	0: A1 Horizon, 7.6: A2 layer	none	Cabbage Palm,slash pine	This transect has one well
T3-1-40	20-40						same to 33. 33:10YR6/1	33:E Horizon			
T3-1-60	40-60						same to 55. 55: 10YR3/2	55: Bh1			
T3-1-80	60-80						same to 75. 75: 10YR2/1, weakly cemented	75: Bh2			
T3-1-100	80-100						same to 90. 90: change layer type.	90:Bh3			
T3-1-120	100-120						100: 10YR5/3; 115: 5YR5/1 sandy loam	100:E' Layer; 115: Btg			
T3-2-20	0-20	55	N 26° 57.660'	W 80° 09.888'	Pompa no fine sand, occasionally flooded	Aquents	10YR2/1 stratified sand/sandy clay loam, various texture	A	100	a lot of pop ash	
T3-2-40	20-40						10YR2/1 Sandy clay loam	C1			
T3-2-60	40-60						7.5YR2/0	C2			
T3-2-80	60-80						10YR4/2 Sandy texture	C3			
T3-2-100	80-100						10YR5/3 Sand	C4			
	151						5GY6/1 Sandy clay	C5			
T3-3-20	0-20	79	N 26° 57.667'	W 80° 09.911'	Pompa no fine sand, occasionally flooded	Aquents	10YR2/1 Sandy clay	A	85	cypress, pop ash, Brazilian pepper, pond apple	Waypoint 36
T3-3-40	20-40						same to 35. 35: change in texture to 10YR3/1 sand	C1			
T3-3-60	40-60						10YR3/1 stratified sand and sandy clay	C2			
T3-3-80	60-80						same to 70. 70: 10YR4/1 sand	C3			
T3-3-100	80-100						sand 10YR7/1	C4			
T3-3-	100-						same	" "			

Appendix D: UF Soil Survey conducted May 2004 -Transect 3											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
120	120										
T3-4-20	0-20	105	N 26° 57.678'	W 80° 09.922'	Pompa no fine sand, occasionally flooded	Aquents	10YR3/1	A Layer	70	pop ash more than any other site, cypress, red maple, water hickory	
T3-4-40	20-40						24: change to 10YR7/2 fine sand matrix with MPP 2.5YR44 iron red mottling	C1			
T3-4-60	40-60						same	" "			
T3-4-80	60-80						same to 70. 70:texture change to 10YR7/1 stratified sandy loam / 2.5YR5/0 sand	C2			
T3-4-100	80-100						10YR3/2, still stratification	C3			
T3-4-120	100-120						115: change to 10YR7/1 sand to 120+	C4			

Table D- 4. Soil characteristics at Transect #4.

Appendix D: UF Soil Survey conducted May 2004 -Transect 4											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T4-1-20	0-20	5	N 26° 58.161'	W 80° 09.902'	Pompano fine sand, occasionally flooded	Smyrna soil	10YR3/1 fine sand with many uncoated sand grains	A	>120	live oak, w. hickory, cypress, saw palmetto in upland	
T4-1-21	20-40						10YR4/2 fine sand	E			
T4-1-22	40-60						10YR3/2 fine sand	Bh			
T4-1-23	60-80						same	Bh			
T4-1-24	80-100						same to 90. 90: 10R4/3 fine sand	C1			
T4-1-25	100-120						10YR5/3 fine sand; 110 10YR6/2	100: C2; 110: C3			
T4-2-20	0-20	75-85	N 26° 58.136'	W 80° 09.868'	Pompano fine sand, occasionally flooded	Histic Haplaquoll, frequently flooded	10YR2/1 Sapric material	Oa	106	lots of red maples, cypress, pop ash, water hickory, lots of many kinds of ferns.	Waypoint 42 Entire area run over by pigs. Near a well
T4-2-40	20-40						Same to 30. 30: fine sandy loam.	30: C1			
T4-2-60	40-60						Sandy clay loam	C2			
T4-2-80	60-80						10YR4/1 fine sandy loam with stra. layers of 10YR6/2 sand	C3			
T4-2-100	80-100						same				
T4-2-120	100-120						same				
none	163-204+						10YR7/2 sand, entire column is stratified.	C4			
T4-3-20	0-20	115	N 26° 58.107'	W 80° 09.847'	Pompano fine sand, occasionally flooded	Aquents	0: 10YR3/1 fine sand with many uncoated sand grains; 6: stratified 7.5YR3/0 fine sandy loam matrix / 10YR6/2 fine sand / and 5YR3/2 sandy clay loam	A ..6: C1		W. hickory, red maple, laurel oak, cypress.	
T4-3-40	20-40						same	""			
T4-3-60	40-60						same				

Appendix D: UF Soil Survey conducted May 2004 -Transect 4											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T4-3-80	60-80						same				
T4-3-100	80-100						same to 90. 90: sandy clay loam stra. with 5YR3/2 sand	C2			
T4-3-120	100-120						same				
none	120-204+						alternating layers of sand / sandy clay loam	C3			

Table D- 5. Soil characteristics at Transect #5.

Appendix D: UF Soil Survey conducted May 2004 -Transect 5											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T5.1-1-20	0-20	5	N 26^o 58.529'	W 80^o 10.184'	Pompano fine sand, occasionally flooded	Pompano fine sand, occasionally flooded	0: 10YR3/1 fine sand; 10: 10YR5/2 fine sand	0-10:A	>120	live oak, pop ash, saw palmetto	waypoint 47 not a true spodosol because it is not dark enough
T5.1-1-40	20-40						same	C1			
T5.1-1-60	40-60						same				
T5.1-1-80	60-80						10YR6/2 fine sand	C2			
T5.1-1-100	80-100						same				
T5.1-1-120	100-120						same to 110. 110: 10YR4/3 fine sand	110: C3			
T5.1-2-20	0-20	25-35	N 26^o 58.517'	W 80^o 10.177'	Pompano fine sand, occasionally flooded	Aquents	0: 10YR3/1 fine loamy sand; 10: sandy clay loam	0-10: A..C1	>120	cypress, water hickory, red maple, sable palm.	
T5.1-2-40	20-40						10YR6/1 fine sand	C2			
T5.1-2-60	40-60						same				
T5.1-2-80	60-80						10YR4/2 loamy fine sand	C3			
T5.1-2-100	80-100						10YR3/3 loamy fine sand	C4			
T5.1-2-120	100-120						same				
none	150+						same to 150+				
T5.2-1-20	0-20	25	N 26^o 58.554'	W 80^o 10.171'	Pompano fine sand, occasionally flooded	Aquents	0: 10YR 6/3 sand; 5: 5Y 2.5/1 sandy clay loam with C1P10YR5/8 mottles	A…C1	120	red maple, water hickory, cypress	Waypoint 50
T5.2-1-40	20-40						same				
T5.2-1-	40-60						10YR6/2 fine sand	C2			

Appendix D: UF Soil Survey conducted May 2004 -Transect 5											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr. (cm)**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
60											
T5.2-1-80	60-80						color change to 6YR7/2. 70: 2.5Y4/2 fine loamy sand	C3			
T5.2-1-100	80-100						same				
T5-3-120	100-120						same to 110. 110: 10YR6/7 matrix fine sand with10YR4/3 organic streaks	C4			
T5.2-2-20	0-20	80	N 26° 58.542'	W 80° 10.141'	Pompano fine sand, occasionally flooded	Aquents	10YR3/2 sandy clay loam with 7.5YR4/4 mottles	A	125	red maple, water hickory	waypoint 51. unusual: no cypress
T5.2-2-40	20-40						Sandy clay	C1			
T5.2-2-60	40-60						same to 50. 50: 10YR3/1 sandy loam	C2			
T5.2-2-80	60-80						same to 70: loamy sand, same color	C3			
T5.2-2-100	80-100						same				
T5.2-2-120	100-120						10YR7/2 sand with 10YR4/2 streaking	streaking			
none	120+						same	C4^			

Table D- 6. Soil characteristics at Transect #6.

Appendix D: UF Soil Survey conducted May 2004 -Transect 6											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr.**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T6-1-20	0-20	5	N 26° 59.260'	W 80° 09.405'	Nettles sand	Pompano sand	10YR 3/1sand, many uncoated sand grains, few accretions	A horizon: 0	not found	Slash pine, live oak, saw palmetto, gallberry	Nettles sand, poorly drained, transitional between Nettles and Waveland Depressional, not a typical profile.
T6-1-40	20-40						20-30: 10YR 4/2 fine sand; 30-40:10YR 5/2 fine sand, transition to…	C1			
T6-1-60	40-60						10YR 5/2 sand	C2			
T6-1-80	60-80						10YR 6/2	C3 horizon: 60			
T6-1-100	80-100						same to 110				
T6-1-120	100-120						110: 10YR4/3 sand	C4:110, not typical horizon, not enough organic carbon to be a spodosol			
none	204						sandy to 204 cm+				
T6-2-20	0-20	26	N 26° 59.272'	W 80° 09.409'	Terra Ceia Variant muck	Terra Ceia Variant muck	5YR 2.5/1 Muck	OA-1	4	Cypress, pond apple, red maple, white/red mangrove	highly organic, higly decomposed, original plants are unrecognizable (lots of roots found)
T6-2-40	20-40						5YR 2.5/1 Muck	OA-1			
no sample	204						no sand layer found, not viewed	not viewed			
T6-3-20	0-20	115	N 26° 59.321'	W 80° 09.406'	Terra Ceia Variant	Terra Ceia	5YR 2.5/1 Muck	OA-1	33	red/white mangroves, pond	Waypoint 30&31

Appendix D: UF Soil Survey conducted May 2004 -Transect 6											
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr.**	**Layer (cm)**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T6-3-40	20-40				muck	Variant muck	5YR 2.5/1 Muck	OA-1		apples	
T6-3-60	40-60						5YR 2.5/1 Muck	OA-1			
no sample	204						Muck 204+, no sand found				
T6-4-20	0-20	130	NA	NA	Terra Ceia Variant muck	Terra Ceia Variant muck	5YR 2.5/1 Muck	OA-1	15	pond apple, red mangrove, probably white mangrove, live cypress; thick mangrove	
T6-4-40	20-40										
T6-4-60	40-60										

Table D- 7. Soil characteristics at Transect #7.

Appendix D: UF Soil Survey conducted May 2004 -Transect 7											
Sample ID	Depth (cm)	Length, transect (m)	Lat	Long	Map Unit name	On-Site soil series	Soil descr. (cm)	Layer (cm)	Water (cm)	Veg. Desc. Marion	Notes
T7-1-20	0-20	0	N 26° 59.045'	W 80° 09.510'	Terra Ceia Variant Muck	Immokalee series	fine grained sand, 10YR3/1, with many uncoated sand grains	0:A horizon	none	Live oak, saw palmetto (at high points)	Waypoint 32; Hobe: H20 at 60-80" during wet season, excessively drained; high point drops down quickly, transitional area. Section 20,Township 40S, Range 42E. Soil compact, hard to core.
T7-1-40	20-40						same but 10YR6/1, to 70 cm	E			
T7-1-60	40-60										
T7-1-80	60-80						70: 10YR4/3	70:Bh			
T7-1-100	80-100						80:loamy fine sand, 10YR2/2; 90:Bh2	90:Bh2			
T7-1-120	100-120										
none	204						sandy to 204+ cm	Cg			
T7-2-20	0-20	15	N 26° 59.043'	W 80° 09.538'	Terra Ceia Variant Muck	Terra Ceia Variant	5YR2.5/1, muck no sand	Oa	10	Young cypress, poison ivy.	mapped as Okeelanta
T7-2-40	20-40						5YR2.5/1, muck no sand	" "			
T7-3-20	0-20	165	N 26° 59.079'	W 80° 09.560'	Terra Ceia Variant Muck	Okeelanta Variant	5YR2.5/1, muck no sand	Oa	15	Pond Apples, pop ash, cypress	Waypoint 33; 4 wells at this transect.
T7-3-40	20-40										
no sample	180						180:sand layer	Cg			
T7-4-20	0-20	145	N 26° 59.101'	W 80° 09.579'	Terra Ceia Variant Muck	Okeelanta Variant Muck	5YR2.5/1 muck	Oa	27	Red mangrove, cabbage palm, swamp fern, pond apple.	Waypoint 34
T7-4-40	20-40										
T7-4-60	40-60										
no sample	130						130:sand layer	Cg			

Table D- 8. Soil characteristics at Transect #8.

Appendix D: UF Soil Survey conducted May 2004 -Transect 8										
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr.**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T8-1-20	0-20	0-10	N 26° 59.764'	W 80° 09.325'	Nettles Sand	Myakka Sand	A .. sandy to 80 inches(or 204 cm)	>120	Lygodium, cypress seedlings	Sampled on sloping terrain which is a transitional area, possible atypical soil column.
T8-1-40	20-40						E			
T8-1-60	40-60									
T8-1-80	60-80						Bh Layer 60 cm;Myakka Soil: an inclusion in the Nettles Unit			
T8-1-100	80-100						Cg			
T8-1-120	100-120									
T8-2-20	0-20	35	N 26° 59.769'	W 80° 09.347'	Bessie Muck	Okeelanta Variant Muck	Oa	0	This area has cypress canopy, with wax myrtle, pop ash, buttonbush, pond apples.	
T8-2-40	20-40									
T8-2-60	40-60									
T8-2-80	60-80									
T8-2-100	80-100									
T8-2-120	100-120						Cg			
no sample	122						Mineral/sand at 122 cm			
T8-3-20	0-20	65-75	N 26° 59.767'	W 80° 09.367'	Okeelanta, an inclusion in the Bessie Muck	Okeelanta, an inclusion in the Bessie Muck	Oa	15		
T8-3-40	20-40									
T8-3-60	40-60									
T8-3-80	60-80									
T8-3-100	80-100									
T8-3-120	100-120						Cg			
no sample	196						Mineral/sand layer at 196 cm			

Appendix D: UF Soil Survey conducted May 2004 -Transect 8										
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Soil descr.**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T8-4-20	0-20	115	N 26° 59.762'	W 80° 09.391'	Bessie Muck	Okeelanta Variant Muck	Oa	17		Location very close to river. Could not collect sample above mineral layer, too wet. Make way points 12 and 13 here, and 14-20 en route back to start point.
T8-4-40	20-40									
T8-4-60	40-60						Cg			
No sample	140						Mineral layer at 140 cm			

Table D- 9. Soil characteristics at Transect #9.

Appendix D: UF Soil Survey conducted May 2004 -Transect 9										
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**soil description**	**Water (cm)**	**Veg. description Marion**	**Notes**
T9-1-20	0-20	0-10	N 26° 59.373'	W 80° 08.646'	Pomello Sand, 0 to 5% slopes	Pomello Series		>140	Cabbage palms died only in this transect	
T9-1-40	20-40						A			
T9-1-60	40-60									
T9-1-80	60-80						E			
T9-1-100	80-100									
T9-1-120	100-120						Bh			
T9-1-140	120-140						Spodic Horizon at 125 cm			
T9-2-20	0-20	25-35	NA	NA	Okeelanta Variant Muck	Okeelanta Variant Muck	Oa	46	A very salty area.	
T9-2-40	20-40									
T9-2-60	40-60									
T9-2-80	60-80						Cg			
no sample	155						Mineral layer at 155 cm			
T9-3-20	0-20	55-65	N 26° 59.341'	W 80° 08.641'	Okeelanta Variant Muck	Gator Muck, flooded	Oa	40		
T9-3-40	20-40									
T9-3-60	40-60									
T9-3-80	60-80						Cg			
T9-3-100	80-100						Mineral layer at 90 cm			
T9-4-20	0-20	175-185	N 26° 59.281'	W 80° 08.634'	Okeelanta Variant Muck	Okeelanta Variant Muck	Oa	25	Can't sample due to effects of w. table.	
T9-4-40	20-40						Cg			
no sample	168						Mineral layer at 168 cm			

Table D- 10. Soil characteristics at Transect #10.

Appendix D: UF Soil Survey conducted May 2004 -Transect 10									
Sample ID	**Depth (cm)**	**Length, transect (m)**	**Lat**	**Long**	**Map Unit name**	**On-Site soil series**	**Water (cm)**	**Veg. Desc. Marion**	**Notes**
T10-1-20	0-20	0-10	N 27° 00.058'	W 80° 07.036'	Waveland Sand, Depressional	Waveland depressional, sandy all the way down	25	old freshwater marsh?	
T10-1-40	20-40					Waveland depressional			
T10-1-60	40-60					Waveland depressional			
T10-1-80	60-80					Waveland depressional			
T10-1-100	80-100					Waveland depressional, Bh begins at 80 cm			
T10-2-20	0-20	25-35 (30)	N 27° 00.054'	W 80° 07.022'	Salerno Sand	Okeelanta Muck Variant	32	Take waypoint 26, mapped as Waveland in Soil Survey	
T10-2-40	20-40					Okeelanta Muck Variant			
T10-2-60	40-60					Okeelanta Muck Variant			
no sample	96					Mineral/sand layer at 96 cm (96-150+)			
T10-3-20	0-20	55-65	N 27° 00.057'	W 80° 07.004'	Salerno Sand	Sanibel Muck	40		Take waypoint 27
T10-3-40	20-40					Sand at 30 cm			
T10-3-60	40-60					Sandy to 60+			
T10-4-20	0-20		N 27° 00.062'	W 80° 06.997'	Satellite Variant Sand	Aquents	50	Take waypoint 28,water is low	
T10-4-40	20-40					Loamy Mineral layer at 50 cm, sandy to 80+ cm			
T10-4-60	40-60								
T10-4-80	60-80								

Appendix E

Canopy, Shrub and Groundcover Vegetation Data and Summary Tables from the 2003 Study of the Loxahatchee River

APPENDIX E

Canopy, Shrub and Groundcover Vegetation Data from the 2003 Study of the Loxahatchee River

Table E- 1. Summary of Plots

Plot#	Elevation	Rivermile	Forest Type	Soil Type
T111	12.56	14.5	MH	Riviera Fine Sand
T112	11.91	14.5	MH	Riviera Fine Sand
T113	13.54	14.5	HH/U	Riviera Fine Sand
T114	12.89	14.5	HH	Riviera Fine Sand
T115	10.67	14.5	Rsw1	Aquents
T116	10.05	14.5	Rsw1	Aquents
T117	10.05	14.5	Rsw1	Aquents
T118	9.99	14.5	Rsw1	Aquents
T119	10.48	14.5	Rsw1	Aquents
T1210	10.19	14.5	Rblh1	Aquents
T1211	10.55	14.5	Rsw1	Aquents
T1212	9.62	14.5	Rsw1	Aquents
T1213	9.97	14.5	Rsw1	Aquents
T1214	9.27	14.5	Rsw1	Aquents
T1215	10.4	14.5	HH	Pineda Fine Sand
T2116	7.85	13.57	Rblh1	Wabasso Fine Sand
T2117	7.65	13.57	Rsw1	Chobee/Sapric Muck
T2118	7.4	13.57	HH/Rsw1	Chobee/Sapric Muck
T2119	8.27	13.57	Rsw1	Chobee/Sapric Muck
T2120	7.53	13.57	HH/Rsw1	Chobee/Sapric Muck
T2121	7.92	13.57	HH	Chobee/Sapric Muck
T2122	9.95	13.57	HH	Chobee/Sapric Muck
T2223	11.41	13.43	MH	Pineda Fine Sand
T2224	11.36	13.43	MH	Pineda Fine Sand
T2225	10.17	13.43	MH	Pineda Fine Sand
T2226	7.05	13.43	HH/Rsw1	Gator/Sapric Muck
T2227	6.63	13.43	Rsw1	Sapric Muck
T2228	6.37	13.43	Rsw1	Sapric Muck
T3129	5.4	12.07	Rblh2	Nettles Sand
T3130	4.75	12.07	Rblh3	Nettles Sand
T3131	4.09	12.07	Rsw2	Aquents
T3132	3.65	12.07	Rsw2	Aquents
T3133	4.1	12.07	Rsw1	Aquents
T3134	4.15	12.07	Rsw2	Aquents
T3135	3.98	12.07	Rsw2	Aquents
T3136	3.24	12.07	Rsw1	Aquents
T3137	3.65	12.07	Rsw2	Aquents
T3138	4.04	12.07	Rsw2	Aquents
T3139	3.9	12.07	Rsw2	Aquents
T3240	5.35	12.07	U/HH	Nettles Sand
T3241	4.53	12.07	Rblh2	Nettles Sand
T4142	4.2	11.18	MH	Smyrna Fine Sand
T4143	2.22	11.18	Rsw1	Histic Haplaquoll
T4144	2.62	11.18	Rsw1	Histic Haplaquoll
T4145	2.22	11.18	Rblh2	Histic Haplaquoll

Plot#	Elevation	Rivermile	Forest Type	Soil Type
T4146	2.22	11.18	Rsw1	Histic Haplaquoll
T4147	2.02	11.18	Rsw1	Histic Haplaquoll
T4148	1.92	11.18	Rsw1	Histic Haplaquoll
T4149	2.12	11.18	Rblh2	Histic Haplaquoll
T4150	2.62	11.18	Rblh3	Histic Haplaquoll
T4151	2.18	11.18	Rsw2	Aquents
T4152	2.66	11.18	Rsw1	Aquents
T4153	2.045	11.18	Rblh2	Aquents
T5154	6.43	10.33	MH	Pompano Fine Sand
T5155	4.34	10.33	HH/Rblh3	Pompano Fine Sand
T5156	3.04	10.33	Rblh3	Pompano Fine Sand
T5157	3.02	10.33	Rsw1	Aquents
T5158	3.4	10.33	Rsw1/Rblh2	Aquents
T5259	3.55	10.33	Rblh1	Aquents
T5260	3.05	10.33	Rsw1	Aquents
T5261	3.03	10.33	Rsw1	Aquents
T5262	3.4	10.33	Rsw1	Aquents
T5263	3.37	10.33	Rblh2	Aquents
T5264	3.18	10.33	Rblh2	Aquents
T5265	2.9	10.33	Rblh2	Aquents
T5266	2.44	10.33	Rblh2	Aquents
T5267	3.81	10.33	Rblh2	Aquents
T6168	4.09	8.43	U	Pompano Sand
T6169	1.85	8.43	U	Pompano Sand
T6170	1.87	8.43	Rsw1	Terra Ceia Variant Muck
T6171	1.77	8.43	UTsw3	Terra Ceia Variant Muck
T6172	1.82	8.43	UTsw3	Terra Ceia Variant Muck
T6173	1.72	8.43	UTsw3	Terra Ceia Variant Muck
T6174	1.72	8.43	UTsw3	Terra Ceia Variant Muck
T6175	1.72	8.43	UTsw3	Terra Ceia Variant Muck
T6176	1.62	8.43	UTmix	Terra Ceia Variant Muck
T6177	1.67	8.43	UTsw1	Terra Ceia Variant Muck
T6178	1.55	8.43	UTsw1	Terra Ceia Variant Muck
T6179	1.55	8.43	UTsw1	Terra Ceia Variant Muck
T6180	1.55	8.43	UTsw1	Terra Ceia Variant Muck
T6281	1.64	8.43	UTsw3	Terra Ceia Variant Muck
T6282	1.61	8.43	UTsw1	Terra Ceia Variant Muck
T6283	1.22	8.43	UTsw1	Terra Ceia Variant Muck
T7184	5.12	9.1	MH/Rsw1	Immokalee Fine Sand
T7185	1.54	9.1	Rsw1	Terra Ceia Variant Inclusion
T7186	1.74	9.1	Rsw1	Terra Ceia Variant Inclusion
T7187	1.64	9.1	Rmix	Terra Ceia Variant Inclusion
T7188	1.64	9.1	Rmix	Terra Ceia Variant Inclusion
T7189	1.64	9.1	Rmix	Terra Ceia Variant Inclusion
T7190	1.59	9.1	Rmix	Terra Ceia Variant Inclusion
T7191	1.39	9.1	Rmix	Terra Ceia Variant Inclusion
T7192	1.5	9.1	UTsw1	Okeelanta Variant Muck

Plot#	Elevation	Rivermile	Forest Type	Soil Type
T7193	1.5	9.1	UTsw1	Okeelanta Variant Muck
T7194	1.36	9.1	UTsw1	Okeelanta Variant Muck
T7195	1.5	9.1	UTsw1	Okeelanta Variant Muck
T7196	1.4	9.1	UTsw2	Okeelanta Variant Muck
T7197	1.45	9.1	UTsw2	Okeelanta Variant Muck
T7198	0.56	9.1	UTsw2	Okeelanta Variant Muck
T8199	2.06	8.13	Rmix	Nettles w/Myakka Sand
T81100	1.82	8.13	HH	Nettles w/Myakka Sand
T81101	1.67	8.13	Rmix	Okeelanta Variant Muck
T81102	1.67	8.13	UTmix	Okeelanta Inclusion in Bessie muck
T81103	1.67	8.13	UTmix	Okeelanta Inclusion in Bessie muck
T81104	1.57	8.13	UTsw1	Okeelanta Inclusion in Bessie muck
T81105	1.46	8.13	UTmix	Okeelanta Inclusion in Bessie muck
T81106	1.54	8.13	UTsw1	Okeelanta Inclusion in Bessie muck
T81107	1.19	8.13	UTmix	Okeelanta Inclusion in Bessie muck
T81108	0.77	8.13	UTsw1	Okeelanta Variant Muck
T81109	1.34	8.13	UTsw1	Okeelanta Variant Muck
T81110	1.34	8.13	UTsw1	Okeelanta Variant Muck
T91111	9.58	6.46	U	Pomello Sand
T91112	1.88	6.46	HH	Pomello Sand
T91113	1.55	6.46	LTsw2	Okeelanta Variant Muck
T91114	1.55	6.46	LTsw2	Okeelanta Variant Muck
T91115	1.55	6.46	LTsw2	Okeelanta Variant Muck
T91116	1.75	6.46	LTmix	Gator Muck
T91117	1.91	6.46	HH/LTsw2	Gator Muck
T91118	1.65	6.46	LTsw2	Okeelanta Variant Muck
T91119	1.55	6.46	LTsw2	Okeelanta Variant Muck
T91120	1.55	6.46	LTsw2	Okeelanta Variant Muck
T91121	1.55	6.46	LTsw2	Okeelanta Variant Muck
T91122	1.51	6.46	LTsw2	Okeelanta Variant Muck
T91123	1.56	6.46	LTsw2	Okeelanta Variant Muck
T91124	1.51	6.46	LTsw2	Okeelanta Variant Muck
T91125	1.61	6.46	LTsw2	Okeelanta Variant Muck
T91126	1.51	6.46	LTsw2	Okeelanta Variant Muck
T91127	1.51	6.46	LTsw1	Okeelanta Variant Muck
T91128	1.87	6.46	LTsw1	Okeelanta Variant Muck
T91129	1.46	6.46	LTsw1	Okeelanta Variant Muck
T91130	1.31	6.46	LTsw1	Okeelanta Variant Muck
T10131	7.06	1.8	HH/Marsh	Waveland Sand Depressional
T10132	7.03	1.8	Marsh	Waveland Sand Depressional
T10133	7.83	1.8	UTsw2	Okeelanta Variant Muck
T10134	7.23	1.8	UTmix	Okeelanta Variant Muck
T10135	7.18	1.8	HH	Sanibel Muck
T10136	7.03	1.8	UTMix	Sanibel Muck
T10137	7.28	1.8	UTMix	Aquents
T10138	6.77	1.8	UTMix	Aquents

Table E- 2. 2003 Canopy Data

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
1-1	1	5	SP	33.6	886.7	MH
1-1	1	5	SP	26.9	568.3	
1-1	1	5	SP	27.	572.6	
1-1	1	5	PE	37.8	1122.2	
1-1	1	5	QV	21.7	369.8	MH
1-1	2	15	SP	31.3	769.4	
1-1	2	15	SP	28.9	656.0	
1-1	2	15	SP	25.5	510.7	
1-1	2	15	SP	27.1	576.8	
1-1	2	15	QV	35.3	978.7	
1-1	2	15	QV	48.7	1862.7	
1-1	2	15	SP	21.0	346.4	
1-1	2	15	SP	31.6	784.3	
1-1	2	15	QL	29.2	669.7	
1-1	3	25	SP	33	855.3	HH/U
1-1	3	25	SP	32	804.2	
1-1	3	25	SP	22.3	390.6	
1-1	3	25	SP	28.1	620.2	
1-1	3	25	PE	40.1	1262.9	
1-1	3	25	QL	35.8	1006.6	
1-1	4	35	SP	31.8	794.2	HH
1-1	4	35	SP	24.1	456.2	
1-1	4	35	PE	68.9	3728.5	
1-1	5	45	TD	38.3	1152.1	Rsw1
1-1	5	45	TD	73.8	4277.6	
1-1	5	45	TD	79.3	4939.0	
1-1	6	55	TD	44.2	1534.4	Rsw1
1-1	6	55	TD	57.5	2596.7	
1-1	6	55	TD	67.9	3621.0	
1-1	6	55	SP	41.2	1333.2	
1-1	7	65	TD	47.8	1794.5	Rsw1
1-1	7	65	TD	74.3	4335.8	
1-1	7	65	SP	30.1	711.6	
1-1	7	65	AR	8.9	62.2	
1-1	8	75	TD	71.3	3992.7	Rsw1
1-1	8	75	TD	44.2	1534.4	
1-1	8	75	TD	80.4	5076.9	
1-1	8	75	SP	27.1	576.8	
1-1	9	85	TD	84.2	5568.2	Rsw1
1-1	9	85	TD	43.2	1465.7	
1-1	9	85	TD	37.1	1081.0	
1-1	9	85	TD	48.6	1855.1	
1-1	9	85	SP	30.5	730.6	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
1-1	10	5	AR	62.7	3087.6	Rblh1
1-2	10	5	SP	29.8	697.5	
1-2	10	5	AG	5.3	22.1	
1-2	11	15	CS	6.9	37.4	Rsw1
1-2	11	15	TD	45.5	1626.0	
1-2	11	15	TD	20.6	333.3	
1-2	12	25	SP	31.7	789.2	Rsw1
1-2	12	25	TD	33.8	897.3	
1-2	12	25	TD	63.7	3186.9	
1-2	12	25	TD	58.	2642.1	
1-2	12	25	TD	49.3	1908.9	
1-2	12	25	TD	73.9	4289.2	
1-2	13	35	TD	50.2	1979.2	Rsw1
1-2	13	35	TD	56.2	2480.6	
1-2	13	35	TD	45.5	1626.0	
1-2	13	35	TD	54.9	2367.2	
1-2	13	35	TD	19.3	292.6	
1-2	13	35	TD	48.2	1824.7	
1-2	13	35	TD	35.7	1001.0	
1-2	14	45	DEAD AR	35.7	1001.0	Rsw1
1-2	14	45	TD	25.	490.9	
1-2	14	45	TD	9.9	77.0	
1-2	14	45	TD	50.3	1987.1	
1-2	14	45	TD	28.6	642.4	
1-2	15	55	TD	25.3	502.7	HH
1-2	15	55	TD	22.1	383.6	
1-2	15	55	SP	39.3	1213.0	
1-2	15	55	SP	28.9	656.0	
1-2	15	55	SP	34.2	918.6	
1-2	15	55	SP	25.4	506.7	
1-2	15	55	SP	29.4	678.9	
1-2	15	55	SP	33.2	865.7	
1-2	15	55	SP	35.2	973.1	
1-2	15	55	SP	33.4	876.2	
1-2	15	55	CS	16.3	208.7	
1-2	15	55	CS	13.3	138.9	
1-2	15	55	CS	10.2	81.7	
2-1	16	5	SP	29.7	692.8	Rblh1
2-1	16	5	AR	20.4	326.9	
2-1	16	5	AR	11.2	98.5	
2-1	16	5	AR	21.6	366.4	
2-1	16	5	AR	34.8	951.1	
2-1	16	5	TD	51.	2042.8	
2-1	16	5	TD	71.4	4003.9	
2-1	16	5	TD	31.3	769.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
2-1	16	5	CA	9.7	73.9	
2-1	17	15	SP	32.6	834.7	Rsw1
2-1	17	15	AR	35.3	978.7	
2-1	17	15	TD	81.5	5216.8	
2-1	17	15	TD	75.1	4429.7	
2-1	17	15	TD	79.1	4914.1	
2-1	18	25	SP	26.1	535.0	HH/Rsw1
2-1	18	25	SP	35.	962.1	
2-1	18	25	SP	33.7	892.0	
2-1	18	25	SP	30.6	735.4	
2-1	18	25	TD	104.6	8593.2	
2-1	19	35	TD	37.3	1092.7	Rsw1
2-1	19	35	TD	86.6	5890.1	
2-1	20	45	SP	28.8	651.4	HH/Rsw1
2-1	20	45	SP	37.8	1122.2	
2-1	20	45	SP	29.8	697.5	
2-1	20	45	FC	10.7	89.9	
2-1	20	45	FC	9.4	69.4	
2-1	20	45	FC	7.	38.5	
2-1	20	45	FC	10.4	84.9	
2-1	21	55	SP	26.4	547.4	HH
2-1	21	55	SP	26.9	568.3	
2-1	21	55	SP	32.2	814.3	
2-1	21	55	SP	32.0	804.2	
2-1	21	55	SP	32.5	829.6	
2-1	22	65	SP	29.6	688.1	HH
2-1	22	65	SP	29.	660.5	
2-1	22	65	SP	32.1	809.3	
2-1	22	65	SP	34.2	918.6	
2-1	22	65	SP	53.	2206.2	
2-1	22	65	SP	27.4	589.6	
2-1	22	65	QL	33.6	886.7	
2-1	22	65	SP	28.1	620.2	
2-1	22	65	SP	27.6	598.3	
2-1	22	65	SP	31.8	794.2	
2-1	22	65	FC	13.9	151.7	
2-2	23	5	SP	29.9	702.2	MH
2-2	23	5	SP	37.	1075.2	
2-2	23	5	SP	30.8	745.1	
2-2	23	5	QL	50.	1963.5	
2-2	23	5	QL	24.4	467.6	
2-2	23	5	SP	35.1	967.6	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
2-2	23	5	SP	31.5	779.3	
2-2	23	5	PE	58.2	2660.3	
2-2	24	15	SP	23.6	437.4	MH
2-2	24	15	SP	30.6	735.4	
2-2	24	15	SP	32.5	829.6	
2-2	24	15	SP	26.3	543.3	
2-2	24	15	SP	28.9	656.0	
2-2	24	15	SP	26.5	551.5	
2-2	24	15	SP	36.1	1023.5	
2-2	25	25	SP	37.6	1110.4	MH
2-2	25	25	SP	29.2	669.7	
2-2	25	25	SP	26.8	564.1	
2-2	25	25	SP	24.8	483.1	
2-2	25	25	SP	37.5	1104.5	
2-2	25	25	SP	25.5	510.7	
2-2	25	25	SP	26.1	535.0	
2-2	25	25	SP	25.6	514.7	
2-2	25	25	SP	30.1	711.6	
2-2	25	25	SP	25.2	498.8	
2-2	25	25	SP	25.4	506.7	
2-2	25	25	SP	29.2	669.7	
2-2	26	35	SP	26.1	535.0	HH/Rsw1
2-2	26	35	SP	30.	706.9	
2-2	26	35	TD / FA	85	5674.5	
2-2	27	45	TD	74	4300.8	Rsw1
2-2	27	45	TD	104.5	8576.7	
2-2	28	55	TD	114.	10207.0	Rsw1
2-2	28	55	AR	59.6	2789.9	
2-2	28	55	FC	13.8	149.6	
2-2	28	55	FC	15.7	193.6	
2-2	28	55	FC	11.2	98.5	
2-2	28	55	FC	29.	660.5	
2-2	28	55	SP	49.2	1901.2	
3-1	29	5	AR	7.7	46.6	Rblh2
3-1	29	5	AR	5.	19.6	
3-1	29	5	AR	14.1	156.1	
3-1	29	5	AR	6.5	33.2	
3-1	29	5	QL	5.8	26.4	
3-1	30	15	AR	7.2	40.7	Rblh3
3-1	30	15	QL	59.8	2808.6	
3-1	30	15	QL	70.2	3870.5	
3-1	30	15	SP	23.3	426.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
3-1	30	15	SP	24.9	487.0	
3-1	30	15	SP	23.2	422.7	
3-1	31	25	SP	31.	754.8	Rsw2
3-1	31	25	FC	15.8	196.1	
3-1	31	25	FC	9.4	69.4	
3-1	31	25	FC	18.6	271.7	
3-1	31	25	FC	11.7	107.5	
3-1	31	25	FC	11.7	107.5	
3-1	31	25	FC	11.9	111.2	
3-1	31	25	FC	14.6	167.4	
3-1	31	25	FC	18	254.5	
3-1	31	25	FC	18.9	280.6	
3-1	31	25	FC	18.6	271.7	
3-1	31	25	FC	24.5	471.4	
3-1	31	25	FC	11.4	102.1	
3-1	31	25	FC	11.4	102.1	
3-1	31	25	FC	16.3	208.7	
3-1	32	35	FC	18.6	271.7	Rsw2
3-1	32	35	FC	24.3	463.8	
3-1	32	35	FC	20.1	317.3	
3-1	32	35	FC	16.9	224.3	
3-1	32	35	FC	24.6	475.3	
3-1	32	35	FC	10.9	93.3	
3-1	32	35	FC	17.1	229.7	
3-1	32	35	FC	16.8	221.7	
3-1	32	35	FC	17.9	251.6	
3-1	32	35	AG	5.2	21.2	
3-1	33	45	TD	81.6	5229.6	Rsw1
3-1	33	45	FC	15.7	193.6	
3-1	33	45	FC	17.8	248.8	
3-1	33	45	FC	13.6	145.3	
3-1	33	45	FC	9.3	67.9	
3-1	33	45	(DEAD)FC	28.5	637.9	
3-1	34	55	FC	5.0	19.6	Rsw2
3-1	34	55	FC	18.1	257.3	
3-1	34	55	FC	9.1	65.0	
3-1	34	55	FC	14.9	174.4	
3-1	34	55	FC	27.5	594.0	
3-1	34	55	FC	23.1	419.1	
3-1	34	55	AG	8.3	54.1	
3-1	34	55	AG	6.6	34.2	
3-1	34	55	AG	6.9	37.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
3-1	35	65	TD	83.1	5423.7	Rsw2
3-1	35	65	FC	28.3	629.0	
3-1	35	65	FC	8.4	55.4	
3-1	35	65	FC	22.2	387.1	
3-1	35	65	FC	6.1	29.2	
3-1	35	65	AG	6.5	33.2	
3-1	35	65	AG	9.1	65.0	
3-1	35	65	AG	6.9	37.4	
3-1	35	65	FA	8.3	54.1	
3-1	36	75	TD	50.2	1979.2	Rsw1
3-1	36	75	TD	151.1	17931.6	
3-1	36	75	FC	15.1	179.1	
3-1	36	75	FC	13.1	134.8	
3-1	36	75	AG	7.3	41.9	
3-1	36	75	FA	20.3	323.7	
3-1	36	75	ST	6.8	36.3	
3-1	36	75	ST	16.1	203.6	
3-1	36	75	ST	6.1	29.2	
3-1	37	85	FC	15	176.7	Rsw2
3-1	37	85	FC	15.1	179.1	
3-1	37	85	FC	16.9	224.3	
3-1	37	85	FC	28.6	642.4	
3-1	37	85	FC	16.6	216.4	
3-1	37	85	FC	17.	227.0	
3-1	37	85	FC	7.8	47.8	
3-1	37	85	FC	20.6	333.3	
3-1	37	85	FC	22.5	397.6	
3-1	38	95	FC	12.5	122.7	Rsw2
3-1	38	95	FC	18.4	265.9	
3-1	38	95	FC	18.6	271.7	
3-1	38	95	FC	20.4	326.9	
3-1	38	95	FC	14.4	162.9	
3-1	38	95	FC	19.8	307.9	
3-1	38	95	SP	33.5	881.4	
3-1	39	105	FC	14.	153.9	Rsw2
3-1	39	105	FC	41.5	1352.7	
3-1	39	105	FC	29.1	665.1	
3-1	39	105	FC	18.3	263.0	
3-1	39	105	FC	13.9	151.7	
3-1	39	105	FC	18.6	271.7	
3-1	39	105	TD	38.2	1146.1	
3-2	40	5	PE	42.2	1398.7	U/HH

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
3-2	40	5	SP	20.4	326.9	
3-2	40	5	SP	30.5	730.6	
3-2	41	15	SP	29.7	692.8	Rblh2
3-2	41	15	SP	22.5	397.6	
3-2	41	15	SP	28.3	629.0	
3-2	41	15	SP	26.9	568.3	
3-2	41	15	SP	29.	660.5	
3-2	41	15	SP	19.7	304.8	
3-2	41	15	AR	12.6	124.7	
3-2	41	15	AR	36.	1017.9	
3-2	41	15	AR	33.1	860.5	
3-2	41	15	AR	15.9	198.6	
3-2	41	15	AR	5.7	25.5	
3-2	41	15	IC	5.9	27.3	
4-1	42	5	QV	11.	95.0	MH
4-1	42	5	QV	22.5	397.6	
4-1	42	5	QV	13.5	143.1	
4-1	42	5	QV	25.5	510.7	
4-1	42	5	QV	15.4	186.3	
4-1	42	5	QV	21.4	359.7	
4-1	42	5	QM	7.1	39.6	
4-1	43	15	TD	17.1	229.7	Rsw1
4-1	43	15	TD	37.4	1098.6	
4-1	43	15	TD	34.2	918.6	
4-1	43	15	CA	13.7	147.4	
4-1	43	15	CA	7.1	39.6	
4-1	44	25	TD	43.4	1479.3	Rsw1
4-1	44	25	TD	64.5	3267.5	
4-1	44	25	CA	25.3	502.7	
4-1	44	25	CA	8.9	62.2	
4-1	44	25	AR	17.3	235.1	
4-1	44	25	AR	5.3	22.1	
4-1	44	25	DEAD TD	56.3	2489.5	
4-1	44	25	MC	6.1	29.2	
4-1	44	25	AR	6.1	29.2	
4-1	44	25	AR	20.7	336.5	
4-1	45	35	CA	40.5	1288.2	Rblh2
4-1	45	35	CA	23.8	444.9	
4-1	45	35	CA	21.7	369.8	
4-1	45	35	AR	7.3	41.9	
4-1	45	35	AR	9.1	65.0	
4-1	45	35	AR	9.2	66.5	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
4-1	45	35	AR	19.	283.5	
4-1	45	35	AR	5.7	25.5	
4-1	46	45	FC	7.2	40.7	Rsw1
4-1	46	45	FC	13.9	151.7	
4-1	46	45	FC	8.4	55.4	
4-1	46	45	FC	25.3	502.7	
4-1	46	45	FC	9.8	75.4	
4-1	46	45	FC	12.1	115.0	
4-1	46	45	FC	18.1	257.3	
4-1	46	45	DEAD FC	10.3	83.3	
4-1	46	45	TD	40.4	1281.9	
4-1	47	55	FC	13.7	147.4	Rsw1
4-1	47	55	FC	18.1	257.3	
4-1	47	55	FC	13.	132.7	
4-1	47	55	FC	13.2	136.8	
4-1	47	55	FC	10.2	81.7	
4-1	47	55	FC	14.5	165.1	
4-1	47	55	TD	56.4	2498.3	
4-1	47	55	CA	42.3	1405.3	
4-1	48	65	FC	6.3	31.2	Rsw1
4-1	48	65	FC	7.1	39.6	
4-1	48	65	FC	14.4	162.9	
4-1	48	65	FC	13.4	141.0	
4-1	48	65	FC	8.3	54.1	
4-1	48	65	FC	9.6	72.4	
4-1	48	65	FC	8.	50.3	
4-1	48	65	TD	16.4	211.2	
4-1	48	65	TD	23.	415.5	
4-1	48	65	TD	12.	113.1	
4-1	48	65	CA	13.9	151.7	
4-1	48	65	AR	5.9	27.3	
4-1	48	65	TD	11.9	111.2	
4-1	48	65	TD	16.1	203.6	
4-1	49	75	FC	7.8	47.8	Rblh2
4-1	49	75	TD	9.3	67.9	
4-1	49	75	TD	15.4	186.3	
4-1	49	75	TD	11.1	96.8	
4-1	49	75	TD	15.7	193.6	
4-1	49	75	CA	39.8	1244.1	
4-1	49	75	CA	30.9	749.9	
4-1	49	75	AR	5.4	22.9	
4-1	49	75	AR	9.6	72.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
4-1	49	75	AR	9.5	70.9	
4-1	49	75	AR	6.6	34.2	
4-1	49	75	TD	5.7	25.5	
4-1	49	75	AR	5.	19.6	
4-1	50	85	CA	48.1	1817.1	Rblh3
4-1	50	85	CA	87.8	6054.5	
4-1	50	85	SP	58.	2642.1	
4-1	51	95	SP	32.4	824.5	Rsw2
4-1	51	95	FC	14.9	174.4	
4-1	51	95	FC	26.2	539.1	
4-1	51	95	FC	12.4	120.8	
4-1	51	95	FC	13.6	145.3	
4-1	52	105	FC	7.2	40.7	Rsw1
4-1	52	105	AR	10.9	93.3	
4-1	52	105	TD	70.4	3892.6	
4-1	52	105	DEAD TD	40.7	1301.0	
4-1	52	105	QL	23.6	437.4	
4-1	53	115	CA	88.6	6165.3	Rblh2
4-1	53	115	CA	16.8	221.7	
4-1	53	115	DEAD FC	7.4	43.0	
4-1	53	115	FC	7.8	47.8	
4-1	53	115	FC	8.	50.3	
4-1	53	115	FC	8.6	58.1	
4-1	53	115	AR	33.3	870.9	
4-1	53	115	TD	36.2	1029.2	
4-1	53	115	TD	83.6	5489.1	
4-1	53	115	QL	15.1	179.1	
4-1	53	115	FA	5.	19.6	
4-1	53	115	CA	45.7	1640.3	
5-1	54	5	QV	11.8	109.4	MH
5-1	54	5	QV	18.7	274.6	
5-1	55	15	QV	8.5	56.7	HH/Rblh3
5-1	55	15	QL	14	153.9	
5-1	55	15	QL	22.4	394.1	
5-1	55	15	QL	49.2	1901.2	
5-1	55	15	QL	49.5	1924.4	
5-1	55	15	CA	48.9	1878.1	
5-1	56	25	CA	40.5	1288.2	Rblh3
5-1	56	25	CA	5.5	23.8	
5-1	56	25	AR	14.7	169.7	
5-1	56	25	AR	17.5	240.5	
5-1	56	25	AR	13.6	145.3	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
5-1	56	25	TD	35.8	1006.6	
5-1	56	25	DEAD TREE	5.7	25.5	
5-1	57	35	CA	16.8	221.7	Rsw1
5-1	57	35	TD	61.7	2989.9	
5-1	57	35	TD	71.3	3992.7	
5-1	57	35	SP	23.8	444.9	
5-1	58	45	TD	27.9	611.4	Rsw1 / Rblh2
5-1	58	45	CA	64.1	3227.1	
5-1	58	45	CA	61.2	2941.7	
5-1	58	45	AR	32.1	809.3	
5-1	58	45	QL	8.9	62.2	
5-2	59	5	AR	39.4	1219.2	Rblh1
5-2	59	5	QL	17.2	232.4	
5-2	59	5	FC	9.9	77.0	
5-2	59	5	TD	22.7	404.7	
5-2	60	15	AR	52.3	2148.3	Rsw1
5-2	60	15	AR	47.4	1764.6	
5-2	60	15	AR	37.2	1086.9	
5-2	60	15	SP	31.8	794.2	
5-2	60	15	TD	30.8	745.1	
5-2	60	15	TD	16.9	224.3	
5-2	60	15	TD	17.	227.0	
5-2	60	15	TD	30.5	730.6	
5-2	60	15	TD	43.9	1513.6	
5-2	60	15	TD	43.	1452.2	
5-2	60	15	TD	20.3	323.7	
5-2	60	15	TD	68.2	3653.1	
5-2	61	25	AR	47.6	1779.5	Rsw1
5-2	61	25	TD	58.4	2678.6	
5-2	61	25	TD	37.	1075.2	
5-2	61	25	TD	33.2	865.7	
5-2	61	25	IC	13.3	138.9	
5-2	62	35	TD	31.8	794.2	Rsw1
5-2	62	35	TD	38.5	1164.2	
5-2	62	35	TD	57.	2551.8	
5-2	62	35	CA	9.6	72.4	
5-2	63	45	CA	5.7	25.5	Rblh2
5-2	63	45	CA	67.7	3599.7	
5-2	64	55	TD	6.6	34.2	Rblh2
5-2	64	55	SP	27.	572.6	
5-2	64	55	SP	33.	855.3	
5-2	64	55	QL	33.6	886.7	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
5-2	64	55	DEAD SP	30.7	740.2	
5-2	64	55	RR	9.9	77.0	
5-2	65	65	CA	49.8	1947.8	Rblh2
5-2	65	65	CA	15.9	198.6	
5-2	65	65	CA	45.7	1640.3	
5-2	65	65	SP	21.4	359.7	
5-2	65	65	AR	15.9	198.6	
5-2	66	75	CA	29.6	688.1	Rblh2
5-2	66	75	CA	59.2	2752.5	
5-2	66	75	CA	53.5	2248.0	
5-2	66	75	SP	24.4	467.6	
5-2	66	75	CA	9.2	66.5	
5-2	67	85	CA	94.6	7028.7	Rblh2
5-2	67	85	CA	20.7	336.5	
5-2	67	85	CA	23.8	444.9	
5-2	67	85	SP	42.9	1445.5	
5-2	67	85	PB	5.5	23.8	
5-2	67	85	PB	15.5	188.7	
5-2	67	85	GRAPE VINE	10.2	81.7	
6-1	68	5	PE	40.3	1275.6	U
6-1	68	5	PE	31.2	764.5	
6-1	68	5	QV	12.9	130.7	
6-1	69	15	SP	20.	314.2	U
6-1	69	15	SP	17.4	237.8	
6-1	69	15	SP	22.9	411.9	
6-1	69	15	IC	6.4	32.2	
6-1	69	15	PP	13.2	136.8	
6-1	70	25	TD	31.1	759.6	Rsw1
6-1	70	25	TD	18	254.5	
6-1	70	25	TD	72.7	4151.1	
6-1	70	25	MC	6.5	33.2	
6-1	70	25	TD	14.2	158.4	
6-1	70	25	CO	5.8	26.4	
6-1	70	25	AR	17.5	240.5	
6-1	71	35	TD	17.3	235.1	UTsw3
6-1	71	35	MC	5.2	21.2	
6-1	71	35	MC	5.1	20.4	
6-1	71	35	RM	5.6	24.6	
6-1	71	35	RM	5.1	20.4	
6-1	71	35	RM	6.5	33.2	
6-1	71	35	RM	8.2	52.8	
6-1	71	35	RM	5.8	26.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	71	35	RM	5.3	22.1	
6-1	71	35	AG	10.9	93.3	
6-1	71	35	AG	23.1	419.1	
6-1	71	35	LR	16.2	206.1	
6-1	71	35	LR	15.	176.7	
6-1	71	35	LR	12.	113.1	
6-1	71	35	LR	11.3	100.3	
6-1	71	35	LR	11.7	107.5	
6-1	71	35	LR	13.4	141.0	
6-1	71	35	LR	11.8	109.4	
6-1	71	35	LR	6	28.3	
6-1	71	35	LR	17.2	232.4	
6-1	71	35	LR	12.8	128.7	
6-1	71	35	LR	9.6	72.4	
6-1	71	35	LR	13.1	134.8	
6-1	71	35	LR	13.6	145.3	
6-1	71	35	LR	9.8	75.4	
6-1	71	35	RM	6.5	33.2	
6-1	71	35	SP	28.7	646.9	
6-1	72	45	RM	6.6	34.2	UTsw3
6-1	72	45	RM	6.6	34.2	
6-1	72	45	RM	5.5	23.8	
6-1	72	45	RM	6.2	30.2	
6-1	72	45	RM	5.8	26.4	
6-1	72	45	RM	8.2	52.8	
6-1	72	45	RM	7.1	39.6	
6-1	72	45	RM	6.6	34.2	
6-1	72	45	RM	9.2	66.5	
6-1	72	45	DEAD TD	96.2	7268.4	
6-1	72	45	DEAD TD	81.2	5178.5	
6-1	72	45	SP	25.	490.9	
6-1	72	45	SP	28.5	637.9	
6-1	72	45	SP	26	530.9	
6-1	72	45	AG	12.2	116.9	
6-1	72	45	DEAD AG	23.3	426.4	
6-1	72	45	LR	10	78.5	
6-1	72	45	LR	10.1	80.1	
6-1	72	45	LR	6.4	32.2	
6-1	72	45	LR	8.2	52.8	
6-1	72	45	LR	7.5	44.2	
6-1	72	45	LR	8.	50.3	
6-1	72	45	LR	5.1	20.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	72	45	LR	5.9	27.3	
6-1	72	45	LR	5.8	26.4	
6-1	72	45	LR	7.4	43.0	
6-1	72	45	LR	16.9	224.3	
6-1	72	45	LR	8.4	55.4	
6-1	72	45	LR	8.8	60.8	
6-1	72	45	LR	8.1	51.5	
6-1	72	45	LR	10.8	91.6	
6-1	72	45	LR	10.5	86.6	
6-1	72	45	LR	8.4	55.4	
6-1	72	45	LR	9.1	65.0	
6-1	72	45	LR	11.5	103.9	
6-1	72	45	MC	6.2	30.2	
6-1	72	45	MC	11.3	100.3	
6-1	72	45	MC	6.4	32.2	
6-1	73	55	LR	6.	28.3	UTsw3
6-1	73	55	LR	13.3	138.9	
6-1	73	55	LR	9.8	75.4	
6-1	73	55	LR	10.	78.5	
6-1	73	55	LR	7.8	47.8	
6-1	73	55	LR	5.7	25.5	
6-1	73	55	LR	7.2	40.7	
6-1	73	55	LR	5.4	22.9	
6-1	73	55	LR	8.9	62.2	
6-1	73	55	LR	10.3	83.3	
6-1	73	55	LR	5.1	20.4	
6-1	73	55	LR	6.2	30.2	
6-1	73	55	LR	8.3	54.1	
6-1	73	55	LR	7.3	41.9	
6-1	73	55	LR	9.	63.6	
6-1	73	55	LR	8.5	56.7	
6-1	73	55	LR	10.1	80.1	
6-1	73	55	LR	9.1	65.0	
6-1	73	55	LR	7.1	39.6	
6-1	73	55	LR	9.2	66.5	
6-1	73	55	LR	11.3	100.3	
6-1	73	55	LR	7.2	40.7	
6-1	73	55	LR	8.2	52.8	
6-1	73	55	LR	7.9	49.0	
6-1	73	55	LR	9.4	69.4	
6-1	73	55	LR	7.1	39.6	
6-1	73	55	LR	6.6	34.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	73	55	LR	6.1	29.2	
6-1	73	55	LR	10	78.5	
6-1	73	55	LR	13.7	147.4	
6-1	73	55	LR	9.5	70.9	
6-1	73	55	MC	5.1	20.4	
6-1	73	55	MC	5.1	20.4	
6-1	73	55	MC	9.2	66.5	
6-1	74	65	AG	6.2	30.2	UTsw3
6-1	74	65	LR	9.6	72.4	
6-1	74	65	LR	10.	78.5	
6-1	74	65	LR	9.1	65.0	
6-1	74	65	LR	5.4	22.9	
6-1	74	65	LR	6.4	32.2	
6-1	74	65	LR	6	28.3	
6-1	74	65	LR	9.9	77.0	
6-1	74	65	LR	9.8	75.4	
6-1	74	65	LR	14.9	174.4	
6-1	74	65	LR	8.3	54.1	
6-1	74	65	LR	5.5	23.8	
6-1	74	65	LR	10.8	91.6	
6-1	74	65	LR	6.8	36.3	
6-1	74	65	LR	6.2	30.2	
6-1	74	65	LR	7.9	49.0	
6-1	74	65	LR	8.	50.3	
6-1	74	65	LR	11.1	96.8	
6-1	74	65	LR	5.5	23.8	
6-1	74	65	LR	11.	95.0	
6-1	74	65	LR	8.6	58.1	
6-1	74	65	LR	7.3	41.9	
6-1	74	65	MC	6.3	31.2	
6-1	75	75	RM	5.5	23.8	UTsw3
6-1	75	75	RM	5.6	24.6	
6-1	75	75	RM	5.	19.6	
6-1	75	75	RM	5.	19.6	
6-1	75	75	RM	5.5	23.8	
6-1	75	75	SP	28.2	624.6	
6-1	75	75	AG	5.9	27.3	
6-1	75	75	LR	5.7	25.5	
6-1	75	75	LR	7.1	39.6	
6-1	75	75	LR	6.2	30.2	
6-1	75	75	LR	5.	19.6	
6-1	75	75	LR	6.3	31.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	75	75	LR	8.3	54.1	
6-1	75	75	LR	9.0	63.6	
6-1	75	75	LR	7.3	41.9	
6-1	75	75	LR	13.5	143.1	
6-1	75	75	LR	8.9	62.2	
6-1	75	75	LR	8.8	60.8	
6-1	75	75	LR	10.	78.5	
6-1	75	75	LR	8.	50.3	
6-1	75	75	LR	8.6	58.1	
6-1	75	75	LR	13.5	143.1	
6-1	75	75	LR	10.	78.5	
6-1	75	75	LR	9.0	63.6	
6-1	75	75	LR	11.5	103.9	
6-1	75	75	LR	9.7	73.9	
6-1	75	75	LR	17.8	248.8	
6-1	75	75	LR	5.3	22.1	
6-1	75	75	LR	5.5	23.8	
6-1	75	75	RL	9.2	66.5	
6-1	75	75	RL	5.8	26.4	
6-1	76	85	SP	29.4	678.9	UTmix
6-1	76	85	SP	27.3	585.3	
6-1	76	85	SP	29.6	688.1	
6-1	76	85	MC	5.3	22.1	
6-1	76	85	MC	7.1	39.6	
6-1	76	85	MC	6.5	33.2	
6-1	76	85	MC	6.8	36.3	
6-1	76	85	RM	6.1	29.2	
6-1	76	85	ST	10.8	91.6	
6-1	76	85	TD	17.2	232.4	
6-1	76	85	TD	19.4	295.6	
6-1	76	85	LR	13.5	143.1	
6-1	76	85	LR	11.9	111.2	
6-1	76	85	LR	10.4	84.9	
6-1	77	95	MC	8.1	51.5	UTsw1
6-1	77	95	RM	7.0	38.5	
6-1	77	95	RM	6.2	30.2	
6-1	77	95	RM	6.0	28.3	
6-1	77	95	RM	7.2	40.7	
6-1	77	95	RM	5.0	19.6	
6-1	77	95	ST	6.4	32.2	
6-1	77	95	ST	6.7	35.3	
6-1	77	95	DEAD TD	101.7	8123.3	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	77	95	LR	13.9	151.7	
6-1	77	95	LR	12.1	115.0	
6-1	77	95	LR	11.1	96.8	
6-1	77	95	LR	7.2	40.7	
6-1	77	95	RM	7	38.5	
6-1	77	95	RM	5	19.6	
6-1	77	95	RM	6.7	35.3	
6-1	77	95	AG	21.9	376.7	
6-1	77	95	AG	5.7	25.5	
6-1	77	95	AG	7.7	46.6	
6-1	77	95	AG	18.2	260.2	
6-1	77	95	AG	5.5	23.8	
6-1	77	95	LR	9.2	66.5	
6-1	77	95	LR	9.8	75.4	
6-1	77	95	RM	6.1	29.2	
6-1	77	95	RM	9.	63.6	
6-1	77	95	RM	5.9	27.3	
6-1	77	95	RM	6.8	36.3	
6-1	77	95	FC	5.9	27.3	
6-1	77	95	FC	6.2	30.2	
6-1	77	95	FC	5.1	20.4	
6-1	77	95	AG	4.4	15.2	
6-1	77	95	AG	5.4	22.9	
6-1	77	95	AG	6.8	36.3	
6-1	78	105	SP	30.3	721.1	UTsw1
6-1	78	105	RM	6.8	36.3	
6-1	78	105	RM	7.4	43.0	
6-1	78	105	RM	5.1	20.4	
6-1	78	105	RM	6.5	33.2	
6-1	78	105	RM	5.5	23.8	
6-1	78	105	DEAD TD	26.1	535.0	
6-1	78	105	LR	13.5	143.1	
6-1	78	105	RM	5.5	23.8	
6-1	78	105	RM	5.5	23.8	
6-1	78	105	RM	5.3	22.1	
6-1	78	105	RM	7.	38.5	
6-1	78	105	RM	6.2	30.2	
6-1	78	105	AG	6.4	32.2	
6-1	78	105	RM	5.8	26.4	
6-1	78	105	RM	6.6	34.2	
6-1	78	105	RM	7.2	40.7	
6-1	78	105	RM	6.4	32.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	78	105	RM	5.8	26.4	
6-1	78	105	FC	5.9	27.3	
6-1	78	105	FC	5.9	27.3	
6-1	78	105	RR	13.9	151.7	
6-1	78	105	RM	6.9	37.4	
6-1	78	105	RM	5.3	22.1	
6-1	78	105	RM	5.3	22.1	
6-1	78	105	RM	5.9	27.3	
6-1	79	115	MC	5.1	20.4	UTsw1
6-1	79	115	MC	6.9	37.4	
6-1	79	115	MC	6.4	32.2	
6-1	79	115	RM	6.5	33.2	
6-1	79	115	RM	6.1	29.2	
6-1	79	115	RM	5.2	21.2	
6-1	79	115	RM	5.1	20.4	
6-1	79	115	ST	8.9	62.2	
6-1	79	115	LR	6.2	30.2	
6-1	79	115	LR	13.3	138.9	
6-1	79	115	LR	14.9	174.4	
6-1	79	115	LR	10.2	81.7	
6-1	79	115	RM	5.5	23.8	
6-1	79	115	RM	5.3	22.1	
6-1	79	115	RM	15.8	196.1	
6-1	79	115	RM	5.3	22.1	
6-1	79	115	AG	11.7	107.5	
6-1	79	115	AG	5.9	27.3	
6-1	79	115	RM	6.2	30.2	
6-1	79	115	RM	5.	19.6	
6-1	79	115	RM	6.5	33.2	
6-1	79	115	RM	6.4	32.2	
6-1	79	115	RM	6.	28.3	
6-1	79	115	FC	5.	19.6	
6-1	79	115	AG	5	19.6	
6-1	79	115	RM	8.5	56.7	
6-1	79	115	RM	5.5	23.8	
6-1	79	115	RM	8.	50.3	
6-1	79	115	RM	7.5	44.2	
6-1	79	115	RM	5.1	20.4	
6-1	79	115	RM	8.9	62.2	
6-1	79	115	RM	6.1	29.2	
6-1	79	115	RM	6.5	33.2	
6-1	80	125	AG	5.3	22.1	UTsw1

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-1	80	125	AG	5.7	25.5	
6-1	80	125	AG	8.	50.3	
6-1	80	125	LR	8.9	62.2	
6-1	80	125	LR	11.9	111.2	
6-1	80	125	LR	13.5	143.1	
6-1	80	125	RM	5.7	25.5	
6-1	80	125	RM	7.	38.5	
6-1	80	125	RM	6.8	36.3	
6-1	80	125	RM	8.	50.3	
6-1	80	125	RM	9.4	69.4	
6-1	80	125	RM	7.9	49.0	
6-1	80	125	RM	15.2	181.5	
6-1	80	125	RM	5.7	25.5	
6-1	80	125	RM	5.2	21.2	
6-1	80	125	RM	5.7	25.5	
6-1	80	125	RM	8.9	62.2	
6-1	80	125	DEAD SP	28.4	633.5	
6-1	80	125	SP	27.8	607.0	
6-1	80	125	ST	5.5	23.8	
6-1	80	125	ST	5.4	22.9	
6-1	80	125	DEAD TD	111.1	9694.3	
6-2	81	5	AG	5.1	20.4	UTsw3
6-2	81	5	AG	6.4	32.2	
6-2	81	5	AG	17.6	243.3	
6-2	81	5	RM	8.5	56.7	
6-2	81	5	RM	8.1	51.5	
6-2	81	5	LR	19.2	289.5	
6-2	81	5	LR	5.7	25.5	
6-2	81	5	LR	16.4	211.2	
6-2	81	5	LR	11.5	103.9	
6-2	81	5	ST	5.1	20.4	
6-2	81	5	ST	6.3	31.2	
6-2	81	5	ST	5.3	22.1	
6-2	81	5	DEAD SP	18.8	277.6	
6-2	81	5	DEAD TD	109.5	9417.1	
6-2	82	15	AG	8.5	56.7	UTsw1
6-2	82	15	AG	8.2	52.8	
6-2	82	15	AG	8.2	52.8	
6-2	82	15	AG	9.7	73.9	
6-2	82	15	RM	5.3	22.1	
6-2	82	15	RM	7.3	41.9	
6-2	82	15	RM	7.2	40.7	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-2	82	15	RM	7.	38.5	
6-2	82	15	RM	6.7	35.3	
6-2	82	15	RM	10.	78.5	
6-2	82	15	RM	7.6	45.4	
6-2	82	15	RM	6.2	30.2	
6-2	82	15	RM	7.3	41.9	
6-2	82	15	MC	7.5	44.2	
6-2	82	15	AG	5.9	27.3	
6-2	82	15	AG	11.7	107.5	
6-2	82	15	AG	6.8	36.3	
6-2	82	15	AG	5.1	20.4	
6-2	82	15	RM	7.3	41.9	
6-2	82	15	RM	5.6	24.6	
6-2	82	15	AG	5.2	21.2	
6-2	82	15	AG	6.	28.3	
6-2	82	15	AG	7.2	40.7	
6-2	82	15	SP	27.5	594.0	
6-2	82	15	TD	48.2	1824.7	
6-2	82	15	ST	5.	19.6	
6-2	82	15	ST	5.3	22.1	
6-2	82	15	ST	12.4	120.8	
6-2	82	15	ST	7.5	44.2	
6-2	82	15	DEAD SP	27.4	589.6	
6-2	82	15	ST	10.6	88.2	
6-2	82	15	ST	8.	50.3	
6-2	83	25	AG	8.5	56.7	UTsw1
6-2	83	25	AG	5.8	26.4	
6-2	83	25	AG	10.9	93.3	
6-2	83	25	RM	7.2	40.7	
6-2	83	25	RM	9.	63.6	
6-2	83	25	RM	9.	63.6	
6-2	83	25	RM	5.9	27.3	
6-2	83	25	RM	6.5	33.2	
6-2	83	25	RM	5.	19.6	
6-2	83	25	RM	6.8	36.3	
6-2	83	25	RM	5.	19.6	
6-2	83	25	RM	6.8	36.3	
6-2	83	25	RM	5.	19.6	
6-2	83	25	MC	6.3	31.2	
6-2	83	25	RM	6.3	31.2	
6-2	83	25	RM	7.1	39.6	
6-2	83	25	RM	5.9	27.3	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
6-2	83	25	RM	6.1	29.2	
6-2	83	25	RM	7.5	44.2	
6-2	83	25	AG	5.6	24.6	
6-2	83	25	AG	6.9	37.4	
6-2	83	25	AG	12.1	115.0	
6-2	83	25	AG	5.6	24.6	
6-2	83	25	AG	6.1	29.2	
6-2	83	25	AG	5.3	22.1	
6-2	83	25	SP	23.	415.5	
6-2	83	25	ST	9.	63.6	
6-2	83	25	AG	5.6	24.6	
6-2	83	25	AG	7.1	39.6	
6-2	83	25	AG	17.7	246.1	
6-2	83	25	AG	5.5	23.8	
6-2	83	25	RM	5.2	21.2	
6-2	83	25	RM	5.	19.6	
6-2	83	25	RM	5.9	27.3	
6-2	83	25	RM	6.8	36.3	
6-2	83	25	RM	5.7	25.5	
6-2	83	25	RM	6.2	30.2	
6-2	83	25	RM	7.8	47.8	
6-2	83	25	RM	5.2	21.2	
6-2	83	25	AG	5.3	22.1	
6-2	83	25	AG	8.3	54.1	
7-1	84	5	QV	11.5	103.9	MH/Rsw1
7-1	84	5	QV	18.6	271.7	
7-1	84	5	QV	7.4	43.0	
7-1	84	5	QV	9.	63.6	
7-1	84	5	QV	12.5	122.7	
7-1	84	5	TD	50.1	1971.4	
7-1	84	5	MC	6.2	30.2	
7-1	84	5	MC	7.7	46.6	
7-1	84	5	QV	22.9	411.9	
7-1	84	5	QV	12.3	118.8	
7-1	84	5	QV	25.6	514.7	
7-1	85	15	TD	39.5	1225.4	Rsw1
7-1	85	15	TD	27.3	585.3	
7-1	85	15	TD	27.9	611.4	
7-1	85	15	TD	48.8	1870.4	
7-1	85	15	RP	5.0	19.6	
7-1	85	15	AR	6.1	29.2	
7-1	85	15	TD	25.8	522.8	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	85	15	TD	47.5	1772.1	
7-1	86	25	TD	36.2	1029.2	Rsw1
7-1	86	25	TD	17.3	235.1	
7-1	86	25	TD	45.2	1604.6	
7-1	86	25	TD	50.5	2003.0	
7-1	86	25	MC	5.5	23.8	
7-1	86	25	MC	9.1	65.0	
7-1	86	25	MC	5.8	26.4	
7-1	86	25	MC	5.1	20.4	
7-1	86	25	RR	6.2	30.2	
7-1	86	25	SP	25.	490.9	
7-1	86	25	SP	28.2	624.6	
7-1	86	25	ST	6.7	35.3	
7-1	86	25	SC	6.2	30.2	
7-1	86	25	SC	7.6	45.4	
7-1	86	25	DEAD TD	13.9	151.7	
7-1	86	25	MC	6.2	30.2	
7-1	86	25	MC	6.7	35.3	
7-1	87	35	TD	39.7	1237.9	Rmix
7-1	87	35	TD	36.2	1029.2	
7-1	87	35	MC	9.0	63.6	
7-1	87	35	MC	7.2	40.7	
7-1	87	35	MC	14.1	156.1	
7-1	87	35	MC	7.	38.5	
7-1	87	35	MC	7.	38.5	
7-1	87	35	SP	29.5	683.5	
7-1	87	35	SP	28.2	624.6	
7-1	87	35	SP	35.3	978.7	
7-1	87	35	MC	10.2	81.7	
7-1	87	35	MC	9.6	72.4	
7-1	87	35	AR	29.7	692.8	
7-1	87	35	AR	5.9	27.3	
7-1	87	35	SP	27.1	576.8	
7-1	87	35	SP	29.6	688.1	
7-1	87	35	SP	30.3	721.1	
7-1	87	35	FC	7	38.5	
7-1	87	35	CO	6.2	30.2	
7-1	88	45	MC	7.6	45.4	Rmix
7-1	88	45	MC	5.8	26.4	
7-1	88	45	MC	7.1	39.6	
7-1	88	45	SP	30.9	749.9	
7-1	88	45	SP	26.5	551.5	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	88	45	SP	24.1	456.2	
7-1	88	45	TD	21.8	373.3	
7-1	88	45	DEAD TD	56.6	2516.1	
7-1	88	45	FC	7.7	46.6	
7-1	88	45	MC	6.7	35.3	
7-1	88	45	MC	6.1	29.2	
7-1	88	45	MC	11.1	96.8	
7-1	89	55	MC	5.3	22.1	Rmix
7-1	89	55	MC	5.8	26.4	
7-1	89	55	MC	8.6	58.1	
7-1	89	55	MC	8.	50.3	
7-1	89	55	MC	13.7	147.4	
7-1	89	55	SP	30.9	749.9	
7-1	89	55	SP	27.3	585.3	
7-1	89	55	SP	28.4	633.5	
7-1	89	55	SP	28.7	646.9	
7-1	89	55	TD	28.5	637.9	
7-1	89	55	TD	23.8	444.9	
7-1	89	55	TD	45.	1590.4	
7-1	89	55	TD	21.7	369.8	
7-1	89	55	FC	5.1	20.4	
7-1	89	55	FC	5.8	26.4	
7-1	89	55	FC	7.1	39.6	
7-1	89	55	FC	5.6	24.6	
7-1	89	55	MC	8.8	60.8	
7-1	89	55	AR	23.1	419.1	
7-1	89	55	AR	8.2	52.8	
7-1	89	55	RR	9.2	66.5	
7-1	89	55	DEAD SP	24.5	471.4	
7-1	89	55	AG	5.4	22.9	
7-1	90	65	MC	5.6	24.6	Rmix
7-1	90	65	MC	10.3	83.3	
7-1	90	65	MC	6.	28.3	
7-1	90	65	MC	8.8	60.8	
7-1	90	65	SP	34.4	929.4	
7-1	90	65	SP	28.	615.8	
7-1	90	65	SP	26.	530.9	
7-1	90	65	TD	7.2	40.7	
7-1	90	65	TD	18.6	271.7	
7-1	90	65	TD	24.2	460.0	
7-1	90	65	FC	6.1	29.2	
7-1	90	65	MC	7.5	44.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	91	75	MC	7.8	47.8	Rmix
7-1	91	75	SP	26.5	551.5	
7-1	91	75	SP	25.5	510.7	
7-1	91	75	SP	28.1	620.2	
7-1	91	75	TD	14.8	172.0	
7-1	91	75	TD	43.4	1479.3	
7-1	91	75	FC	11.8	109.4	
7-1	91	75	AR	10.3	83.3	
7-1	91	75	AR	5.1	20.4	
7-1	91	75	AR	11.4	102.1	
7-1	91	75	AR	6.0	28.3	
7-1	91	75	LR	7.7	46.6	
7-1	91	75	AG	5.0	19.6	
7-1	91	75	SC	7.6	45.4	
7-1	92	85	FC	5.2	21.2	UTsw1
7-1	92	85	FC	7.9	49.0	
7-1	92	85	FC	6.1	29.2	
7-1	92	85	TD	19.5	298.6	
7-1	92	85	TD	26.1	535.0	
7-1	92	85	AR	8.8	60.8	
7-1	92	85	MC	9.3	67.9	
7-1	92	85	MC	5.5	23.8	
7-1	92	85	RM	6.4	32.2	
7-1	92	85	AG	20.3	323.7	
7-1	92	85	AG	5.7	25.5	
7-1	93	95	TD	35.	962.1	UTsw1
7-1	93	95	TD	17.8	248.8	
7-1	93	95	MC	6.	28.3	
7-1	93	95	MC	6.2	30.2	
7-1	93	95	AG	6.	28.3	
7-1	93	95	AG	6.4	32.2	
7-1	93	95	AG	5.2	21.2	
7-1	93	95	AG	5.5	23.8	
7-1	93	95	AG	5.1	20.4	
7-1	93	95	SaC	5.5	23.8	
7-1	93	95	SaC	5.6	24.6	
7-1	93	95	SaC	7.4	43.0	
7-1	93	95	SaC	5.8	26.4	
7-1	94	105	FC	6.7	35.3	UTsw1
7-1	94	105	FC	5.9	27.3	
7-1	94	105	FC	9.2	66.5	
7-1	94	105	FC	6.	28.3	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	94	105	FC	6.8	36.3	
7-1	94	105	TD	9.6	72.4	
7-1	94	105	TD	43.8	1506.7	
7-1	94	105	TD	10.6	88.2	
7-1	94	105	TD	21.2	353.0	
7-1	94	105	AR	6.4	32.2	
7-1	94	105	AG	5.6	24.6	
7-1	94	105	AG	5.5	23.8	
7-1	94	105	AG	5.6	24.6	
7-1	94	105	AG	5.	19.6	
7-1	94	105	SaC	6.3	31.2	
7-1	94	105	FC	5.4	22.9	
7-1	94	105	FC	5.9	27.3	
7-1	94	105	FC	5.5	23.8	
7-1	95	115	FC	8.5	56.7	UTsw1
7-1	95	115	FC	8.1	51.5	
7-1	95	115	FC	5.8	26.4	
7-1	95	115	TD	9.6	72.4	
7-1	95	115	TD	16.2	206.1	
7-1	95	115	TD	11.8	109.4	
7-1	95	115	AG	5.5	23.8	
7-1	95	115	AG	7.6	45.4	
7-1	95	115	AG	6.1	29.2	
7-1	95	115	AG	5.4	22.9	
7-1	95	115	AG	5.5	23.8	
7-1	95	115	SaC	11.1	96.8	
7-1	95	115	SaC	7.5	44.2	
7-1	95	115	SaC	5.5	23.8	
7-1	95	115	SaC	6.9	37.4	
7-1	95	115	SaC	5.	19.6	
7-1	95	115	SaC	12.1	115.0	
7-1	95	115	AG	5.	19.6	
7-1	95	115	AG	11.2	98.5	
7-1	95	115	AG	6.2	30.2	
7-1	95	115	AG	6.3	31.2	
7-1	95	115	AG	5.	19.6	
7-1	96	125	AG	6.	28.3	UTsw2
7-1	96	125	AG	5.	19.6	
7-1	96	125	AG	6.	28.3	
7-1	96	125	AG	5.8	26.4	
7-1	96	125	AG	6.2	30.2	
7-1	96	125	AG	10.6	88.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	96	125	AG	6.3	31.2	
7-1	96	125	AG	5.4	22.9	
7-1	96	125	AG	5.8	26.4	
7-1	96	125	SaC	6.7	35.3	
7-1	96	125	SaC	5.0	19.6	
7-1	96	125	SaC	5.2	21.2	
7-1	96	125	SaC	7.3	41.9	
7-1	96	125	RM	6.3	31.2	
7-1	96	125	RM	7.6	45.4	
7-1	96	125	AG	5.7	25.5	
7-1	96	125	AG	5.1	20.4	
7-1	96	125	AG	5.3	22.1	
7-1	96	125	AG	5.8	26.4	
7-1	96	125	AG	6.7	35.3	
7-1	96	125	AG	6.8	36.3	
7-1	96	125	FC	11.6	105.7	
7-1	96	125	SP	26.5	551.5	
7-1	96	125	MC	6.2	30.2	
7-1	96	125	DEAD TD	21.	346.4	
7-1	96	125	AG	5.1	20.4	
7-1	96	125	AG	5.9	27.3	
7-1	96	125	AG	6.8	36.3	
7-1	96	125	AG	6.2	30.2	
7-1	96	125	AG	8.7	59.4	
7-1	96	125	AG	15.8	196.1	
7-1	96	125	SaC	5.9	27.3	
7-1	97	135	AG	7.4	43.0	UTsw2
7-1	97	135	AG	8.9	62.2	
7-1	97	135	AG	9.7	73.9	
7-1	97	135	AG	9.3	67.9	
7-1	97	135	AG	5.2	21.2	
7-1	97	135	AG	7.2	40.7	
7-1	97	135	AG	15.2	181.5	
7-1	97	135	AG	5.3	22.1	
7-1	97	135	AG	10.1	80.1	
7-1	97	135	AG	5.4	22.9	
7-1	97	135	RM	6.3	31.2	
7-1	97	135	RM	8.5	56.7	
7-1	97	135	RM	6.2	30.2	
7-1	97	135	RM	6.5	33.2	
7-1	97	135	RM	5.3	22.1	
7-1	97	135	AG	10.6	88.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	97	135	AG	17.2	232.4	
7-1	97	135	AG	12.2	116.9	
7-1	97	135	AG	6.2	30.2	
7-1	97	135	FC	8.0	50.3	
7-1	97	135	FC	6.8	36.3	
7-1	97	135	FC	6.9	37.4	
7-1	97	135	FC	7.3	41.9	
7-1	97	135	FC	6.3	31.2	
7-1	97	135	SP	32.9	850.1	
7-1	97	135	SP	21.3	356.3	
7-1	97	135	SP	25.6	514.7	
7-1	97	135	SP	22.2	387.1	
7-1	97	135	MC	9.7	73.9	
7-1	97	135	MC	5.2	21.2	
7-1	97	135	MC	8.	50.3	
7-1	97	135	MC	6.8	36.3	
7-1	97	135	AG	6.2	30.2	
7-1	97	135	AG	10.2	81.7	
7-1	97	135	AG	5.8	26.4	
7-1	97	135	RM	7.1	39.6	
7-1	97	135	RM	9.9	77.0	
7-1	97	135	RM	6.1	29.2	
7-1	97	135	RM	8.4	55.4	
7-1	97	135	RM	5.6	24.6	
7-1	97	135	RM	5.5	23.8	
7-1	97	135	LR	9.3	67.9	
7-1	97	135	DEAD SP	32.2	814.3	
7-1	97	135	RM	6.0	28.3	
7-1	97	135	RM	5.5	23.8	
7-1	97	135	RM	6.1	29.2	
7-1	97	135	RM	6.5	33.2	
7-1	98	145	AG	5.8	26.4	UTsw2
7-1	98	145	AG	5.5	23.8	
7-1	98	145	AG	6.8	36.3	
7-1	98	145	AG	5.8	26.4	
7-1	98	145	AG	6.1	29.2	
7-1	98	145	AG	5.1	20.4	
7-1	98	145	AG	13.	132.7	
7-1	98	145	AG	7.2	40.7	
7-1	98	145	AG	7.3	41.9	
7-1	98	145	AG	16.5	213.8	
7-1	98	145	RM	6.1	29.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
7-1	98	145	RM	7.	38.5	
7-1	98	145	RM	5.5	23.8	
7-1	98	145	RM	5.8	26.4	
7-1	98	145	RM	7.8	47.8	
7-1	98	145	FC	7.8	47.8	
7-1	98	145	FC	5.4	22.9	
7-1	98	145	SP	29.8	697.5	
7-1	98	145	SP	26.8	564.1	
7-1	98	145	SP	30.1	711.6	
7-1	98	145	SP	17.9	251.6	
7-1	98	145	SP	28.8	651.4	
7-1	98	145	AG	6.6	34.2	
7-1	98	145	AG	5.	19.6	
7-1	98	145	AG	5.1	20.4	
7-1	98	145	AG	6.2	30.2	
7-1	98	145	RM	6.1	29.2	
7-1	98	145	RM	5.9	27.3	
7-1	98	145	RM	6.2	30.2	
7-1	98	145	RM	6.6	34.2	
7-1	98	145	RM	8.	50.3	
7-1	98	145	RM	5.6	24.6	
7-1	98	145	LR	8.2	52.8	
7-1	98	145	RM	5.1	20.4	
7-1	98	145	RM	6.6	34.2	
7-1	98	145	RM	5.5	23.8	
7-1	98	145	RM	5.0	19.6	
7-1	98	145	SP	22.8	408.3	
8-1	99	5	SR	16.2	206.1	Rmix
8-1	99	5	TD	117.3	10806.5	
8-1	100	15	TD	8.2	52.8	HH
8-1	100	15	MC	13.3	138.9	
8-1	100	15	MC	8.	50.3	
8-1	100	15	MC	6.2	30.2	
8-1	100	15	MC	6.4	32.2	
8-1	100	15	MC	11.8	109.4	
8-1	100	15	MC	8.7	59.4	
8-1	100	15	MC	15.	176.7	
8-1	100	15	AR	8.8	60.8	
8-1	100	15	AR	6.5	33.2	
8-1	100	15	DEAD MC	8.8	60.8	
8-1	100	15	MC	6.2	30.2	
8-1	100	15	MC	6.6	34.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
8-1	101	25	TD	12.5	122.7	Rmix
8-1	101	25	TD	25.	490.9	
8-1	101	25	TD	8.1	51.5	
8-1	101	25	MC	8.0	50.3	
8-1	101	25	MC	11.3	100.3	
8-1	101	25	MC	8.4	55.4	
8-1	101	25	MC	9.2	66.5	
8-1	101	25	MC	6.2	30.2	
8-1	101	25	MC	5.7	25.5	
8-1	101	25	MC	12.3	118.8	
8-1	101	25	MC	6.5	33.2	
8-1	101	25	CO	5.4	22.9	
8-1	101	25	PB	9.9	77.0	
8-1	102	35	TD	6.3	31.2	UTmix
8-1	102	35	MC	9.6	72.4	
8-1	102	35	MC	11.3	100.3	
8-1	102	35	MC	5.3	22.1	
8-1	102	35	MC	6.4	32.2	
8-1	102	35	MC	7.9	49.0	
8-1	102	35	AR	5.3	22.1	
8-1	102	35	AR	11.	95.0	
8-1	102	35	PB	9.3	67.9	
8-1	102	35	PB	5.9	27.3	
8-1	102	35	AG	5.9	27.3	
8-1	102	35	AG	5.1	20.4	
8-1	102	35	AG	5.	19.6	
8-1	102	35	AG	8.8	60.8	
8-1	102	35	AG	8.7	59.4	
8-1	102	35	ST	8.6	58.1	
8-1	102	35	FC	5.9	27.3	
8-1	102	35	AG	5.9	27.3	
8-1	102	35	DEAD TREE	15.5	188.7	
8-1	103	45	PC	5.6	24.6	UTmix
8-1	103	45	TD	33.2	865.7	
8-1	103	45	SP	30.1	711.6	
8-1	103	45	MC	6.7	35.3	
8-1	103	45	MC	8.8	60.8	
8-1	103	45	MC	7.7	46.6	
8-1	103	45	ST	9.2	66.5	
8-1	103	45	ST	7.3	41.9	
8-1	103	45	AG	6.1	29.2	
8-1	103	45	AG	5.6	24.6	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
8-1	103	45	AG	5.7	25.5	
8-1	103	45	AG	5.8	26.4	
8-1	103	45	DEAD MC	14.8	172.0	
8-1	104	55	PC	5.	19.6	UTsw1
8-1	104	55	TD	26.1	535.0	
8-1	104	55	TD	52.7	2181.3	
8-1	104	55	MC	5.7	25.5	
8-1	104	55	MC	6.4	32.2	
8-1	104	55	AG	5.	19.6	
8-1	104	55	AG	6.2	30.2	
8-1	104	55	AG	5.4	22.9	
8-1	104	55	AG	6.8	36.3	
8-1	104	55	DEAD TD	75.	4417.9	
8-1	105	65	PC	5.8	26.4	UTmix
8-1	105	65	MC	5.	19.6	
8-1	105	65	ST	10.2	81.7	
8-1	105	65	ST	8.2	52.8	
8-1	105	65	ST	6.6	34.2	
8-1	105	65	AG	5.1	20.4	
8-1	105	65	AG	7.	38.5	
8-1	105	65	AG	5.	19.6	
8-1	105	65	AG	5.3	22.1	
8-1	105	65	AG	5.1	20.4	
8-1	105	65	AR	5.2	21.2	
8-1	106	75	TD	28.5	637.9	UTsw1
8-1	106	75	TD	37.6	1110.4	
8-1	106	75	TD	29.8	697.5	
8-1	106	75	MC	8.	50.3	
8-1	106	75	ST	8.2	52.8	
8-1	106	75	AG	5.3	22.1	
8-1	106	75	DEAD TD	175.1	24080.3	
8-1	106	75	SaC	8.4	55.4	
8-1	106	75	SaC	11.	95.0	
8-1	107	85	TD	29.1	665.1	UTmix
8-1	107	85	TD	32.1	809.3	
8-1	107	85	TD	5.3	22.1	
8-1	107	85	TD	6.3	31.2	
8-1	107	85	DEAD TD	103.9	8478.5	
8-1	107	85	SP	26.1	535.0	
8-1	107	85	MC	6.8	36.3	
8-1	107	85	AG	7.5	44.2	
8-1	107	85	AG	5.4	22.9	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
8-1	107	85	LR	15.7	193.6	
8-1	107	85	LR	16.2	206.1	
8-1	107	85	LR	11.3	100.3	
8-1	107	85	LR	9.4	69.4	
8-1	108	95	SP	21.4	359.7	UTsw1
8-1	108	95	AG	5.4	22.9	
8-1	108	95	AG	5.2	21.2	
8-1	108	95	AG	5.5	23.8	
8-1	108	95	AG	15.8	196.1	
8-1	108	95	AG	5.0	19.6	
8-1	108	95	FC	7.5	44.2	
8-1	108	95	FC	5.1	20.4	
8-1	108	95	RM	5.	19.6	
8-1	108	95	AG	5.3	22.1	
8-1	108	95	AG	6.	28.3	
8-1	108	95	AG	9.7	73.9	
8-1	108	95	AG	8.8	60.8	
8-1	108	95	AG	7.8	47.8	
8-1	108	95	AG	5.2	21.2	
8-1	108	95	AG	6.	28.3	
8-1	108	95	AG	20.8	339.8	
8-1	109	105	TD	46.9	1727.6	UTsw1
8-1	109	105	TD	25.8	522.8	
8-1	109	105	SP	25.3	502.7	
8-1	109	105	SP	25.2	498.8	
8-1	109	105	SP	26.5	551.5	
8-1	109	105	FC	10.5	86.6	
8-1	110	115	TD	9.3	67.9	UTsw1
8-1	110	115	TD	6.1	29.2	
8-1	110	115	TD	18.9	280.6	
8-1	110	115	TD	14.	153.9	
8-1	110	115	SP	33.	855.3	
8-1	110	115	MC	7.6	45.4	
8-1	110	115	MC	5.	19.6	
8-1	110	115	MC	5.2	21.2	
8-1	110	115	AG	12.5	122.7	
8-1	110	115	AG	5.8	26.4	
8-1	110	115	AG	5.	19.6	
8-1	110	115	AG	5.	19.6	
8-1	110	115	AG	5.5	23.8	
8-1	110	115	AG	5.3	22.1	
8-1	110	115	AG	5.2	21.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
8-1	110	115	AG	6.8	36.3	
8-1	110	115	AG	6.5	33.2	
8-1	110	115	AG	5.	19.6	
8-1	110	115	TD	12.	113.1	
8-1	110	115	TD	12.9	130.7	
8-1	110	115	TD	7.7	46.6	
8-1	110	115	TD	7.3	41.9	
9-1	111	5	PE	35.3	978.7	U
9-1	111	5	PE	9.7	73.9	
9-1	112	15	SP	37.5	1104.5	HH
9-1	112	15	SP	37.8	1122.2	
9-1	112	15	SP	13.2	136.8	
9-1	112	15	SP	17.1	229.7	
9-1	112	15	AG	5.3	22.1	
9-1	112	15	AG	5.	19.6	
9-1	112	15	AG	5.8	26.4	
9-1	112	15	LR	22.5	397.6	
9-1	113	25	SP	32.1	809.3	LTsw2
9-1	113	25	SP	32.2	814.3	
9-1	113	25	LR	19.5	298.6	
9-1	113	25	LR	27.3	585.3	
9-1	113	25	LR	14.5	165.1	
9-1	113	25	LR	13.5	143.1	
9-1	113	25	LR	8.6	58.1	
9-1	113	25	LR	8.5	56.7	
9-1	113	25	LR	6.3	31.2	
9-1	113	25	LR	12.4	120.8	
9-1	113	25	LR	24.5	471.4	
9-1	113	25	LR	22.4	394.1	
9-1	113	25	LR	18.5	268.8	
9-1	113	25	LR	8.3	54.1	
9-1	113	25	LR	12.1	115.0	
9-1	113	25	LR	15.6	191.1	
9-1	113	25	LR	9.7	73.9	
9-1	113	25	LR	7.9	49.0	
9-1	113	25	LR	5.3	22.1	
9-1	113	25	LR	5.8	26.4	
9-1	113	25	LR	16.2	206.1	
9-1	113	25	LR	15.9	198.6	
9-1	113	25	LR	9.1	65.0	
9-1	113	25	LR	8.3	54.1	
9-1	113	25	LR	10.8	91.6	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	113	25	LR	10.	78.5	
9-1	113	25	LR	5.7	25.5	
9-1	113	25	ST	5.7	25.5	
9-1	113	25	RM	17.9	251.6	
9-1	113	25	RM	6.8	36.3	
9-1	113	25	DEAD TD	71.5	4015.2	
9-1	114	35	LR	11.3	100.3	LTsw2
9-1	114	35	LR	8.2	52.8	
9-1	114	35	LR	13.7	147.4	
9-1	114	35	LR	9.5	70.9	
9-1	114	35	LR	11.1	96.8	
9-1	114	35	LR	8.6	58.1	
9-1	114	35	LR	10.	78.5	
9-1	114	35	LR	12.8	128.7	
9-1	114	35	LR	5.	19.6	
9-1	114	35	LR	19.5	298.6	
9-1	114	35	LR	14.6	167.4	
9-1	114	35	LR	8.2	52.8	
9-1	114	35	LR	23.4	430.1	
9-1	114	35	LR	19.1	286.5	
9-1	114	35	LR	15.4	186.3	
9-1	114	35	LR	7.7	46.6	
9-1	114	35	LR	16.9	224.3	
9-1	114	35	DEAD SP	25.8	522.8	
9-1	114	35	DEAD SP	33.3	870.9	
9-1	114	35	DEAD SP	26.9	568.3	
9-1	114	35	DEAD LR	15.9	198.6	
9-1	114	35	ST	5.9	27.3	
9-1	114	35	LR	15.4	186.3	
9-1	114	35	LR	6.2	30.2	
9-1	114	35	LR	15.9	198.6	
9-1	114	35	LR	16.4	211.2	
9-1	114	35	LR	10.3	83.3	
9-1	114	35	DEAD TD	60.7	2893.8	
9-1	114	35	DEAD TD	65.2	3338.8	
9-1	114	35	SP	15.2	181.5	
9-1	114	35	LR	25.7	518.7	
9-1	114	35	LR	6.1	29.2	
9-1	114	35	LR	7.0	38.5	
9-1	115	45	LR	12.7	126.7	LTsw2
9-1	115	45	LR	11.7	107.5	
9-1	115	45	LR	9.9	77.0	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	115	45	LR	9.5	70.9	
9-1	115	45	LR	5.5	23.8	
9-1	115	45	LR	5.1	20.4	
9-1	115	45	LR	17.3	235.1	
9-1	115	45	LR	12.6	124.7	
9-1	115	45	LR	7.2	40.7	
9-1	115	45	LR	21.8	373.3	
9-1	115	45	LR	10.3	83.3	
9-1	115	45	LR	4.9	18.9	
9-1	115	45	LR	12	113.1	
9-1	115	45	LR	14.1	156.1	
9-1	115	45	LR	13.3	138.9	
9-1	115	45	DEAD TD	61.5	2970.6	
9-1	115	45	DEAD TD	58.	2642.1	
9-1	115	45	LR	5.	19.6	
9-1	115	45	LR	11.5	103.9	
9-1	115	45	LR	12.2	116.9	
9-1	115	45	LR	12.8	128.7	
9-1	115	45	LR	12.1	115.0	
9-1	115	45	DEAD SP	26.6	555.7	
9-1	115	45	DEAD SP	28.8	651.4	
9-1	115	45	DEAD SP	28.	615.8	
9-1	115	45	SP	29.6	688.1	
9-1	115	45	LR	11.2	98.5	
9-1	115	45	LR	13.1	134.8	
9-1	115	45	LR	8.	50.3	
9-1	115	45	LR	5.8	26.4	
9-1	115	45	LR	9.7	73.9	
9-1	115	45	LR	14.	153.9	
9-1	116	55	LR	15.4	186.3	LTmix
9-1	116	55	LR	5.4	22.9	
9-1	116	55	LR	8.7	59.4	
9-1	116	55	LR	8.2	52.8	
9-1	116	55	LR	10.5	86.6	
9-1	116	55	LR	11.3	100.3	
9-1	116	55	LR	8.	50.3	
9-1	116	55	DEAD TD	51.9	2115.6	
9-1	116	55	DEAD SP	29.4	678.9	
9-1	116	55	DEAD SP	30.4	725.8	
9-1	116	55	SP	29.4	678.9	
9-1	116	55	SP	26.5	551.5	
9-1	116	55	SP	33.1	860.5	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	116	55	SP	33.2	865.7	
9-1	116	55	SP	27.1	576.8	
9-1	116	55	SP	23.8	444.9	
9-1	117	65	LR	10.3	83.3	HH/LTsw2
9-1	117	65	LR	11.9	111.2	
9-1	117	65	LR	7.	38.5	
9-1	117	65	LR	6.3	31.2	
9-1	117	65	LR	5.5	23.8	
9-1	117	65	LR	9.5	70.9	
9-1	117	65	SP	29.1	665.1	
9-1	117	65	SP	25.6	514.7	
9-1	117	65	SP	28.7	646.9	
9-1	117	65	SP	29.7	692.8	
9-1	117	65	SP	22.2	387.1	
9-1	117	65	SP	28.2	624.6	
9-1	117	65	SP	30.9	749.9	
9-1	117	65	SP	48.1	1817.1	
9-1	117	65	ST	5.3	22.1	
9-1	118	75	LR	6.3	31.2	LTsw2
9-1	118	75	LR	14.8	172.0	
9-1	118	75	LR	16.5	213.8	
9-1	118	75	LR	16.	201.1	
9-1	118	75	LR	22.9	411.9	
9-1	118	75	LR	12.9	130.7	
9-1	118	75	LR	7.5	44.2	
9-1	118	75	LR	9.6	72.4	
9-1	118	75	LR	14.	153.9	
9-1	118	75	LR	16.2	206.1	
9-1	118	75	LR	14.7	169.7	
9-1	118	75	LR	20.9	343.1	
9-1	118	75	SP	26.4	547.4	
9-1	118	75	SP	18.8	277.6	
9-1	118	75	SP	27.1	576.8	
9-1	118	75	ST	6.	28.3	
9-1	118	75	ST	25.	490.9	
9-1	118	75	AG	8.5	56.7	
9-1	119	85	LR	14.9	174.4	LTsw2
9-1	119	85	LR	14.6	167.4	
9-1	119	85	LR	11.5	103.9	
9-1	119	85	LR	10.4	84.9	
9-1	119	85	LR	16.4	211.2	
9-1	119	85	LR	16.2	206.1	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	119	85	LR	17.6	243.3	
9-1	119	85	LR	9.	63.6	
9-1	119	85	LR	20.7	336.5	
9-1	119	85	LR	16.6	216.4	
9-1	119	85	LR	19.9	311.0	
9-1	119	85	LR	15.4	186.3	
9-1	119	85	LR	19.4	295.6	
9-1	119	85	LR	5.9	27.3	
9-1	119	85	LR	5.1	20.4	
9-1	119	85	LR	10.3	83.3	
9-1	119	85	SP	22.1	383.6	
9-1	119	85	SP	23.9	448.6	
9-1	119	85	SP	23.4	430.1	
9-1	119	85	AG	14.8	172.0	
9-1	119	85	DEAD SP	21.9	376.7	
9-1	120	95	LR	13.5	143.1	LTsw2
9-1	120	95	LR	14.1	156.1	
9-1	120	95	LR	9.5	70.9	
9-1	120	95	LR	20.9	343.1	
9-1	120	95	LR	14.2	158.4	
9-1	120	95	LR	11.6	105.7	
9-1	120	95	LR	14.3	160.6	
9-1	120	95	LR	17.5	240.5	
9-1	120	95	LR	21.9	376.7	
9-1	120	95	LR	24.3	463.8	
9-1	120	95	LR	14.7	169.7	
9-1	120	95	LR	7.6	45.4	
9-1	120	95	LR	15.1	179.1	
9-1	120	95	LR	8.4	55.4	
9-1	120	95	LR	10.9	93.3	
9-1	120	95	LR	13.7	147.4	
9-1	120	95	LR	7.6	45.4	
9-1	120	95	LR	10.3	83.3	
9-1	120	95	LR	11.6	105.7	
9-1	120	95	SP	24.2	460.0	
9-1	120	95	AG	5.4	22.9	
9-1	120	95	AG	8.9	62.2	
9-1	120	95	DEAD SP	26.	530.9	
9-1	120	95	DEAD SP	29.1	665.1	
9-1	120	95	DEAD TD	41.3	1339.6	
9-1	120	95	ST	6.5	33.2	
9-1	120	95	ST	8.4	55.4	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	120	95	ST	6.2	30.2	
9-1	120	95	LR	14.8	172.0	
9-1	120	95	LR	6.7	35.3	
9-1	120	95	LR	15.5	188.7	
9-1	120	95	LR	14.8	172.0	
9-1	121	105	LR	20.	314.2	LTsw2
9-1	121	105	LR	6.3	31.2	
9-1	121	105	LR	21.4	359.7	
9-1	121	105	LR	18.7	274.6	
9-1	121	105	LR	11.1	96.8	
9-1	121	105	LR	18.	254.5	
9-1	121	105	LR	7.5	44.2	
9-1	121	105	LR	25.	490.9	
9-1	121	105	LR	21.8	373.3	
9-1	121	105	LR	11.	95.0	
9-1	121	105	LR	9.1	65.0	
9-1	121	105	LR	19.4	295.6	
9-1	121	105	LR	6.9	37.4	
9-1	121	105	LR	10.6	88.2	
9-1	121	105	LR	6.9	37.4	
9-1	121	105	LR	5.5	23.8	
9-1	121	105	LR	18.6	271.7	
9-1	121	105	SP	28.8	651.4	
9-1	121	105	AG	5.4	22.9	
9-1	121	105	AG	7.8	47.8	
9-1	121	105	DEAD SP	30.1	711.6	
9-1	121	105	DEAD TD	69.1	3750.1	
9-1	121	105	ST	10.3	83.3	
9-1	121	105	ST	6.2	30.2	
9-1	121	105	LR	5.2	21.2	
9-1	121	105	LR	17.1	229.7	
9-1	121	105	LR	15.3	183.9	
9-1	121	105	LR	7.6	45.4	
9-1	121	105	RM	6.1	29.2	
9-1	122	115	LR	12.	113.1	LTsw2
9-1	122	115	LR	7.	38.5	
9-1	122	115	LR	13.4	141.0	
9-1	122	115	LR	16.8	221.7	
9-1	122	115	LR	20.	314.2	
9-1	122	115	LR	11.8	109.4	
9-1	122	115	LR	23.2	422.7	
9-1	122	115	LR	19.8	307.9	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	122	115	LR	20.2	320.5	
9-1	122	115	LR	6.5	33.2	
9-1	122	115	LR	6.1	29.2	
9-1	122	115	LR	7.5	44.2	
9-1	122	115	LR	8.1	51.5	
9-1	122	115	LR	16.8	221.7	
9-1	122	115	LR	9.6	72.4	
9-1	122	115	LR	25.5	510.7	
9-1	122	115	AG	8.6	58.1	
9-1	122	115	DEAD SP	24.6	475.3	
9-1	122	115	ST	6.2	30.2	
9-1	122	115	LR	10.	78.5	
9-1	122	115	LR	10.2	81.7	
9-1	123	125	LR	17.4	237.8	LTsw2
9-1	123	125	LR	14.3	160.6	
9-1	123	125	LR	20.7	336.5	
9-1	123	125	LR	17.2	232.4	
9-1	123	125	LR	14.1	156.1	
9-1	123	125	LR	20.4	326.9	
9-1	123	125	LR	17.4	237.8	
9-1	123	125	LR	7.8	47.8	
9-1	123	125	LR	42.2	1398.7	
9-1	123	125	LR	16.3	208.7	
9-1	123	125	LR	12.4	120.8	
9-1	123	125	LR	7.6	45.4	
9-1	123	125	LR	15.4	186.3	
9-1	123	125	FA	5.7	25.5	
9-1	123	125	DEAD SP	23.6	437.4	
9-1	123	125	ST	5.6	24.6	
9-1	123	125	DEAD TD	71.5	4015.2	
9-1	123	125	DEAD TD	37.4	1098.6	
9-1	123	125	DEAD TD	91.5	6575.5	
9-1	124	135	LR	6.3	31.2	LTsw2
9-1	124	135	LR	17.2	232.4	
9-1	124	135	LR	16.8	221.7	
9-1	124	135	LR	21.5	363.1	
9-1	124	135	LR	14.3	160.6	
9-1	124	135	LR	22.1	383.6	
9-1	124	135	LR	14.7	169.7	
9-1	124	135	LR	8.5	56.7	
9-1	124	135	LR	12.2	116.9	
9-1	124	135	LR	29.4	678.9	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	124	135	LR	12.7	126.7	
9-1	124	135	LR	17.	227.0	
9-1	124	135	LR	10.6	88.2	
9-1	124	135	LR	17.5	240.5	
9-1	124	135	LR	15.7	193.6	
9-1	124	135	LR	13.8	149.6	
9-1	124	135	ST	11.	95.0	
9-1	124	135	ST	5.7	25.5	
9-1	124	135	ST	11.	95.0	
9-1	124	135	RM	9.6	72.4	
9-1	124	135	DEAD LR	10.3	83.3	
9-1	125	145	LR	12.9	130.7	LTsw2
9-1	125	145	LR	8.6	58.1	
9-1	125	145	LR	15.2	181.5	
9-1	125	145	LR	5.9	27.3	
9-1	125	145	LR	20.	314.2	
9-1	125	145	LR	17.	227.0	
9-1	125	145	LR	22.6	401.1	
9-1	125	145	LR	14.5	165.1	
9-1	125	145	LR	8.8	60.8	
9-1	125	145	LR	10.5	86.6	
9-1	125	145	LR	9.8	75.4	
9-1	125	145	LR	17.2	232.4	
9-1	125	145	LR	13.2	136.8	
9-1	125	145	LR	17.8	248.8	
9-1	125	145	LR	15.6	191.1	
9-1	125	145	DEAD SP	24.5	471.4	
9-1	125	145	DEAD TD	64.0	3217.0	
9-1	125	145	DEAD TD	86.5	5876.5	
9-1	125	145	RM	7.8	47.8	
9-1	125	145	RM	6.3	31.2	
9-1	125	145	RM	8.8	60.8	
9-1	126	155	LR	17.	227.0	LTsw2
9-1	126	155	LR	14.3	160.6	
9-1	126	155	LR	19.	283.5	
9-1	126	155	LR	5.2	21.2	
9-1	126	155	LR	11.3	100.3	
9-1	126	155	LR	22.6	401.1	
9-1	126	155	LR	15.1	179.1	
9-1	126	155	LR	10.5	86.6	
9-1	126	155	LR	12.8	128.7	
9-1	126	155	LR	18.2	260.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	126	155	LR	11.1	96.8	
9-1	126	155	LR	13.1	134.8	
9-1	126	155	LR	13.3	138.9	
9-1	126	155	RM	9.4	69.4	
9-1	126	155	RM	7.5	44.2	
9-1	126	155	RM	5.4	22.9	
9-1	126	155	RM	7.2	40.7	
9-1	126	155	RM	9.1	65.0	
9-1	127	165	RM	6.7	35.3	LTsw1
9-1	127	165	RM	5.9	27.3	
9-1	127	165	RM	5.3	22.1	
9-1	127	165	RM	6.7	35.3	
9-1	127	165	RM	7.9	49.0	
9-1	127	165	RM	8.9	62.2	
9-1	127	165	RM	6.4	32.2	
9-1	127	165	RM	8.5	56.7	
9-1	127	165	RM	6.8	36.3	
9-1	127	165	RM	5.9	27.3	
9-1	127	165	RM	7.3	41.9	
9-1	127	165	RM	8.2	52.8	
9-1	127	165	RM	17.2	232.4	
9-1	127	165	RM	6.4	32.2	
9-1	127	165	RM	7.7	46.6	
9-1	127	165	RM	7.5	44.2	
9-1	127	165	RM	7.4	43.0	
9-1	127	165	RM	6.1	29.2	
9-1	127	165	RM	13.	132.7	
9-1	127	165	RM	7.7	46.6	
9-1	127	165	RM	5.5	23.8	
9-1	127	165	RM	6.4	32.2	
9-1	127	165	RM	7.1	39.6	
9-1	127	165	RM	9.1	65.0	
9-1	127	165	LR	18.5	268.8	
9-1	127	165	LR	21.4	359.7	
9-1	127	165	LR	15.1	179.1	
9-1	127	165	LR	6.8	36.3	
9-1	127	165	LR	8.5	56.7	
9-1	127	165	LR	21.8	373.3	
9-1	127	165	LR	18.2	260.2	
9-1	127	165	LR	8.1	51.5	
9-1	127	165	SP	27.2	581.1	
9-1	127	165	DEAD TD	101.9	8155.3	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	127	165	DEAD TD	111.4	9746.8	
9-1	127	165	DEAD TD	57.	2551.8	
9-1	127	165	AG	6.8	36.3	
9-1	128	175	RM	7.9	49.0	LTsw1
9-1	128	175	RM	7.	38.5	
9-1	128	175	RM	8.1	51.5	
9-1	128	175	RM	6.9	37.4	
9-1	128	175	RM	7.2	40.7	
9-1	128	175	RM	7.4	43.0	
9-1	128	175	RM	9.8	75.4	
9-1	128	175	RM	7.7	46.6	
9-1	128	175	RM	5.4	22.9	
9-1	128	175	RM	5.5	23.8	
9-1	128	175	RM	8.5	56.7	
9-1	128	175	RM	7.7	46.6	
9-1	128	175	RM	6.5	33.2	
9-1	128	175	RM	8.1	51.5	
9-1	128	175	RM	5.2	21.2	
9-1	128	175	RM	8.2	52.8	
9-1	128	175	RM	7.7	46.6	
9-1	128	175	RM	7.	38.5	
9-1	128	175	RM	6.3	31.2	
9-1	128	175	RM	11.6	105.7	
9-1	128	175	RM	5.9	27.3	
9-1	128	175	LR	26.3	543.3	
9-1	128	175	LR	15.3	183.9	
9-1	128	175	LR	23.3	426.4	
9-1	129	185	RM	5.	19.6	LTsw1
9-1	129	185	RM	8.1	51.5	
9-1	129	185	RM	7.2	40.7	
9-1	129	185	RM	6.2	30.2	
9-1	129	185	RM	9.4	69.4	
9-1	129	185	RM	7.1	39.6	
9-1	129	185	RM	7.9	49.0	
9-1	129	185	RM	8.8	60.8	
9-1	129	185	RM	5.8	26.4	
9-1	129	185	RM	6.2	30.2	
9-1	129	185	RM	5.9	27.3	
9-1	129	185	RM	5.3	22.1	
9-1	129	185	RM	6.4	32.2	
9-1	129	185	RM	5.3	22.1	
9-1	129	185	RM	6.1	29.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
9-1	129	185	LR	29.	660.5	
9-1	129	185	LR	5.1	20.4	
9-1	130	195	RM	9.3	67.9	
9-1	130	195	RM	6.3	31.2	LTsw1
9-1	130	195	RM	6.3	31.2	
9-1	130	195	RM	8.4	55.4	
9-1	130	195	RM	7.	38.5	
9-1	130	195	RM	5.	19.6	
9-1	130	195	RM	9.8	75.4	
9-1	130	195	RM	5.9	27.3	
9-1	130	195	RM	8.	50.3	
9-1	130	195	RM	5.7	25.5	
9-1	130	195	RM	17.5	240.5	
9-1	130	195	RM	9.3	67.9	
9-1	130	195	RM	5.9	27.3	
9-1	130	195	RM	7.7	46.6	
9-1	130	195	RM	8.1	51.5	
9-1	130	195	RM	6.7	35.3	
9-1	130	195	RM	6.1	29.2	
9-1	130	195	RM	5.5	23.8	
9-1	130	195	RM	5.4	22.9	
9-1	130	195	RM	11.	95.0	
9-1	130	195	RM	8.1	51.5	
9-1	130	195	RM	7.	38.5	
9-1	130	195	RM	8.4	55.4	
9-1	130	195	DEAD SP	20.6	333.3	
9-1	130	195	DEAD SP	23.9	448.6	
9-1	130	195	LR	8.6	58.1	
10-1	131	5	AR	6.7	35.3	HH/Marsh
10-1	131	5	MC	6.2	30.2	
10-1	132	15	MC	6.0	28.3	Marsh
10-1	132	15	MC	5.3	22.1	
10-1	133	25	MC	5.3	22.1	UTsw2
10-1	133	25	MC	6.	28.3	
10-1	133	25	AG	5.8	26.4	
10-1	133	25	AG	6.2	30.2	
10-1	133	25	AG	18.1	257.3	
10-1	133	25	AG	7.1	39.6	
10-1	133	25	AG	13.6	145.3	
10-1	133	25	AG	25.8	522.8	
10-1	133	25	AG	5.2	21.2	
10-1	133	25	AG	6.1	29.2	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
10-1	133	25	IC	7.1	39.6	
10-1	133	25	TD	21.8	373.3	
10-1	133	25	ST	8.6	58.1	
10-1	133	25	ST	7.	38.5	
10-1	133	25	ST	5.7	25.5	
10-1	133	25	AG	17.7	246.1	
10-1	133	25	AG	14.9	174.4	
10-1	134	35	MC	5.4	22.9	UTMix
10-1	134	35	MC	6.4	32.2	
10-1	134	35	MC	6.6	34.2	
10-1	134	35	AG	5.7	25.5	
10-1	134	35	AG	5.8	26.4	
10-1	134	35	AG	14.1	156.1	
10-1	134	35	AG	7.8	47.8	
10-1	134	35	AG	7.8	47.8	
10-1	134	35	AG	9.9	77.0	
10-1	134	35	AG	5.5	23.8	
10-1	134	35	AG	5.7	25.5	
10-1	134	35	AG	5.4	22.9	
10-1	134	35	PE	5.4	22.9	
10-1	134	35	SP	28.5	637.9	
10-1	134	35	SP	33.7	892.0	
10-1	134	35	SP	23.	415.5	
10-1	134	35	SP	29.5	683.5	
10-1	134	35	SP	29.4	678.9	
10-1	135	45	SP	21.7	369.8	HH
10-1	135	45	SP	24.5	471.4	
10-1	135	45	SP	30.5	730.6	
10-1	135	45	SP	30.9	749.9	
10-1	135	45	PB	8.8	60.8	
10-1	135	45	ST	8.2	52.8	
10-1	135	45	IC	7.5	44.2	
10-1	135	45	SP	25.3	502.7	
10-1	135	45	SP	25.8	522.8	
10-1	135	45	SP	31.9	799.2	
10-1	135	45	SP	24.9	487.0	
10-1	135	45	MC	5.8	26.4	
10-1	135	45	MC	5.5	23.8	
10-1	135	45	MC	7.3	41.9	
10-1	135	45	MC	14.2	158.4	
10-1	135	45	MC	9.7	73.9	
10-1	135	45	MC	5.3	22.1	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
10-1	135	45	PC	5.9	27.3	
10-1	135	45	QL	37.9	1128.2	
10-1	135	45	SP	27.	572.6	
10-1	135	45	SP	42.5	1418.6	
10-1	136	55	SP	31.7	789.2	UTMix
10-1	136	55	SP	28.7	646.9	
10-1	136	55	SP	19.5	298.6	
10-1	136	55	SP	33.5	881.4	
10-1	136	55	ST	6.2	30.2	
10-1	136	55	SP	28.4	633.5	
10-1	136	55	AG	14.6	167.4	
10-1	136	55	AG	22.5	397.6	
10-1	136	55	AG	14.4	162.9	
10-1	136	55	AG	6.2	30.2	
10-1	136	55	AG	13.2	136.8	
10-1	136	55	AG	10.5	86.6	
10-1	136	55	AG	9.4	69.4	
10-1	137	65	SP	29.4	678.9	UTMix
10-1	137	65	SP	32.	804.2	
10-1	137	65	SP	31.7	789.2	
10-1	137	65	SP	25.2	498.8	
10-1	137	65	SP	24.1	456.2	
10-1	137	65	SP	19.4	295.6	
10-1	137	65	SP	29.6	688.1	
10-1	137	65	SP	25.5	510.7	
10-1	137	65	MC	5.8	26.4	
10-1	137	65	MC	5.4	22.9	
10-1	137	65	MC	5.3	22.1	
10-1	137	65	SP	27.9	611.4	
10-1	137	65	AG	16.4	211.2	
10-1	137	65	AG	6.9	37.4	
10-1	137	65	AG	5.	19.6	
10-1	137	65	AG	6.5	33.2	
10-1	137	65	AG	8.4	55.4	
10-1	138	75	SP	25.3	502.7	UTMix
10-1	138	75	SP	30.9	749.9	
10-1	138	75	SP	29.1	665.1	
10-1	138	75	ST	11.2	98.5	
10-1	138	75	ST	8.2	52.8	
10-1	138	75	SP	33.8	897.3	
10-1	138	75	SP	25.8	522.8	
10-1	138	75	MC	7.8	47.8	

Transect No.	Plot No.	Distance	Tree Sp.	dbh	Basal Area	Forest Type
10-1	138	75	MC	6.	28.3	
10-1	138	75	SP	25.3	502.7	
10-1	138	75	LR	8.2	52.8	
10-1	138	75	LR	7.6	45.4	
10-1	138	75	LR	6.3	31.2	
10-1	138	75	LR	5.1	20.4	
10-1	138	75	LR	7.2	40.7	
10-1	138	75	LR	5.9	27.3	

Table E-3: Shrub species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
FERNS			
Blechnaceae			
Blechnum serrulatum	Native	FACW	
Nephrolepidaceae			
Nephrolepis exaltata	Native	FACU	
Osmundaceae			
Osmunda cinnamomea	Native	FACW	Commercially Exploited
Osmunda regalis	Native	OBL	Commercially Exploited
Pteridaceae			
Acrostichum danaeifolium	Native	OBL	
Schizaeaceae			
Lygodium microphyllum	Non-Native	--	EPPC-I
Thelypteridaceae			
Thelypteris interrupta	Native	FAC	
Thelypteris palustris	Native	FACW	
Thelypteris serrata	Native	FACW	Endangered
MONOCOTS			
Arecaceae			
Sabal palmetto	Native	FAC	
Serenoa repens	Native	FACU	
Cyperaceae			
Cladium jamaicense	Native	OBL	
Poaceae			
Tripsacum dactyloides	Native	FAC	
Typhaceae			
Typha domingensis	Native	OBL	

Table E-3: Shrub species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
DICOTS			
Anacardiaceae			
Schinus terebinthifolius	Non-Native	FAC	EPPC-I
Toxicodendron radicans	Native	FAC	
Annonaceae			
Annona glabra	Native	OBL	
Apocynaceae			
Rhabdadenia biflora	Native	FACW	
Aquifoliaceae			
Ilex cassine	Native	FACW	
Asteraceae			
Baccharis halimifolia	Native	FAC	
Pluchea odorata	Native	FACW	
Chrysobalanaceae			
Chrysobalanus icaco	Native	FACW	
Combretaceae			
Laguncularia racemosa	Native	FACW	
Convolvulaceae			
Ipomoea indica	Native	FAC	
Ericaceae			
Lyonia fruticosa	Native	FAC	
Fabaceae			
Amorpha fruiticosa	Native	FACW	
Fagaceae			
Quercus laurifolia	Native	FACW	
Quercus virginiana	Native	FACU	
Iteaceae			
Itea virginica	Native	FACW	

Table E-3: Shrub species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Lamiaceae			
Callicarpa americana	Native	FACU	
Lauraceae			
Persea borbonia	Native	FACW	
Malvaceae			
Urena lobata	Non-Native	FAC	EPPC-I
Moraceae			
Ficus microcarpa	Non-Native	--	EPPC-I
Myricaceae			
Myrica cerifera	Native	FAC	
Myrsinaceae			
Ardisia escalloniodes	Native	FAC	
Rapanea punctata	Native	FAC	
Myrtaceae			
Psidium cattleianum	Non-Native	FAC	EPPC-I
Syzygium cumini	Non-Native	FAC	EPPC-I
Oleaceae			
Fraxinus caroliniana	Native	OBL	
Rhizophoraceae			
Rhizophora mangle	Native	OBL	
Rubiaceae			
Cephalanthus occidentalis	Native	OBL	
Psychotria nervosa	Native	FAC	
Psychotria sulzneri	Native	FAC	
Sapindaceae			
Acer rubrum	Native	FACW	
Urticaceae			
Boehmeria cylindrica	Native	OBL	

Table E-3: Shrub species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Vitaceae			
Vitis rotundifolia	Native	FAC	

Table E-4: Groundcover species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
FERNS			
Blechnaceae			
Blechnum serrulatum	Native	FACW	
Nephrolepidaceae			
Nephrolepis exaltata	Native	FACU	
Osmundaceae			
Osmunda cinnamomea	Native	FACW	Commercially Exploited
Osmunda regalis	Native	OBL	Commercially Exploited
Polypoidiaceae			
Pleopeltis polypoioides	Native	--	
Psilotaceae			
Psilotum nudum	Native	FACW	
Pteridaceae			
Acrostichum danaeifolium	Native	OBL	
Schizaeaceae			
Lygodium microphyllum	Non-Native	--	EPPC-I
Thelypteridaceae			
Thelypteris dentata	Non-Native	FACW	
Thelypteris interrupta	Native	FAC	
Thelypteris kunthii	Native	FACW	
Thelypteris palustris	Native	FACW	
Thelypteris serrata	Native	FACW	Endangered

Table E-4: Groundcover species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
GYMNOSPERMS			
Cupressaceae			
Taxodium distichum	Native	OBL	
MONOCOTS			
Alismataceae			
Sagittaria latifolia	Native	OBL	
Amaryllidaceae			
Crinum americanum	Native	OBL	
Araceae			
Colocasia esculenta	Non-Native	FACW	EPPC-I
Syngonium podophyllum	Non-Native	--	EPPC-I
Arecaceae			
Sabal palmetto	Native	FAC	
Serenoa repens	Native	FACU	
Bromeliaceae			
Tillandsia fasciculata	Native	--	Endangered
Tillandsia setacea	Native	--	
Cannaceae			
Canna flaccida	Native	OBL	
Commelinaceae			
Commelina diffusa	Native	FACW	
Cyperaceae			
Carex lupuliformis	Native	OBL	
Cladium jamaicense	Native	OBL	
Cyperus haspan	Native	OBL	
Cyperus ligularis	Native	FACW	
Cyperus retrorsus	Native	FACU	

Table E-4: Groundcover species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Eleocharis baldwinii	Native	FACW	
Rhynchospora inundata	Native	OBL	
Rhynchospora rariflora	Native	OBL	
Poaceae			
Dichanthelium commutatum	Native	FAC	
Panicum rigidulum	Native	FACW	
Panicum virgatum	Native	FAC	
Tripsacum dactyloides	Native	FAC	
Smilaceae			
Smilax bona-nox	Native	FAC	
Typhaceae			
Typha domingensis	Native	OBL	
Xyridaceae			
Xyris spp.	Native	OBL	
DICOTS			
Acanthaceae			
Hygrophila polysperma	Non-Native	OBL	EPPC-I
Amaranthaceae			
Alternanthera philoxeroides	Non-Native	OBL	EPPC-II
Alternanthera sessila	Non-Native	FACU	
Anacardiaceae			
Schinus terebinthifolius	Non-Native	FAC	EPPC-I
Toxicodendron radicans	Native	FAC	
Annonaceae			
Annona glabra	Native	OBL	

Table E-4: Groundcover species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Apocynaceae			
Rhabdadenia biflora	Native	FACW	
Sarcostemma clausum	Native	FACW	
Aquifoliaceae			
Ilex cassine	Native	FACW	
Ilex glabra	Native	FACW	
Araliaceae			
Hydrocotyle spp.	Native	OBL	
Asteraceae			
Baccharis glomeruliflora	Native	FACW	
Baccharis halimifolia	Native	FAC	
Bidens alba	Native	FACW	
Chromolaena odorata	Native	--	
Erechites hieracifolia	Native	FAC	
Melanthera nivea	Native	FACU	
Mikania scandens	Native	FACW	
Pluchea odorata	Native	FACW	
Sphagneticola trilobata	Non-Native	FAC	EPPC-II
Chrysobalanaceae			
Chrysobalanus icaco	Native	FACW	
Clusiaceae			
Hypericum spp.	Native	--	
Combretaceae			
Laguncularia racemosa	Native	FACW	
Convolvulaceae			
Ipomoea indica	Native	FAC	
Ericaceae			

Table E-4: Groundcover species by family with native, wetland, and endangered status designations.

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Bejaria racemosa	Native	FAC	
Lyonia fruticosa	Native	FAC	
Lyonia lucida	Native	FACW	
Euphorbiaceae			
Bischofia javanica	Non-Native	--	EPPC-I
Fabaceae			
Abrus precatorius	Non-Native	--	EPPC-I
Amorpha fruiticosa	Native	FACW	
Apios americana	Native	FACW	
Chamaecrista fasciculata	Native	FACU	
Dalbergia ecastaphyllum	Native	FACW	
Desmodium triflorum	Non-Native	FACU	
Galactia spp.,			
Mimosa quadrivalvis	Native	--	
Senna pendula	Non-Native	FAC	EPPC-I
Fagaceae			
Quercus laurifolia	Native	FACW	
Quercus myrtifolia	Native	--	
Quercus virginiana	Native	FACU	
Iteaceae			
Itea virginica	Native	FACW	
Juglandaceae			
Carya aquatica	Native	OBL	
Lamiaceae			
Callicarpa americana	Native	FACU	
Hyptis alata	Native	OBL	
Lauraceae			

Table E-4: **Groundcover species by family with native, wetland, and endangered status designations.**

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Persea borbonia	Native	FACW	
Loganiaceae			
Mitreola petiolata	Native	FACW	
Malvaceae			
Sida acuta	Native	--	
Urena lobata	Non-Native	FAC	EPPC-II
Moraceae			
Ficus microcarpa	Non-Native		EPPC-I
Morus rubra	Native	FAC	
Myricaceae			
Myrica cerifera	Native	FAC	
Myrsinaceae			
Ardisia escalloniodes	Native	FAC	
Rapanea punctata	Native	FAC	
Myraceae			
Syzgium cumini	Non-Native	FAC	EPPC-I
Myrtaceae			
Psidium cattleianum	Non-Native	FAC	EPPC-I
Syzygium cumini	Non-Native	FAC	EPPC-I
Oleaceae			
Fraxinus caroliniana	Native	OBL	
Onagraceae			
Ludwigia octovalvis	Native	OBL	
Ludwigia peruviana	Non-Native	OBL	
Ludwigia repens	Native	OBL	
Polygonaceae			
Polygonum hydropiperoides	Native	OBL	

Table E-4: **Groundcover species by family with native, wetland, and endangered status designations.**

Scientific Name	Native/ Non-native	Wetland Status	Endangered/ Invasive Status
Pologonum punctatum	Native	FACW	
Primulaceae			
Samolus valerandi	Native	OBL	
Rhizophoraceae			
Rhizophora mangle	Native	OBL	
Rosaceae			
Rubus trivialis	Native	FAC	
Rubiaceae			
Cephalanthus occidentalis	Native	OBL	
Psychotria nervosa	Native	FAC	
Psychotria sulzneri	Native	FAC	
Salicaceae			
Salix caroliniana	Native	OBL	
Sapindaceae			
Acer rubrum	Native	FACW	
Saururaceae			
Saururus cernuus	Native	OBL	
Urticaceae			
Boehmeria cylindrica	Native	OBL	
Veronicaceae			
Bacopa monnieri	Native	OBL	
Limnophila sessiliflora	Non-Native	OBL	EPPC-II
Micranthemum glomeratum	Native	OBL	Endemic
Vitaceae			
Parthenocissus quinquefolia	Native	FAC	
Vitis rotundifolia	Native	FAC	

Table E- 5. 2003 Shrub Data

Transect No.	Plot No.	Distance	Species Code[a]	Cover (cm)	Forest Type
1-1	1	5	SABPAL	14	MHam
1-1	1	5	SABPAL	6	
1-1	1	5	BLESER	15	
1-1	1	5	BLESER	21	
1-1	2	15	SABPAL	85	MHam
1-1	2	15	SABPAL	250	
1-1	2	15	CALAME	120	
1-1	3	25	SABPAL	60	HHam / Upla
1-1	3	25	SABPAL	51	
1-1	4	35	BLESER	170	HHam
1-1	4	35	CALAME	84	
1-1	4	35	CALAME	56	
1-1	4	35	PSYNER	90	
1-1	4	35	ARDESC	12	
1-1	5	45	--	--	Rsw1
1-1	6	55	--	--	Rsw1
1-1	7	65	--	--	Rsw1
1-1	8	75	ACRDAN	60	Rsw1
1-1	9	85	ACRDAN	57	Rsw1
1-1	9	85	ACRDAN	59	
1-1	9	85	ACRDAN	21	
1-1	9	85	ANNGLA	77	
1-2	10	5	THEINT	45	Rblh1
1-2	10	5	THEINT	38	
1-2	10	5	CEPOCC	125	
1-2	10	5	ANNGLA	25	
1-2	11	15	THEINT	100	Rsw1
1-2	11	15	ACRDAN	33	
1-2	11	15	ACRDAN	55	
1-2	11	15	ACRDAN	25	
1-2	12	25	ACRDAN	27	Rsw1
1-2	12	25	ACRDAN	6	
1-2	12	25	ACRDAN	58	
1-2	12	25	ACRDAN	44	
1-2	12	25	ACRDAN	5	
1-2	13	35			Rsw1
1-2	14	45			Rsw1
1-2	15	55	ARDESC	50	HHam

Transect No.	Plot No.	Distance	Species Code[a]	Cover (cm)	Forest Type
1-2	15	55	BLESER	63	
1-2	15	55	IPOIND	17	
2-1	16	5	CEPOCC	50	Rblh1
2-1	16	5	ACERUB	53	
2-1	17	15			Rsw1
2-1	18	25	ACRDAN	4	HHam / Rsw1
2-1	18	25	ACRDAN	66	
2-1	18	25	ACRDAN	47	
2-1	18	25	ACRDAN	26	
2-1	18	25	ACRDAN	37	
2-1	18	25	ACRDAN	21	
2-1	18	25	THESER	3	
2-1	18	25	THESER	33	
2-1	18	25	ACRDAN	27	
2-1	18	25	ACRDAN	34	
2-1	18	25	ACRDAN	52	
2-1	19	35	ACRDAN	162	Rsw1
2-1	19	35	ACRDAN	6	
2-1	19	35	ACRDAN	40	
2-1	19	35	ACRDAN	46	
2-1	19	35	ITEVIR	45	
2-1	19	35	THEINT	6	
2-1	20	45	BLESER	9	HHam / Rsw1
2-1	20	45	BLESER	15	
2-1	20	45	BLESER	34	
2-1	20	45	ITEVIR	66	
2-1	20	45	ITEVIR	20	
2-1	20	45	ITEVIR	20	
2-1	20	45	ITEVIR	51	
2-1	20	45	ITEVIR	80	
2-1	20	45	ITEVIR	78	
2-1	21	55	ARDESC	170	HHam
2-1	21	55	ARDESC	130	
2-1	21	55	ARDESC	148	
2-1	22	65	ARDESC	30	HHam
2-1	22	65	ARDESC	127	
2-2	23	5	SERREP	301	MHam
2-2	23	5	SERREP	71	
2-2	23	5	CALAME	38	
2-2	23	5	SABPAL	105	
2-2	24	15	CALAME	67	MHam

Transect No.	Plot No.	Distance	Species Code[a]	Cover (cm)	Forest Type
2-2	24	15	CALAME	28	
2-2	24	15	URELOB	20	
2-2	24	15	URELOB	30	
2-2	24	15	URELOB	38	
2-2	24	15	BLESER	32	
2-2	25	25	CALAME	20	MHam
2-2	25	25	ARDESC	114	
2-2	25	25	CHRICA	174	
2-2	26	35			HHam / Rsw1
2-2	27	45	THESER	17	Rsw1
2-2	27	45	ITEVIR	80	
2-2	27	45	ITEVIR	28	
2-2	28	55	ITEVIR	317	Rsw1
2-2	28	55	ACRDAN	65	
3-1	29	5	PSYNER	74	Rblh2
3-1	29	5	PSYNER	38	
3-1	29	5	PSYNER	16	
3-1	29	5	PSYNER	41	
3-1	29	5	RAPPUN	79	
3-1	29	5	RAPPUN	117	
3-1	29	5	RAPPUN	29	
3-1	29	5	RAPPUN	46	
3-1	29	5	PSYNER	18	
3-1	29	5	BLESER	26	
3-1	30	15			Rblh3
3-1	31	25	ACRDAN	40	Rsw2
3-1	31	25	ACRDAN	51	
3-1	31	25	ACRDAN	28	
3-1	31	25	ACRDAN	19	
3-1	32	35	ACRDAN	25	Rsw2
3-1	33	45	ACRDAN	183	Rsw1
3-1	33	45	VITROT	70	
3-1	33	45	PSYSUL	134	
3-1	33	45	PSYSUL	52	
3-1	33	45	THEINT	24	
3-1	33	45	THEINT	24	
3-1	33	45	THESER	10	
3-1	34	55	THESER	26	Rsw2
3-1	34	55	THESER	45	
3-1	35	65	ACRDAN	122	Rsw2
3-1	35	65	THEINT	26	

Transect No.	Plot No.	Distance	Species Code[a]	Cover (cm)	Forest Type
3-1	36	75			Rsw1
3-1	37	85			Rsw2
3-1	38	95	ACRDAN	226	Rsw2
3-1	38	95	ACRDAN	426	
3-1	38	95	THESER	44	
3-1	38	95	THESER	20	
3-1	38	95	THEINT	24	
3-1	38	95	THEINT	10	
3-1	38	95	CEPOCC	128	
3-1	39	105	THESER	18	Rsw2
3-1	39	105	THESER	25	
3-1	39	105	THESER	29	
3-1	39	105	THESER	5	
3-1	39	105	THEINT	13	
3-2	40	5	TRIDAC	210	UPLA / HHam
3-2	40	5	TRIDAC	44	
3-2	40	5	TRIDAC	20	
3-2	41	15	URELOB	20	Rblh2
3-2	41	15	URELOB	10	
4-1	42	5	SERREP	85	MHam
4-1	42	5	SERREP	214	
4-1	42	5	SERREP	7	
4-1	42	5	SERREP	14	
4-1	42	5	SERREP	2	
4-1	42	5	SERREP	145	
4-1	42	5	SERREP	8	
4-1	43	15	ANNGLA	0.5	Rsw1
4-1	43	15	ANNGLA	18	
4-1	43	15	ANNGLA	15	
4-1	43	15	THEINT	20	
4-1	43	15	THEINT	10	
4-1	43	15	THEINT	16	
4-1	44	25	THEINT	26	Rsw1
4-1	44	25	THEINT	6	
4-1	44	25	THEINT	22	
4-1	44	25	ACRDAN	29	
4-1	44	25	ACRDAN	40	
4-1	44	25	ACERUB	128	
4-1	44	25	ITEVIR	47	
4-1	44	25	ITEVIR	.5	
4-1	44	25	ITEVIR	32	

Transect No.	Plot No.	Distance	Species Code[a]	Cover (cm)	Forest Type
4-1	45	35	ITEVIR	30	Rblh2
4-1	45	35	PSYNER	20	
4-1	45	35	BLESER	28	
4-1	46	45	FRACAR	86	Rsw1
4-1	46	45	ITEVIR	21	
4-1	46	45	ITEVIR	11	
4-1	46	45	ITEVIR	53	
4-1	46	45	ITEVIR	28	
4-1	46	45	ITEVIR	6	
4-1	46	45	THEINT	26	
4-1	46	45	THEINT	13	
4-1	46	45	THEINT	19	
4-1	46	45	THEINT	57	
4-1	46	45	THEINT	32	
4-1	46	45	ITEVIR	20	
4-1	46	45	ITEVIR	157	
4-1	46	45	ITEVIR	65	
4-1	46	45	THEINT	57	
4-1	46	45	THEINT	20	
4-1	47	55	ITEVIR	30	Rsw1
4-1	47	55	ITEVIR	166	
4-1	47	55	ACERUB	70	
4-1	47	55	CEPOCC	150	
4-1	47	55	CEPOCC	30	
4-1	47	55	ACRDAN	206	
4-1	48	65	FRACAR	120	Rsw1
4-1	48	65	ACRDAN	350	
4-1	49	75	ACERUB	40	Rblh2
4-1	49	75	ACRDAN	220	
4-1	49	75	ACRDAN	40	
4-1	49	75	ACRDAN	185	
4-1	49	75	ACRDAN	57	
4-1	50	85	BLESER	11	Rblh3
4-1	50	85	BLESER	10	
4-1	50	85	BLESER	22	
4-1	50	85	BLESER	33	
4-1	50	85	PSYNER	16	
4-1	50	85	BLESER	16	
4-1	50	85	BLESER	40	
4-1	50	85	BLESER	33	
4-1	50	85	THEINT	61	
4-1	51	95	BLESER	5	Rsw2

Transect No.	Plot No.	Distance	Species Code[a]	Cover (cm)	Forest Type
4-1	51	95	BLESER	36	
4-1	51	95	BLESER	17	
4-1	51	95	BLESER	44	
4-1	51	95	BLESER	23	
4-1	51	95	THEINT	25	
4-1	51	95	ITEVIR	44	
4-1	52	105	BLESER	17	Rsw1
4-1	52	105	ITEVIR	13	
4-1	53	115	THEINT	7	Rblh2
4-1	53	115	THEINT	28	
4-1	53	115	THESER	11	
4-1	53	115	SCHTER	12	
5-1	54	5	BLESER	22	MHam
5-1	54	5	BLESER	59	
5-1	54	5	SERREP	54	
5-1	54	5	SERREP	50	
5-1	54	5	SERREP	83	
5-1	54	5	SERREP	75	
5-1	55	15	BLESER	24	HH/Rblh3
5-1	55	15	SERREP	50	
5-1	55	15	SERREP	35	
5-1	55	15	SERREP	76	
5-1	55	15	PSYSUL	20	
5-1	55	15	PSYNER	50	
5-1	55	15	PSYNER	104	
5-1	55	15	ARDESC	20	
5-1	56	25	BLESER	4	Rblh3
5-1	56	25	BLESER	29	
5-1	57	35	BLESER	16	Rsw1
5-1	57	35	BLESER	10	
5-1	57	35	BLESER	30	
5-1	58	45	BLESER	18	Rsw1 /Rblh2
5-1	58	45	BLESER	13	
5-2	59	5	THEINT	29	Rblh1
5-2	60	15			Rsw1
5-2	61	25			Rsw1
5-2	62	35	BLESER	18	Rsw1
5-2	62	35	BLESER	10	
5-2	63	45	URELOB	83	Rblh2
5-2	63	45	UNISPP	65	
5-2	64	55	BLESER	62	Rblh2

5-2	64	55	BLESER	4	
5-2	64	55	BLESER	14	
5-2	65	65	BLESER	15	Rblh2
5-2	65	65	BLESER	15	
5-2	65	65	SABPAL	402	
5-2	66	75			Rblh2
5-2	67	85	QUELAU	80	Rblh2
5-2	67	85	ARDESC	32	
5-2	67	85	ARDESC	73	
5-2	67	85	SABPAL	200	
6-1	68	5	SERREP	180	Upla
6-1	68	5	SERREP	93	
6-1	68	5	SERREP	275	
6-1	68	5	SERREP	58	
6-1	68	5	QUEVIR	30	
6-1	69	15	PSICAT	600	Upla
6-1	69	15	BLESER	82	
6-1	69	15	BLESER	105	
6-1	69	15	THEPAL	12	
6-1	70	25	BLESER	5	Rsw1
6-1	70	25	ACRDAN	82	
6-1	70	25	CEPOCC	40	
6-1	70	25	AMOFRU	50	
6-1	71	35	ACRDAN	69	UTsw3
6-1	71	35	ACRDAN	25	
6-1	71	35	ACRDAN	37	
6-1	71	35	CEPOCC	13	
6-1	72	45	RHIMAN	13	UTsw3
6-1	72	45	RHIMAN	83	
6-1	72	45	RHIMAN	95	
6-1	72	45	CEPOCC	27	
6-1	72	45	CEPOCC	113	
6-1	72	45	CEPOCC	62	
6-1	72	45	CEPOCC	16	
6-1	72	45	OSMREG	73	
6-1	72	45	ACRDAN	95	
6-1	73	55	CEPOCC	28	UTsw3
6-1	73	55	ACRDAN	20	
6-1	73	55	ACRDAN	84	
6-1	73	55	LAGRAC	378	
6-1	73	55	LAGRAC	355	
6-1	73	55	ANNGLA	243	

6-1	74	65	ACRDAN	61	UTsw3
6-1	74	65	ACRDAN	42	
6-1	74	65	ACRDAN	59	
6-1	74	65	LAGRAC	113	
6-1	74	65	ANNGLA	95	
6-1	74	65	ANNGLA	29	
6-1	74	65	MYRCER	206	
6-1	74	65	MYRCER	185	
6-1	74	65	SCHTER	190	
6-1	74	65	SCHTER	147	
6-1	75	75	RHIMAN	81	UTsw3
6-1	75	75	RHIMAN	450	
6-1	75	75	RHIMAN	137	
6-1	75	75	LAGRAC	135	
6-1	75	75	SCHTER	128	
6-1	76	85	ACRDAN	84	UTmix
6-1	76	85	ACRDAN	30	
6-1	76	85	RHIMAN	824	
6-1	76	85	SCHTER	47	
6-1	77	95	ACRDAN	49	UTsw1
6-1	77	95	RHIMAN	340	
6-1	77	95	FRACAR	55	
6-1	78	105	ACRDAN	37	UTsw1
6-1	78	105	ACRDAN	15	
6-1	78	105	ACRDAN	8	
6-1	78	105	ACRDAN	43	
6-1	78	105	ACRDAN	25	
6-1	78	105	RHIMAN	182	
6-1	78	105	RHIMAN	345	
6-1	78	105	CEPOCC	32	
6-1	79	115	ACRDAN	46	UTsw1
6-1	79	115	RHIMAN	120	
6-1	79	115	RHIMAN	83	
6-1	79	115	RHIMAN	87	
6-1	79	115	MYRCER	170	
6-1	80	125	ANNGLA	295	UTsw1
6-1	80	125	ANNGLA	416	
6-1	80	125	ACRDAN	105	
6-1	80	125	ACRDAN	23	
6-1	80	125	ACRDAN	84	
6-1	80	125	ACRDAN	97	
6-2	81	5	ACRDAN	75	UTsw3
6-2	81	5	ACRDAN	34	

6-2	81	5	ACRDAN	167	
6-2	81	5	ACRDAN	30	
6-2	81	5	FRACAR	247	
6-2	81	5	ANNGLA	246	
6-2	81	5	ANNGLA	75	
6-2	81	5	ANNGLA	42	
6-2	82	15	ACRDAN	66	UTsw1
6-2	82	15	ACRDAN	100	
6-2	82	15	ACRDAN	186	
6-2	82	15	RAPPUN	55	
6-2	83	25	ACRDAN	54	UTsw1
6-2	83	25	ACRDAN	117	
6-2	83	25	ACRDAN	304	
7-1	84	5	BLESER	31	MHam / Rsw1
7-1	84	5	OSMCIN	28	
7-1	84	5	OSMCIN	27	
7-1	84	5	OSMCIN	121	
7-1	84	5	SERREP	149	
7-1	84	5	SERREP	395	
7-1	84	5	SERREP	13	
7-1	84	5	SERREP	96	
7-1	84	5	LYOFRU	25	
7-1	85	15	BLESER	22	Rsw1
7-1	85	15	CEPOCC	44	
7-1	85	15	CEPOCC	49	
7-1	85	15	CEPOCC	84	
7-1	85	15	ACRDAN	240	
7-1	85	15	ACRDAN	30	
7-1	85	15	ACRDAN	27	
7-1	85	15	MYRCER	149	
7-1	85	15	BACHAL	17	
7-1	85	15	AMOFRU	30	
7-1	86	25	BLESER	19	Rsw1
7-1	86	25	CEPOCC	80	
7-1	86	25	CEPOCC	65	
7-1	86	25	CEPOCC	153	
7-1	86	25	CEPOCC	54	
7-1	86	25	ACRDAN	277	
7-1	86	25	ACRDAN	22	
7-1	86	25	MYRCER	140	
7-1	86	25	SYZCUM	25	
7-1	86	25	OSMREG	82	
7-1	86	25	FRACAR	96	

7-1	86	25	SABPAL	24	
7-1	87	35	BLESER	44	Rmix
7-1	87	35	BLESER	15	
7-1	87	35	BLESER	11	
7-1	87	35	BLESER	20	
7-1	87	35	MYRCER	49	
7-1	87	35	BACHAL	33	
7-1	87	35	BACHAL	168	
7-1	87	35	OSMREG	17	
7-1	87	35	NEPEXA	202	
7-1	87	35	SCHTER	13	
7-1	87	35	RAPPUN	107	
7-1	87	35	FRACAR	79	
7-1	88	45	ACRDAN	42	Rmix
7-1	88	45	ACRDAN	64	
7-1	88	45	ACRDAN	53	
7-1	88	45	ACRDAN	52	
7-1	88	45	ACRDAN	180	
7-1	88	45	MYRCER	123	
7-1	88	45	BACHAL	98	
7-1	88	45	BACHAL	67	
7-1	88	45	AMOFRU	45	
7-1	88	45	AMOFRU	93	
7-1	88	45	ANNGLA	343	
7-1	88	45	ANNGLA	226	
7-1	88	45	CEPOCC	167	
7-1	88	45	SYZCUM	39	
7-1	89	55	ACRDAN	10	Rmix
7-1	89	55	ACRDAN	4	
7-1	89	55	ACRDAN	8	
7-1	89	55	MYRCER	22	
7-1	89	55	CEPOCC	193	
7-1	89	55	CEPOCC	96	
7-1	89	55	CEPOCC	17	
7-1	89	55	SYZCUM	25	
7-1	89	55	SYZCUM	24	
7-1	89	55	SYZCUM	148	
7-1	89	55	OSMREG	40	
7-1	89	55	BLESER	23	
7-1	90	65	ACRDAN	35	Rmix
7-1	90	65	ACRDAN	56	
7-1	90	65	MYRCER	78	
7-1	90	65	ANNGLA	179	

7-1	90	65	ANNGLA	126	
7-1	90	65	CEPOCC	6	
7-1	90	65	SYZCUM	35	
7-1	90	65	SYZCUM	28	
7-1	90	65	SYZCUM	64	
7-1	90	65	OSMREG	55	
7-1	90	65	OSMREG	27	
7-1	90	65	BLESER	20	
7-1	90	65	RAPPUN	64	
7-1	90	65	FRACAR	64	
7-1	90	65	SABPAL	69	
7-1	91	75	ACRDAN	130	Rmix
7-1	91	75	ACRDAN	172	
7-1	91	75	ACRDAN	300	
7-1	91	75	ACRDAN	130	
7-1	91	75	MYRCER	50	
7-1	91	75	ANNGLA	100	
7-1	91	75	CEPOCC	20	
7-1	91	75	SYZCUM	41	
7-1	91	75	SYZCUM	16	
7-1	91	75	FRACAR	8	
7-1	92	85	ACRDAN	66	UTsw1
7-1	92	85	ACRDAN	225	
7-1	92	85	ACRDAN	415	
7-1	92	85	ACRDAN	40	
7-1	92	85	ANNGLA	54	
7-1	92	85	ANNGLA	7	
7-1	92	85	ANNGLA	290	
7-1	93	95	ACRDAN	163	UTsw1
7-1	93	95	ACRDAN	104	
7-1	93	95	ANNGLA	1000	
7-1	93	95	CEPOCC	118	
7-1	93	95	CEPOCC	14	
7-1	93	95	FRACAR	80	
7-1	94	105	ACRDAN	50	UTsw1
7-1	94	105	ACRDAN	39	
7-1	94	105	ACRDAN	68	
7-1	94	105	ACRDAN	112	
7-1	94	105	ACRDAN	110	
7-1	94	105	ANNGLA	175	
7-1	94	105	ANNGLA	510	
7-1	95	115	ACRDAN	525	UTsw1
7-1	95	115	ACRDAN	30	

7-1	95	115	ACRDAN	434	
7-1	95	115	ANNGLA	28	
7-1	95	115	ANNGLA	220	
7-1	95	115	ANNGLA	88	
7-1	95	115	ANNGLA	265	
7-1	95	115	FRACAR	50	
7-1	96	125	ACRDAN	135	UTsw2
7-1	96	125	ACRDAN	77	
7-1	96	125	ACRDAN	44	
7-1	96	125	ACRDAN	296	
7-1	96	125	ACRDAN	86	
7-1	97	135	ACRDAN	105	UTsw2
7-1	97	135	ACRDAN	535	
7-1	98	145	ACRDAN	435	UTsw2
7-1	98	145	ACRDAN	157	
7-1	98	145	ACRDAN	359	
7-1	98	145	RHIMAN	131	
8-1	99	5	SERREP	46	Rmix
8-1	99	5	SERREP	16	
8-1	99	5	LYGMIC	950	
8-1	100	15	PSICAT	20	HHam
8-1	100	15	ACRDAN	158	
8-1	100	15	BLESER	21	
8-1	100	15	CEPOCC	56	
8-1	100	15	CEPOCC	87	
8-1	100	15	MYRCER	57	
8-1	101	25	PSICAT	33	Rmix
8-1	101	25	ACRDAN	36	
8-1	101	25	BLESER	17	
8-1	101	25	CEPOCC	45	
8-1	101	25	CEPOCC	18	
8-1	101	25	CEPOCC	81	
8-1	101	25	MYRCER	57	
8-1	101	25	ARDESC	24	
8-1	101	25	PLUODA	11	
8-1	101	25	SCHTER	23	
8-1	101	25	ACRDAN	75	
8-1	102	35	BLESER	19	UTmix
8-1	102	35	BLESER	19	
8-1	102	35	BLESER	64	
8-1	102	35	CEPOCC	48	
8-1	102	35	MYRCER	21	
8-1	102	35	MYRCER	63	

8-1	102	35	MYRCER	59	
8-1	102	35	MYRCER	12	
8-1	102	35	MYRCER	50	
8-1	102	35	MYRCER	64	
8-1	102	35	OSMREG	25	
8-1	102	35	BACHAL	145	
8-1	102	35	ITEVIR	14	
8-1	103	45	ANNGLA	54	UTmix
8-1	103	45	PLUODA	47	
8-1	103	45	BACHAL	154	
8-1	103	45	ACRDAN	37	
8-1	103	45	BLESER	27	
8-1	103	45	BLESER	11	
8-1	103	45	MYRCER	10	
8-1	103	45	MYRCER	196	
8-1	103	45	MYRCER	123	
8-1	103	45	SABPAL	206	
8-1	103	45	THEINT	16	
8-1	103	45	CEPOCC	18	
8-1	103	45	CHRICA	40	
8-1	103	55	PSICAT	40	
8-1	104	55	PLUODA	36	UTsw1
8-1	104	55	BACHAL	48	
8-1	104	55	ACRDAN	33	
8-1	104	55	ACRDAN	97	
8-1	104	55	ACRDAN	44	
8-1	104	55	ACRDAN	51	
8-1	104	55	ACRDAN	96	
8-1	104	55	MYRCER	19	
8-1	104	55	ACERUB	48	
8-1	104	55	AMOFRU	24	
8-1	104	55	SCHTER	21	
8-1	104	55	BOECYL	10	
8-1	105	65	ANNGLA	451	UTmix
8-1	105	65	BACHAL	60	
8-1	105	65	ACRDAN	219	
8-1	105	65	MYRCER	170	
8-1	105	65	THEINT	20	
8-1	105	65	BOECYL	26	
8-1	105	65	THPSPP	15	
8-1	106	75	BACHAL	16	UTsw1
8-1	106	75	ACRDAN	118	
8-1	106	75	ACRDAN	134	

8-1	106	75	BLESER	26	
8-1	106	75	MYRCER	61	
8-1	106	75	PSICAT	167	
8-1	106	75	SCHTER	24	
8-1	106	75	LAGRAC	15	
8-1	107	85	ANNGLA	92	UTmix
8-1	107	85	ANNGLA	117	
8-1	107	85	ANNGLA	5	
8-1	107	85	SCHTER	32	
8-1	107	85	ACRDAN	45	
8-1	107	85	ACRDAN	150	
8-1	108	95	ANNGLA	50	UTsw1
8-1	108	95	ANNGLA	120	
8-1	108	95	ACRDAN	297	
8-1	108	95	LAGRAC	160	
8-1	108	95	RHIMAN	210	
8-1	109	105	ANNGLA	270	UTsw1
8-1	109	105	ANNGLA	44	
8-1	109	105	ACRDAN	93	
8-1	109	105	ACRDAN	32	
8-1	109	105	ACRDAN	192	
8-1	109	105	TOXRAD	10	
8-1	110	115	ANNGLA	680	UTsw1
8-1	110	115	ACRDAN	310	
8-1	110	115	ACRDAN	35	
8-1	110	115	LAGRAC	63	
9-1	111	5	QUELAU	230	Uplan
9-1	111	5	CHRICA	202	
9-1	111	5	CHRICA	60	
9-1	111	5	CHRICA	88	
9-1	111	5	CHRICA	110	
9-1	112	15	BLESER	300	HHam
9-1	112	15	CHRICA	180	
9-1	112	15	CHRICA	70	
9-1	112	15	CHRICA	140	
9-1	113	25	FICMIC	184	LTsw2
9-1	113	25	ACRDAN	197	
9-1	113	25	ACRDAN	152	
9-1	113	25	ACRDAN	211	
9-1	114	35	ACRDAN	39	LTsw2
9-1	114	35	ACRDAN	49	
9-1	114	35	ACRDAN	60	
9-1	114	35	ACRDAN	35	

9-1	114	35	RHABIF	27	
9-1	115	45	ACRDAN	36	LTsw2
9-1	115	45	ACRDAN	19	
9-1	115	45	ACRDAN	26	
9-1	115	45	ACRDAN	162	
9-1	116	55	ACRDAN	85	LTmix
9-1	116	55	ACRDAN	90	
9-1	117	65	ANNGLA	16	HH/LTsw2
9-1	117	65	SCHTER	2	
9-1	118	75	LAGRAC	48	LTsw2
9-1	118	75	ACRDAN	25	
9-1	119	85	SCHTER	124	LTsw2
9-1	119	85	ACRDAN	180	
9-1	119	85	ACRDAN	102	
9-1	120	95	ACRDAN	44	LTsw2
9-1	120	95	ACRDAN	71	
9-1	120	95	ACRDAN	49	
9-1	120	95	ACRDAN	147	
9-1	121	105	ACRDAN	51	LTsw2
9-1	121	105	ACRDAN	196	
9-1	121	105	ACRDAN	60	
9-1	121	105	ACRDAN	45	
9-1	122	115	SCHTER	168	LTsw2
9-1	122	115	SCHTER	125	
9-1	122	115	ACRDAN	21	
9-1	122	115	ACRDAN	34	
9-1	122	115	ACRDAN	77	
9-1	123	125	ACRDAN	63	LTsw2
9-1	123	125	ACRDAN	20	
9-1	123	125	ACRDAN	45	
9-1	123	125	SCHTER	166	
9-1	124	135	ACRDAN	76	LTsw2
9-1	124	135	ACRDAN	288	
9-1	124	135	ACRDAN	94	
9-1	124	135	ACRDAN	10	
9-1	125	145	ACRDAN	31	LTsw2
9-1	125	145	ACRDAN	446	
9-1	125	145	SCHTER	102	
9-1	125	145	LAGRAC	86	
9-1	126	155	ACRDAN	30	LTsw2
9-1	126	155	SCHTER	147	
9-1	126	155	CHRICA	183	

9-1	126	155	RHIMAN	173	
9-1	126	155	SABPAL	177	
9-1	126	155	ANNGLA	34	
9-1	127	165	RHIMAN	195	LTsw1
9-1	127	165	RHIMAN	33	
9-1	127	165	ACRDAN	34	
9-1	128	175	RHIMAN	38	LTsw1
9-1	128	175	RHIMAN	132	
9-1	128	175	RHIMAN	156	
9-1	128	175	RHIMAN	255	
9-1	128	175	ACRDAN	38	
9-1	128	175	SCHTER	201	
9-1	129	185	RHIMAN	52	LTsw1
9-1	129	185	RHIMAN	61	
9-1	129	185	RHIMAN	83	
9-1	129	185	RHIMAN	27	
9-1	129	185	RHIMAN	8	
9-1	129	185	RHIMAN	356	
9-1	130	195	RHIMAN	410	LTsw1
9-1	130	195	RHIMAN	150	
9-1	130	195	RHIMAN	258	
9-1	130	195	ACRDAN	37	
9-1	130	195	ACRDAN	130	
9-1	130	195	ACRDAN	195	
10-1	131	5	CLAJAM	148	HH/Marsh
10-1	131	5	CLAJAM	59	
10-1	131	5	CLAJAM	30	
10-1	131	5	CLAJAM	113	
10-1	131	5	CLAJAM	66	
10-1	131	5	SCHTER	10	
10-1	131	5	MYRCER	69	
10-1	131	5	MYRCER	158	
10-1	131	5	ACRDAN	40	
10-1	132	15	CLAJAM	204	Marsh
10-1	132	15	SCHTER	137	
10-1	132	15	SCHTER	24	
10-1	132	15	SCHTER	243	
10-1	132	15	MYRCER	48	
10-1	132	15	MYRCER	93	
10-1	132	15	MYRCER	21	
10-1	132	15	ACRDAN	24	
10-1	132	15	ANNGLA	55	
10-1	132	15	BLESER	113	

10-1	132	15	CEPOCC	11	
10-1	133	25	CLAJAM	88	UTsw2
10-1	133	25	SCHTER	92	
10-1	133	25	MYRCER	127	
10-1	133	25	MYRCER	52	
10-1	133	25	MYRCER	130	
10-1	133	25	MYRCER	124	
10-1	133	25	ANNGLA	40	
10-1	133	25	ANNGLA	31	
10-1	133	25	CEPOCC	38	
10-1	133	25	CEPOCC	85	
10-1	133	25	PERBOR	99	
10-1	134	35	CLAJAM	45	Utmix
10-1	134	35	MYRCER	243	
10-1	134	35	CEPOCC	74	
10-1	134	35	CEPOCC	42	
10-1	134	35	PSICAT	142	
10-1	135	45	CLAJAM	82	H hammock
10-1	135	45	ILECAS	41	
10-1	135	45	PSICAT	74	
10-1	135	45	MYRCER	134	
10-1	135	45	BLESER	11	
10-1	135	45	BLESER	21	
10-1	135	45	BLESER	17	
10-1	135	45	RAPPUN	87	
10-1	135	45	RAPPUN	20	
10-1	136	55	MYRCER	320	UTmix
10-1	136	55	BLESER	14	
10-1	136	55	BLESER	30	
10-1	136	55	RAPPUN	43	
10-1	136	55	ANNGLA	110	
10-1	136	55	ACRDAN	98	
10-1	136	55	ACRDAN	50	
10-1	137	65	MYRCER	112	UTmix
10-1	137	65	BLESER	14	
10-1	137	65	ANNGLA	161	
10-1	137	65	ANNGLA	76	
10-1	137	65	ANNGLA	205	
10-1	137	65	SCHTER	144	
10-1	137	65	LAGRAC	164	
10-1	137	65	SABPAL	34	
10-1	138	75	MYRCER	66	UTmix
10-1	138	75	ANNGLA	440	

10-1	138	75	SCHTER	102	

[a] Species code list is provided in **Appendix C**

Table E- 6. Transect 1 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U (0.5)	M H (2)	H H (2.5)	Rblh2	Rblh1 (1)	Sw3	Sw2	Sw1 (9)
Acer rubrum								
Acrostichum danaeifolium								**4**
Amorpha fruticosa								
Annona glabra					**1**			**1**
Ardisia escallonioides			**2**					
Baccharis halimifolia								
Blechnum serrulatum		**1**	**2**					
Boehmeria cylindrica								
Callicarpa americana		**1**	**1**					
Cephalanthus occidentalis					**1**			
Chrysobalanus icaco								
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana								
Ilex cassine								
Ipomoea indica			**1**					
Itea virginica								
Laguncularia racemosa								
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera								
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa			**1**					
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata								
Rhabdadenia biflora								
Rhizophora mangle								
Roystonea regia								
Sabal palmetto	**0.5**	**2**	**0.5**					
Salix caroliniana								
Schinus terebinthifolius								

Shrub Species	Forest Type (# plots)							
	U (0.5)	M H (2)	H H (2.5)	Rblh2	Rblh1 (1)	Sw3	Sw2	Sw1 (9)
Serenoa repens								
Syzygium cumini								
Thelypteris (unid. sp.)								
Thelypteris palustris								
Thelypteris interrupta					**1**			**1**
Thelypteris serrata								
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 7. Transect 2 – Frequency of Shrubs by Forest Types

	Forest Type (# plots)							
Shrub Species	**U**	**M H (3)**	**H H (3.5)**	**Mix**	**Rblh1 (1)**	**Sw3**	**Sw2 (0.5)**	**Sw1 (5)**
Acer rubrum					**1**			
Acrostichum danaeifolium			**0.5**					**2.5**
Amorpha fruticosa								
Annona glabra								
Ardisia escallonioides		**1**	**2**					
Baccharis halimifolia								
Blechnum serrulatum		**1**	**0.5**				**0.5**	
Boehmeria cylindrica								
Callicarpa americana		**3**						
Cephalanthus occidentalis					**1**			
Chrysobalanus icaco		**1**						
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana								
Ilex cassine								
Ipomoea indica								
Itea virginica			**0.5**				**0.5**	**3**
Laguncularia racemosa								
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera								
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa								
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata								
Rhabdadenia biflora								
Rhizophora mangle								
Roystonea regia								
Sabal palmetto		**1**						
Salix caroliniana								
Schinus terebinthifolius								

Shrub Species	Forest Type (# plots)							
	U	M H (3)	H H (3.5)	Mix	Rblh1 (1)	Sw3	Sw2 (0.5)	Sw1 (5)
Serenoa repens		**1**						
Syzygium cumini								
Thelypteris spp.								
Thelypteris palustris								
Thelypteris interrupta								**1**
Thelypteris serrata			**0.5**					**1.5**
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata		**1**						
Vitis rotundifolia								
Unidentified spp.								

Table E- 8. Transect 3 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U (0.5)	M H	H H (0.5)	Rblh3 (1)	Rblh2 (1)	Rblh1 (1)	Sw2 (7)	Sw1 (2)
Acer rubrum								
Acrostichum danaeifolium							**4**	**1**
Amorpha fruticosa								
Annona glabra								
Ardisia escallonioides								
Baccharis halimifolia								
Blechnum serrulatum						**1**		
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis							**1**	
Chrysobalanus icaco								
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana								
Ilex cassine								
Ipomoea indica								
Itea virginica								
Laguncularia racemosa								
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera								
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa						**1**		
Psychotria sulzneri								**1**
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata						**1**		
Rhabdadenia biflora								
Rhizophora mangle								
Roystonea regia								
Sabal palmetto								
Salix caroliniana								
Schinus terebinthifolius								

Shrub Species	Forest Type (# plots)							
	U (0.5)	M H	H H (0.5)	Rblh3 (1)	Rblh2 (1)	Rblh1 (1)	Sw2 (7)	Sw1 (2)
Serenoa repens								
Syzygium cumini								
Thelypteris spp.								
Thelypteris palustris								
Thelypteris interrupta							**3**	**1**
Thelypteris serrata							**3**	**1**
Toxicodendron radicans								
Tripsacum dactyloides	**0.5**		**0.5**					
Urena lobata					**1**			
Vitis rotundifolia								**1**
Unidentified spp.								

Table E- 9. Transect 4 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U	M H (1)	H H	Rblh3 (1)	Rblh2 (3)	Sw3	Sw2 (1)	Sw1 (6)
Acer rubrum					**1**			**2**
Acrostichum danaeifolium					**1**			**3**
Amorpha fruticosa								
Annona glabra								**1**
Ardisia escallonioides								
Baccharis halimifolia								
Blechnum serrulatum				**1**	**1**		**1**	**1**
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis								**1**
Chrysobalanus icaco								
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana								**2**
Ilex cassine								
Ipomoea indica								
Itea virginica					**1**		**1**	**4**
Laguncularia racemosa								
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera								
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa				**1**	**1**			
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata								
Rhabdadenia biflora								
Rhizophora mangle								
Roystonea regia								
Sabal palmetto								
Salix caroliniana								
Schinus terebinthifolius					**1**			

Shrub Species	Forest Type (# plots)							
	U	M H (1)	H H	Rblh3 (1)	Rblh2 (3)	Sw3	Sw2 (1)	Sw1 (6)
Serenoa repens		**1**						
Syzygium cumini								
Thelypteris spp.								
Thelypteris palustris								
Thelypteris interrupta				**1**	**1**		**1**	**3**
Thelypteris serrata					**1**			
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 10. Transect 5 – Frequency of Shrubs by Forest Types

	Forest Type (# plots)							
Shrub Species	**U**	**M H (2)**	**H H**	**Rblh3 (3)**	**Rblh2 (5.5)**	**Rblh1**	**Sw2**	**Sw1 (4.5)**
Acer rubrum								
Acrostichum danaeifolium								
Amorpha fruticosa								
Annona glabra								
Ardisia escallonioides				**1**	**1**			
Baccharis halimifolia								
Blechnum serrulatum		**2**		**1**	**2.5**			**2.5**
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis								
Chrysobalanus icaco								
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana								
Ilex cassine								
Ipomoea indica								
Itea virginica								
Laguncularia racemosa								
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera								
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa				**1**				
Psychotria sulzneri				**1**				
Quercus laurifolia					**1**			
Quercus virginiana								
Rapanea punctata								
Rhabdadenia biflora								
Rhizophora mangle								
Roystonea regia								
Sabal palmetto					**2**			
Salix caroliniana								
Schinus terebinthifolius								

Shrub Species	Forest Type (# plots)							
	U	M H (2)	H H	Rblh3 (3)	Rblh2 (5.5)	Rblh1	Sw2	Sw1 (4.5)
Serenoa repens		**1**		**1**				
Syzygium cumini								
Thelypteris spp.								
Thelypteris palustris								
Thelypteris interrupta						**1**		
Thelypteris serrata								
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata					**1**			
Vitis rotundifolia								
Unidentified spp.					**1**			

Table E- 11. Transect 6 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U (2)	M H	H H	Mix (1)	Rblh2	Sw3 (6)	Sw2	Sw1 (7)
Acer rubrum								
Acrostichum danaeifolium				**1**		**5**		**7**
Amorpha fruticosa								
Annona glabra						**3**		**1**
Ardisia escallonioides								
Baccharis halimifolia								
Blechnum serrulatum	**1**							**1**
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis						**3**		**2**
Chrysobalanus icaco								
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana						**1**		**1**
Ilex cassine								
Ipomoea indica								
Itea virginica								
Laguncularia racemosa						**3**		
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera						**1**		**1**
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis						**1**		
Persea borbonia								
Pluchea odorata								
Psidium cattleianum	**1**							
Psychotria nervosa								
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana	**1**							
Rapanea punctata								**1**
Rhabdadenia biflora								
Rhizophora mangle				**1**		**2**		**3**
Roystonea regia								
Sabal palmetto								
Salix caroliniana								
Schinus terebinthifolius				**1**		**2**		

Shrub Species	Forest Type (# plots)							
	U (2)	M H	H H	Mix (1)	Rblh2	Sw3 (6)	Sw2	Sw1 (7)
Serenoa repens	**1**							
Syzygium cumini								
Thelypteris spp.								
Thelypteris palustris	**1**							
Thelypteris interrupta								
Thelypteris serrata								
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 12. Transect 7 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U	M H (0.5)	H H	Mix (5)	Rblh2	Sw3	Sw2 (3)	Sw1 (6.5)
Acer rubrum								
Acrostichum danaeifolium				**4**			**3**	**6**
Amorpha fruticosa				**1**				**1**
Annona glabra				**3**				**4**
Ardisia escallonioides								
Baccharis halimifolia				**2**				**1**
Blechnum serrulatum		**0.5**		**3**				**2.5**
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis				**4**				**3**
Chrysobalanus icaco								
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana				**3**				**3**
Ilex cassine								
Ipomoea indica								
Itea virginica								
Laguncularia racemosa								
Lygodium microphyllum								
Lyonia fruticosa		**0.5**						**0.5**
Myrica cerifera				**5**				**2**
Nephrolepis exaltata				**1**				
Osmunda cinnamomea		**0.5**						**0.5**
Osmunda regalis				**3**				**1**
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa								
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata				**2**				
Rhabdadenia biflora								
Rhizophora mangle							**1**	
Roystonea regia								
Sabal palmetto				**1**				**1**
Salix caroliniana								
Schinus terebinthifolius				**1**				

Shrub Species	Forest Type (# plots)							
	U	M H (0.5)	H H	Mix (5)	Rblh2	Sw3	Sw2 (3)	Sw1 (6.5)
Serenoa repens		**0.5**						**0.5**
Syzygium cumini				**4**				**1**
Thelypteris spp.								
Thelypteris palustris								
Thelypteris interrupta								
Thelypteris serrata								
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 13. Transect 8 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U	M H	H H (1)	Mix (6)	Rblh2	Sw3	Sw2	Sw1 (5)
Acer rubrum								1
Acrostichum danaeifolium			1	4				5
Amorpha fruticosa								1
Annona glabra				3				3
Ardisia escallonioides				1				
Baccharis halimifolia				3				
Blechnum serrulatum			1	3				1
Boehmeria cylindrica				1				1
Callicarpa americana								
Cephalanthus occidentalis			1	3				
Chrysobalanus icaco				1				
Cladium jamaicense								
Ficus microcarpa								
Fraxinus caroliniana								
Ilex cassine								
Ipomoea indica								
Itea virginica				1				
Laguncularia racemosa								3
Lygodium microphyllum				1				
Lyonia fruticosa								
Myrica cerifera			1	4				2
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis				1				
Persea borbonia								
Pluchea odorata				2				1
Psidium cattleianum			1	2				1
Psychotria nervosa								
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata								
Rhabdadenia biflora								
Rhizophora mangle								1
Roystonea regia								
Sabal palmetto				1				
Salix caroliniana								
Schinus terebinthifolius				2				2

Shrub Species	Forest Type (# plots)							
	U	M H	H H (1)	Mix (6)	Rblh2	Sw3	Sw2	Sw1 (5)
Serenoa repens				**1**				
Syzygium cumini								
Thelypteris spp.				**1**				
Thelypteris interrupta				**2**				
Thelypteris serrata								
Toxicodendron radicans								**1**
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 14. Transect 9 – Frequency of Shrubs by Forest Types

Shrub Species	Forest Type (# plots)							
	U (1)	M H	H H (1)	Mix (1)	Rblh2	Sw3	Sw2 (13)	Sw1 (4)
Acer rubrum								
Acrostichum danaeifolium				1			12	3
Amorpha fruticosa								
Annona glabra							2	
Ardisia escallonioides								
Baccharis halimifolia								
Blechnum serrulatum			1					
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis								
Chrysobalanus icaco	1		1				1	
Cladium jamaicense								
Ficus microcarpa							1	
Fraxinus caroliniana								
Ilex cassine								
Ipomoea indica								
Itea virginica								
Laguncularia racemosa							2	
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera								
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia								
Pluchea odorata								
Psidium cattleianum								
Psychotria nervosa								
Psychotria sulzneri								
Quercus laurifolia	1							
Quercus virginiana								
Rapanea punctata								
Rhabdadenia biflora							1	
Rhizophora mangle							1	4
Roystonea regia								
Sabal palmetto							1	
Salix caroliniana								
Schinus terebinthifolius							6	1

	Forest Type (# plots)							
Shrub Species	**U (1)**	**M H**	**H H (1)**	**Mix (1)**	**Rblh2**	**Sw3**	**Sw2 (13)**	**Sw1 (4)**
Serenoa repens								
Syzygium cumini								
Thelypteris spp.								
Thelypteris palustris								
Thelypteris interrupta								
Thelypteris serrata								
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 15. Transect 10 – Frequency of Shrubs by Forest Types

	Forest Type (# plots)							
Shrub Species	**Marsh (1.5)**	**M H**	**H H (2.5)**	**Mix (1)**	**Rblh2**	**Sw3**	**Sw2 (3)**	**Sw1**
Acer rubrum								
Acrostichum danaeifolium	**1.5**		**1.5**					
Amorpha fruticosa								
Annona glabra	**1**		**1**				**3**	
Ardisia escallonioides								
Baccharis halimifolia								
Blechnum serrulatum	**1**		**2**				**1**	
Boehmeria cylindrica								
Callicarpa americana								
Cephalanthus occidentalis	**1**			**1**			**1**	
Chrysobalanus icaco								
Cladium jamaicense	**1.5**		**1.5**	**1**			**1**	
Ficus microcarpa								
Fraxinus caroliniana								
Ilex cassine			**1**					
Ipomoea indica								
Itea virginica								
Laguncularia racemosa							**1**	
Lygodium microphyllum								
Lyonia fruticosa								
Myrica cerifera	**1.5**		**2.5**	**1**			**3**	
Nephrolepis exaltata								
Osmunda cinnamomea								
Osmunda regalis								
Persea borbonia							**1**	
Pluchea odorata								
Psidium cattleianum			**1**	**1**				
Psychotria nervosa								
Psychotria sulzneri								
Quercus laurifolia								
Quercus virginiana								
Rapanea punctata			**2**					
Rhabdadenia biflora								
Rhizophora mangle								
Sabal palmetto							**1**	
Schinus terebinthifolius	**1.5**		**0.5**				**3**	
Serenoa repens								
Syzygium cumini								

Shrub Species	Forest Type (# plots)							
	Marsh (1.5)	M H	H H (2.5)	Mix (1)	Rblh2	Sw3	Sw2 (3)	Sw1
Thelypteris (unid. sp.)								
Thelypteris palustris								
Thelypteris interrupta								
Thelypteris serrata								
Toxicodendron radicans								
Tripsacum dactyloides								
Urena lobata								
Vitis rotundifolia								
Unidentified spp.								

Table E- 16. Frequency of Shrub Species for all Transects by Forest Types

Shrub Species	Forest Type (# plots)											
	U (4)	Marsh (1.5)	M H (8.5)	H H (11)	Mix (14)	Blh3 (3)	Blh2 (9.5)	Blh1 (4)	Sw3 (6)	Sw2 (27.5)	Sw1 (49)	Total (138)
Acer rubrum							1	1			3	5
Acrostichum danaeifolium		1.5		3	10		1		5	19	31.5	71
Amorpha fruticosa					1						2	3
Annona glabra		1		1	6			1	3	5	10	27
Ardisia escallonioides			1	4	1	1	1					8
Baccharis halimifolia					5						1	6
Blechnum serrulatum	1	1	4.5	6.5	6	2	3.5	1		3.5	8	37
Boehmeria cylindrica					1						1	2
Callicarpa americana			4	1								5
Cephalanthus occidentalis		1		1	8			2	3	2	6	23
Chrysobalanus icaco	1		1	1	1					1		5
Cladium jamaicense		1.5		1.5	1					1		5
Ficus microcarpa										1		1
Fraxinus caroliniana					3				1		6	10
Ilex cassine				1								1
Ipomoea indica				1								1
Itea virginica				0.5	1		1			1.5	7	11
Laguncularia racemosa									3	3	3	9
Lygodium microphyllum					1							1
Lyonia fruticosa			0.5								0.5	1
Myrica cerifera		1.5		3.5	10				1	3	5	24
Nephrolepis exaltata					1							1
Osmunda cinnamomea			0.5								0..5	1
Osmunda regalis					4				1		1	6

Shrub Species	Forest Type (# plots)											Total
	U (4)	Marsh (1.5)	M H (8.5)	H H (11)	Mix (14)	Blh3 (3)	Blh2 (9.5)	Blh1 (4)	Sw3 (6)	Sw2 (27.5)	Sw1 (49)	(138)
Persea borbonia										**1**		**1**
Pluchea odorata					**2**						**1**	**3**
Psidium cattleianum	**1**			**2**	**3**						**1**	**7**
Psychotria nervosa				**1**		**2**	**1**	**1**				**5**
Psychotria sulzneri						**1**					**1**	**2**
Quercus laurifolia	**1**						**1**					**2**
Quercus virginiana	**1**											**1**
Rapanea punctata				**2**	**2**			**1**			**1**	**6**
Rhabdadenia biflora										**1**		**1**
Rhizophora mangle					**1**				**2**	**2**	**8**	**13**
Sabal palmetto	**0.5**		**3**	**0.5**	**2**		**2**			**2**	**1**	**11**
Schinus terebinthifolius		**1.5**		**0.5**	**4**		**1**		**2**	**9**	**3**	**21**
Serenoa repens	**1**		**2.5**	**1**	**1**	**1**					**0.5**	**7**
Syzygium cumini					**4**						**1**	**5**
Thelypteris spp.					**1**							**1**
Thelypteris palustris	**1**											**1**
Thelypteris interrupta					**2**	**1**	**1**	**2**		**4**	**6**	**16**
Thelypteris serrata				**0.5**			**1**			**3**	**2.5**	**4**
Toxicodendron radicans											**1**	**1**
Tripsacum dactyloides	**0.5**			**0.5**								**1**
Urena lobata			**1**				**2**					**3**
Vitis rotundifolia											**1**	**1**
Unidentified spp.							**1**					**1**

Table E- 17. Percent Cover of Shrub Species by Transect/Plot – Part I.

Transect/Plot	ACERUB	ACRODAN	AMOFRU	ANNGLA	ARDESC	BACHAL	BLESER	BOECYL	CALAME	CEPOCC	CHRICA	CLAJAM	FICMIC	FRACAR	ILECAS	IMPIND	ITEVIR	LAGRAC	LYGMIC	LYOFRU	MORRUB	MYRCER	NEPEXA
T111	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T112	0	0	0	0	0	0	0	0	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T114	0	0	0	0	0	0	0.17	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0
T115																							
T116																							
T117																							
T118	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T119	0	0.14	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1210	0	0	0	0.03	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0
T1211	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1212	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1213																							
T1214	0	0	0	0	0.05	0	0.06	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0
T1215																							
T2116	0.05	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0
T2117																							
T2118	0	0.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2119	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0	0
T2120	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0.32	0	0	0	0	0	0
T2121	0	0	0	0	0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2122	0	0	0	0	0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2223	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2224	0	0	0	0	0	0	0.03	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2225	0	0	0	0	0.11	0	0	0	0.02	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0

Transect/Plot	ACERUB	ACRODAN	AMOFRU	ANNGLA	ARDESC	BACHAL	BLESER	BOECYL	CALAME	CEPOCC	CHRICA	CLAJAM	FICMIC	FRACAR	ILECAS	IMPIND	ITEVIR	LAGRAC	LYGMIC	LYOFRU	MORRUB	MYRCER	NEPEXA
T2226																							
T2227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0	0	0	0	0	0
T2228	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0
T3129	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3130																							
T3131	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3132	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3133	0	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3135	0	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3136																							
T3137																							
T3138	0	0.65	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0
T3139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3241	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4142	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4143	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4144	0.13	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0	0	0
T4146	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0	0	0.03	0	0	0	0	0	0
T4147	0.07	0.21	0	0	0	0	0	0	0	0.18	0	0	0	0	0	0	0.36	0	0	0	0	0	0
T4148	0	0.35	0	0	0	0	0.03	0	0	0	0	0	0	0.12	0	0	0.2	0	0	0	0	0	0
T4149	0.04	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4150	0	0	0	0	0	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Transect/Plot	ACERUB	ACRODAN	AMOFRU	ANNGLA	ARDESC	BACHAL	BLESER	BOECYL	CALAME	CEPOCC	CHRICA	CLAJAM	FICMIC	FRACAR	ILECAS	IMPIND	ITEVIR	LAGRAC	LYGMIC	LYOFRU	MORRUB	MYRCER	NEPEXA
T4151	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0
T4152	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0
T4153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5154	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5155	0	0	0	0	0.02	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5156	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5157	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5158	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5259	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5260																							
T5261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5262	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5264	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5265	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5266																							
T5267	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6169	0	0	0	0	0	0	0.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6170	0	0.08	0.05	0	0	0	0.01	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0
T6171	0	0.13	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0
T6172	0	0.1	0	0	0	0	0	0	0	0.22	0	0	0	0	0	0	0	0	0	0	0	0	0
T6173	0	0.1	0	0.24	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0.73	0	0	0	0	0
T6174	0	0.16	0	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0	0	0	0.39	0
T6175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.14	0	0	0	0	0

Transect/Plot	ACERUB	ACRODAN	AMOFRU	ANNGLA	ARDESC	BACHAL	BLESER	BOECYL	CALAME	CEPOCC	CHRICA	CLAJAM	FICMIC	FRACAR	ILECAS	IMPIND	ITEVIR	LAGRAC	LYGMIC	LYOFRU	MORRUB	MYRCER	NEPEXA
T6176	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6177	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0
T6178	0	0.13	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0
T6179	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0
T6180	0	0.31	0	0.71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6281	0	0.31	0	0.36	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0	0	0
T6282	0	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6283	0	0.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7184	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0
T7185	0	0.3	0	0	0	0.02	0.02	0	0	0.18	0	0	0	0	0	0	0	0	0	0	0	0.15	0
T7186	0	0.3	0	0	0	0	0.02	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.14	0
T7187	0	0	0	0	0	0.2	0.09	0	0	0.35	0	0	0	0.08	0	0	0	0	0	0	0	0.05	0.2
T7188	0	0.39	0.14	0.57	0	0.17	0	0	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0.12	0
T7189	0	0.02	0	0	0	0	0.02	0	0	0.31	0	0	0	0	0	0	0	0	0	0	0	0.02	0
T7190	0	0.09	0	0.31	0	0	0.02	0	0	0.01	0	0	0	0.06	0	0	0	0	0	0	0	0.08	0
T7191	0	0.73	0	0.1	0	0	0	0	0	0.02	0	0	0	0.01	0	0	0	0	0	0	0	0.05	0
T7192	0	0.75	0	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7193	0	0.27	0	1	0	0	0	0	0	0.13	0	0	0	0.08	0	0	0	0	0	0	0	0	0
T7194	0	0.38	0	0.69	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0
T7195	0	0.99	0	0.6	0	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0	0	0
T7196	0	0.64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7197	0	0.64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0
T7198	0	0.94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T8199	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.95	0	0	0	0
T81100	0	0.16	0	0	0	0	0.02	0	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0.06	0

Transect/Plot	ACERUB	ACRODAN	AMOFRU	ANNGLA	ARDESC	BACHAL	BLESER	BOECYL	CALAME	CEPOCC	CHRICA	CLAJAM	FICMIC	FRACAR	ILECAS	IMPIND	ITEVIR	LAGRAC	LYGMIC	LYOFRU	MORRUB	MYRCER	NEPEXA
T81101	0	0.11	0	0	0.02	0	0.02	0	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0.06	0
T81102	0	0	0	0	0	0.15	0.1	0	0	0.05	0	0	0	0	0	0	0.01	0	0	0	0	0.27	0
T81103	0	0.04	0	0.05	0	0.15	0.04	0	0	0.02	0.05	0	0	0	0	0	0	0	0	0	0	0.33	0
T81104	0.08	0.32	0	0	0	0.05	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0
T81105	0	0.22	0	0.45	0	0.06	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0
T81106	0	0.25	0	0	0	0.02	0.03	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0.06	0
T81107	0	0.2	0	0.21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T81108	0	0.3	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16	0	0	0	0	0
T81109	0	0.32	0	0.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T81110	0	0.35	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0
T91111	0	0	0	0	0	0	0	0	0	0	0	0.46	0	0	0	0	0	0	0	0	0	0	0
T91112	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0	0	0	0	0
T91113	0	0.56	0	0	0	0	0	0	0	0	0	0	0.18	0	0	0	0	0	0	0	0	0	0
T91114	0	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91115	0	0.24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91116	0	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91117	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91118	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0
T91119	0	0.28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91120	0	0.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91121	0	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91122	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91123	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91124	0	0.47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91125	0	0.48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0	0	0	0	0

Transect/Plot	ACERUB	ACRODAN	AMOFRU	ANNGLA	ARDESC	BACHAL	BLESER	BOECYL	CALAME	CEPOCC	CHRICA	CLAJAM	FICMIC	FRACAR	ILECAS	IMPIND	ITEVIR	LAGRAC	LYGMIC	LYOFRU	MORRUB	MYRCER	NEPEXA
T91126	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91127	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91128	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91130	0	0.36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T10131	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.23	0
T10132	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16	0
T10133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.43	0
T10134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.24	0
T10135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0.13	0
T10136	0	0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.32	0
T10137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16	0	0	0	0.11	0
T10138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0

Table E- 18. Percent Cover of Shrub Species by Transect/Plot – Part II.

Transect/Plot	OSMCIN	OSMREG	PERBAR	PLUODA	PSICAT	PSYNER	PSYSUL	QUELAU	QUEVIR	RAPPUN	RHABIF	RHIMAN	SABPAL	SCHTER	SERREP	SYZCUM	THEINT	THEPAL	THESER	TOXRAD	TRIDAC	TYPSPP	URELOB	VITROT
T111	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0
T112	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0
T113	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0
T114	0	0	0	0	0	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T115																								
T116																								
T117																								
T118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0
T1211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
T1212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1213																								
T1214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T1215																								
T2116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2117																								
T2118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0
T2121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0
T2122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2223	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0	0.37	0	0	0	0	0	0	0	0	0

Transect/Plot	OSMCIN	OSMREG	PERBAR	PLUODA	PSICAT	PSYNER	PSYSUL	QUELAU	QUEVIR	RAPPUN	RHABIF	RHIMAN	SABPAL	SCHTER	SERREP	SYZCUM	THEINT	THEPAL	THESER	TOXRAD	TRIDAC	TYPSPP	URELOB	VITROT
T2224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0
T2225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2226																								
T2227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0
T2228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3129	0	0	0	0	0	0.17	0.02	0	0	0.27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3130																								
T3131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T3133	0	0	0	0	0	0.19	0	0	0	0	0	0	0	0	0	0	0.05	0	0.01	0	0	0	0	0.07
T3134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0	0	0	0	0
T3135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0
T3136																								
T3137																								
T3138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0.06	0	0	0	0	0
T3139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0.013	0	0	0	0	0
T3240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.27	0	0	0
T3241	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0
T4142	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.48	0	0	0	0	0	0	0	0	0
T4143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0
T4144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0	0	0
T4145	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0.48	0	0	0	0	0	0	0	0	0
T4146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.22	0	0	0	0	0	0	0
T4147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Transect/Plot	OSMCIN	OSMREG	PERBAR	PLUODA	PSICAT	PSYNER	PSYSUL	QUELAU	QUEVIR	RAPPUN	RHABIF	RHIMAN	SABPAL	SCHTER	SERREP	SYZCUM	THEINT	THEPAL	THESER	TOXRAD	TRIDAC	TYPSPP	URELOB	VITROT
T4148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4149	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4150	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0
T4151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0
T4152	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4153	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0.04	0	0.01	0	0	0	0	0
T5154	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.26	0	0	0	0	0	0	0	0	0
T5155	0	0	0	0	0	0.15	0.02	0	0	0	0	0	0	0	0.16	0	0	0	0	0	0	0	0	0
T5156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5259	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0
T5260																								
T5261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0
T5262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5263	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0
T5264	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5265	0	0	0	0	0	0	0	0.08	0	0	0	0	0.2	0	0	0	0.03	0	0	0	0	0	0	0
T5266																								
T5267	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6168	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0.61	0	0	0	0	0	0	0	0	0
T6169	0	0	0	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0
T6170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Transect/Plot	OSMCIN	OSMREG	PERBAR	PLUODA	PSICAT	PSYNER	PSYSUL	QUELAU	QUEVIR	RAPPUN	RHABIF	RHIMAN	SABPAL	SCHTER	SERREP	SYZCUM	THEINT	THEPAL	THESER	TOXRAD	TRIDAC	TYPSPP	URELOB	VITROT
T6172	0	0.07	0	0	0	0	0	0	0	0	0	0.19	0	0	0	0	0	0	0	0	0	0	0	0
T6173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6174	0	0	0	0	0	0	0	0	0	0	0	0	0	0.34	0	0	0	0	0	0	0	0	0	0
T6175	0	0	0	0	0	0	0	0	0	0	0	0.67	0	0.13	0	0	0	0	0	0	0	0	0	0
T6176	0	0	0	0	0	0	0	0	0	0	0	0.82	0	0.05	0	0	0	0	0	0	0	0	0	0
T6177	0	0	0	0	0	0	0	0	0	0	0	0.34	0	0	0	0	0	0	0	0	0	0	0	0
T6178	0	0	0	0	0	0	0	0	0	0	0	0.53	0	0	0	0	0	0	0	0	0	0	0	0
T6179	0	0	0	0	0	0	0	0	0	0	0	0.29	0	0	0	0	0	0	0	0	0	0	0	0
T6180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6281	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T6283	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7184	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0.65	0	0	0	0	0	0	0	0	0
T7185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7186	0.08	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0.03	0	0	0	0	0	0	0	0	0
T7187	0.02	0	0	0	0	0	0	0	0	0.11	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0
T7188	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0
T7189	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0
T7190	0.08	0	0	0	0	0	0	0	0	0.06	0	0	0.07	0	0.13	0	0	0	0	0	0	0	0	0
T7191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0
T7193	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Transect/Plot	OSMCIN	OSMREG	PERBAR	PLUODA	PSICAT	PSYNER	PSYSUL	QUELAU	QUEVIR	RAPPUN	RHABIF	RHIMAN	SABPAL	SCHTER	SERREP	SYZCUM	THEINT	THEPAL	THESER	TOXRAD	TRIDAC	TYPSPP	URELOB	VITROT
T7196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T7197	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0.65	0	0	0	0	0	0	0	0	0
T7198	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0
T8199	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0	0.06	0.03	0	0	0	0	0	0	0	0
T81100	0	0.01	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T81101	0	0	0.03	0.01	0	0	0	0	0	0	0	0	0	0.03	0	0.04	0	0	0	0	0	0	0	0
T81102	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0
T81103	0	0	0.04	0.05	0	0	0	0	0	0	0	0	0.21	0	0	0.13	0.02	0	0	0	0	0	0	0
T81104	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0.02	0	0.06	0	0	0	0	0	0	0	0
T81105	0	0	0	0	0	0	0	0	0	0	0	0	0.21	0	0	0	0.02	0	0	0	0	0.02	0	0
T81106	0	0	0.19	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0
T81107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0
T81108	0	0	0	0	0	0	0	0	0	0	0	0.21	0	0	0	0	0	0	0	0	0	0	0	0
T81109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0
T81110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91111	0	0	0	0	0	0	0	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91114	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0
T91115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91119	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12	0	0	0	0	0	0	0	0	0	0

Transect/Plot	OSMCIN	OSMREG	PERBAR	PLUODA	PSICAT	PSYNER	PSYSUL	QUELAU	QUEVIR	RAPPUN	RHABIF	RHIMAN	SABPAL	SCHTER	SERREP	SYZCUM	THEINT	THEPAL	THESER	TOXRAD	TRIDAC	TYPSPP	URELOB	VITROT
T91120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91122	0	0	0	0	0	0	0	0	0	0	0	0	0	0.29	0	0	0	0	0	0	0	0	0	0
T91123	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0	0	0	0	0	0	0	0	0	0
T91124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91125	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
T91126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91127	0	0	0	0	0	0	0	0	0	0.17	0.18	0	0.15	0	0	0	0	0	0	0	0	0	0	0
T91128	0	0	0	0	0	0	0	0	0	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T91129	0	0	0	0	0	0	0	0	0	0.06	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0
T91130	0	0	0	0	0	0	0	0	0	0.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T10131	0	0	0	0	0	0	0	0	0	0.82	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0
T10132	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0
T10133	0	0	0.1	0	0	0	0	0	0	0	0	0	0.09	0	0	0	0	0	0	0	0	0	0	0
T10134	0	0	0	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T10135	0	0	0	0	0.07	0	0	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T10136	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T10137	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.14	0	0	0	0	0	0	0	0	0	0
T10138	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0

Table E-19. 2003 Groundcover Data.

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
1-1	1	5	URELOB	1	A	AAA		MHam
1-1	1	5	TOXRAD	2	A			MHam
1-1	1	5	QUEVIR	1	A			MHam
1-1	1	5	UNISPP	25	B			MHam
1-1	1	5	VITROT	1	A			MHam
1-1	1	5	UNISEE	1	A			MHam
1-1	2	15	OSMREG	6	B	CCC		MHam
1-1	2	15	BLESER	31	BCD			MHam
1-1	2	15	THEINT	3	B			MHam
1-1	2	15	PARQUI	5	A			MHam
1-1	2	15	THEDEN	18	A			MHam
1-1	2	15	UNISEE	2	A			MHam
1-1	2	15	URELOB	1	AA			MHam
1-1	2	15	QUESEE	3	AA			MHam
1-1	2	15	SABPAL	8	AAA			MHam
1-1	2	15	VITROT	2	AA			MHam
1-1	2	15	ACERUB	1	A			MHam
1-1	2	15	ABRPRE	1	A			MHam
1-1	3	25	SABPAL	1	AB	AAA		HHam /Upla
1-1	3	25	BLESER	29	ADC			HHam /Upla
1-1	3	25	PARQUI	1	A			HHam /Upla
1-1	3	25	UNISEE	2	AA			HHam /Upla
1-1	3	25	CALAME	1	A			HHam /Upla
1-1	3	25	PSYNER	1	A			HHam /Upla
1-1	3	25	CALAME	1	A			HHam /Upla
1-1	3	25	URELOB	2	A			HHam /Upla
1-1	4	35	SMIBON	1	A	ABC	A	HHam
1-1	4	35	BLESER	58	CCB			HHam
1-1	4	35	SABPAL	1	A			HHam
1-1	4	35	TOXRAD	1	A			HHam
1-1	4	35	DICCOM	7	A			HHam
1-1	4	35	PSYNER	11	A			HHam
1-1	4	35	QUESEE	1	A			HHam
1-1	4	35	URELOB	2	A			HHam
1-1	5	45	UNISEE	5	AAA	AAA	C	Rsw1
1-1	5	45	CARLUP	2	AAA			Rsw1
1-1	5	45	HYDSPP	4	A			Rsw1
1-1	5	45	THEINT	28	C			Rsw1
1-1	5	45	CRAIME	1	A			Rsw1

Table E-19. 2003 Groundcover Data.

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
1-1	6	55	THEINT	19	B	AAC	BA	Rsw1
1-1	6	55	ACRDAN	1	AA			Rsw1
1-1	6	55	BOECYL	3	A			Rsw1
1-1	6	55	ANNGLA	2	A			Rsw1
1-1	6	55	UNISEE	125	AB			Rsw1
1-1	6	55	CARLUP	1	A			Rsw1
1-1	6	55	CRIAME	1	A			Rsw1
1-1	6	55	SAUCER	2	AA			Rsw1
1-1	6	55	PARQUI	1	A			Rsw1
1-1	6	55	THEDEN	16	A			Rsw1
1-1	6	55	THESER	2	A			Rsw1
1-1	6	55	HYDSPP	1	A			Rsw1
1-1	7	65	UNISEE	15	AA	BBB	B	Rsw1
1-1	7	65	THEINT	18	AB			Rsw1
1-1	7	65	SAUCER	9	AA			Rsw1
1-1	7	65	BOECYL	1	A			Rsw1
1-1	7	65	COMDIF	6	AA			Rsw1
1-1	7	65	ALTSES	2	A			Rsw1
1-1	8	75	CRIAME	3	B	BAA	A	Rsw1
1-1	8	75	UNISEE	32	AA			Rsw1
1-1	8	75	SAUCER	1	A			Rsw1
1-1	8	75	SYNPOD	1	A			Rsw1
1-1	9	85	UNISEE	55	AA	AAD	B	Rsw1
1-1	9	85	HYDSPP	17	AA			Rsw1
1-1	9	85	SABPAL	1	A			Rsw1
1-1	9	85	SYNPOD	1	A			Rsw1
1-1	9	85	WEDTRI	1	A			Rsw1
1-1	9	85	UNISPP	4	A			Rsw1
1-1	9	85	PSYNER	1	A			Rsw1
1-2	10	5	CRIAME	4	AAB	AAB	C	Rblh1
1-2	10	5	THEINT	58	AD			Rblh1
1-2	10	5	PSYNER	49	E			Rblh1
1-2	10	5	SAUCER	6	AA			Rblh1
1-2	10	5	ACERUB	1	A			Rblh1
1-2	10	5	COMDIF	55	C			Rblh1
1-2	10	5	SENPEN	3	A			Rblh1
1-2	11	15	THEINT	29	EB	AAB	AB	Rsw1
1-2	11	15	CRIAME	7	B			Rsw1
1-2	11	15	ANNGLA	3	A			Rsw1
1-2	11	15	UNISEE	1	A			Rsw1

Transcect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
1-2	12	25	ACRDAN	3	A	CBB		Rsw1
1-2	12	25	ALTPHI	6	A			Rsw1
1-2	12	25	UNISEE	7	A			Rsw1
1-2	12	25	CRIAME	5	B			Rsw1
1-2	12	25	THEINT	18	BB			Rsw1
1-2	12	25	SAUCER	11	A			Rsw1
1-2	12	25	COMDIF	10	B			Rsw1
1-2	12	25	LUDSEE	1	A			Rsw1
1-2	13	35	CRIAME	16	BBB	ACB		Rsw1
1-2	13	35	THEINT	4	A			Rsw1
1-2	13	35	SAUCER	3	BA			Rsw1
1-2	13	35	ANNGLA	1	A			Rsw1
1-2	13	35	HYDSPP	3	A			Rsw1
1-2	13	35	COMDIF	10	B			Rsw1
1-2	13	35	ALTSES	5	A			Rsw1
1-2	13	35	UNISEE	70	A			Rsw1
1-2	14	45	CRIAME	4	BAA	DBB	B	Rsw1
1-2	14	45	SAUCER	14	AAA			Rsw1
1-2	14	45	XANSAG	3	A			Rsw1
1-2	14	45	HYDSPP	19	AA			Rsw1
1-2	14	45	ALTSES	4	AAA			Rsw1
1-2	14	45	UNISEE	4	A			Rsw1
1-2	14	45	JUVFER	1	A			Rsw1
1-2	15	55	ARDESC	2	A	CAC		HHam
1-2	15	55	JUVFER	1	A			HHam
1-2	15	55	SABPAL	1	A			HHam
1-2	15	55	PSYSUL	3	B			HHam
1-2	15	55	BLESER	3	B			HHam
1-2	15	55	CRIAME	1	A			HHam
2-1	16	5	BLESER	35	CC	AAC		Rblh1
2-1	16	5	THEINT	20	BBB			Rblh1
2-1	16	5	SAUCER	1	AA			Rblh1
2-1	16	5	CARAQU	2	AAA			Rblh1
2-1	16	5	CRIAME	2	B			Rblh1
2-1	16	5	ITEVIR	2	B			Rblh1
2-1	17	15	OSMREG	8	B	BCC		Rsw1
2-1	17	15	BLESER	14	B			Rsw1
2-1	17	15	THEINT	3	A			Rsw1

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
2-1	18	25	THESER	52	CC	ABB		HHam/Rsw1
2-1	18	25	THEINT	15	AAB			HHam/Rsw1
2-1	18	25	SAUCER	9	BB			HHam/Rsw1
2-1	18	25	PSYNER	1	A			HHam/Rsw1
2-1	18	25	PSYSUL	4	B			HHam/Rsw1
2-1	18	25	HYDSPP	17	AA			HHam/Rsw1
2-1	18	25	SABAL	1	A			HHam/Rsw1
2-1	18	25	COMDIF	8	AB			HHam/Rsw1
2-1	18	25	CRIAME	1	A			HHam/Rsw1
2-1	18	25	CARAQU	2	A			HHam/Rsw1
2-1	18	25	MIKSCA	3	A			HHam/Rsw1
2-1	18	25	THEDEN	3	B			HHam/Rsw1
2-1	19	35	THEINT	14	BBB	ABC	B	Rsw1
2-1	19	35	THESER	16	D			Rsw1
2-1	19	35	IMPIND	1	A			Rsw1
2-1	19	35	SAUCER	5	AA			Rsw1
2-1	19	35	ITEVIR	2	AA			Rsw1
2-1	19	35	MIKSCA	2	A			Rsw1
2-1	19	35	CRIAME	5	B			Rsw1
2-1	19	35	BLESER	8	A			Rsw1
2-1	19	35	PSYNER	1	A			Rsw1
2-1	19	35	COMDIF	1	A			Rsw1
2-1	19	35	UNISEE	3	A			Rsw1
2-1	20	45	PSYNER	2	A	BDA	B	HH/Rsw1
2-1	20	45	THEINT	12	BB			HH/Rsw1
2-1	20	45	THESER	2	B			HH/Rsw1
2-1	20	45	UNISEE	1	A			HH/Rsw1
2-1	20	45	BLESER	9	B			HH/Rsw1
2-1	21	55	THEINT	49	BDC	ABB		HHam
2-1	21	55	CARAQU	1	A			HHam
2-1	21	55	PSYNER	5	A			HHam
2-1	21	55	UNISEE	4	AA			HHam
2-1	21	55	BLESER	5	C			HHam
2-1	21	55	ARDESC	6	A			HHam
2-1	22	65	THEINT	41	BDC	BBB	B	HHam
2-1	22	65	BLESER	26	BBC			HHam
2-2	23	5	SABPAL	2	A	EAB	B	MHam
2-2	23	5	VITROT	1	A			MHam
2-2	23	5	UNISEE	1	A			MHam
2-2	23	5	BLESER	9	B			MHam
2-2	23	5	CYPRET	5	B			MHam
2-2	23	5	DICSPP	3	B			MHam
2-2	23	5	CALAME	1	A			MHam

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
2-2	24	15	ARDESC	12	B	CCB	C	MHam
2-2	24	15	URELOB	14	BB			MHam
2-2	24	15	BLESER	15	BB			MHam
2-2	24	15	DICSPP	9	ABA			MHam
2-2	24	15	CALAME	2	AA			MHam
2-2	24	15	UNISEE	4	A			MHam
2-2	25	25	CALAME	2	BA	CED		MHam
2-2	25	25	ARDESC	15	BA			MHam
2-2	25	25	DICSPP	2	A			MHam
2-2	25	25	SABPAL	1	A			MHam
2-2	25	25	UNISEE	2	AA			MHam
2-2	25	25	URELOB	1	A			MHam
2-2	26	35	SAUCER	34	ABA	CCE		HHam/Rsw1
2-2	26	35	HYDSPP	6	A			HHam/Rsw1
2-2	26	35	COMDIF	1	A			HHam/Rsw1
2-2	26	35	THESER	7	BA			HHam/Rsw1
2-2	26	35	UNISEE	5	AA			HHam/Rsw1
2-2	26	35	JUVFER	2	A			HHam/Rsw1
2-2	26	35	DICSPP	3	A			HHam/Rsw1
2-2	27	45	COMDIF	41	B	DDC		Rsw1
2-2	27	45	HYDSPP	134	BAB			Rsw1
2-2	27	45	SAUCER	15	AAB			Rsw1
2-2	27	45	UNISEE	34	AA			Rsw1
2-2	27	45	CRIAME	1	B			Rsw1
2-2	27	45	THESER	6	B			Rsw1
2-2	27	45	ITEVIR	4	B			Rsw1
2-2	28	55	CRIAME	6	BB	CCC		Rsw1
2-2	28	55	COMDIF	8	BAA			Rsw1
2-2	28	55	SAUCER	43	BB			Rsw1
2-2	28	55	ACRDAN	3	B			Rsw1
2-2	28	55	HYDSPP	16	A			Rsw1
2-2	28	55	ITEVIR	1	A			Rsw1

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
3-1	29	5	THEINT	21	BBA	ABC		Rblh2
3-1	29	5	CANFLA	1	B			Rblh2
3-1	29	5	QUESEE	1	A			Rblh2
3-1	29	5	SABPAL	1	A			Rblh2
3-1	29	5	PSYSUL	15	AB			Rblh2
3-1	29	5	SMIBON	2	B			Rblh2
3-1	29	5	BLESER	18	BBB			Rblh2
3-1	29	5	SAUCER	3	B			Rblh2
3-1	29	5	PSYNER	7	B			Rblh2
3-1	29	5	UNISEE	38	AA			Rblh2
3-1	29	5	DICSPP	9	BA			Rblh2
3-1	29	5	RHYRAR	1	A			Rblh2
3-1	29	5	URELOP	1	A			Rblh2
3-1	29	5	CALAME	1	A			Rblh2
3-1	30	15	SAUCER	17	BAA	BBA	B	Rblh3
3-1	30	15	THEINT	44	BAD			Rblh3
3-1	30	15	DICSPP	10	BAA			Rblh3
3-1	30	15	URELOP	3	AA			Rblh3
3-1	30	15	BLESER	23	C			Rblh3
3-1	30	15	PSYSUL	15	BB			Rblh3
3-1	30	15	HYPSPP	2	A			Rblh3
3-1	30	15	SCHTER	1	A			Rblh3
3-1	30	15	UNISEE	3	A			Rblh3
3-1	30	15	SMIBON	2	A			Rblh3
3-1	31	25	BLESER	9	B	BAA	B	Rsw2
3-1	31	25	THEINT	11	B			Rsw2
3-1	31	25	PSYSUL	1	A			Rsw2
3-1	31	25	SAUCER	1	A			Rsw2
3-1	31	25	DISCPP	1	AA			Rsw2
3-1	31	25	FRACAR	5	B			Rsw2
3-1	31	25	LUDREP	1	A			Rsw2
3-1	32	35	COMDIF	3	A	AAB	C	Rsw2
3-1	32	35	THESER	87	D			Rsw2
3-1	32	35	ITEVIR	4	B			Rsw2
3-1	32	35	BOECYC	2	B			Rsw2
3-1	32	35	SAUCER	17	C			Rsw2
3-1	32	35	UNISEE	1	A			Rsw2
3-1	32	35	THEINT	17	B			Rsw2

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
3-1	33	45	THEINT	28	BCB	AAB		Rsw1
3-1	33	45	PSYSUL	15	BB			Rsw1
3-1	33	45	SCHTER	1	A			Rsw1
3-1	33	45	IMPIND	11	BAB			Rsw1
3-1	33	45	VITROT	1	A			Rsw1
3-1	33	45	THESER	1	CB			Rsw1
3-1	33	45	SAUCER	17	B			Rsw1
3-1	33	45	PANRIG	1	A			Rsw1
3-1	33	45	UNICYP	1	A			Rsw1
3-1	34	55	SAUCER	15	BA	BAA	DB	Rsw2
3-1	34	55	THEINT	22	BBB			Rsw2
3-1	34	55	BLESER	1	B			Rsw2
3-1	34	55	CRAIME	1	A			Rsw2
3-1	34	55	THESER	43	AC			Rsw2
3-1	34	55	PSYSUL	1	A			Rsw2
3-1	35	65	SAUCER	12	BBA	ABB	C	Rsw2
3-1	35	65	THEINT	36	BBB			Rsw2
3-1	35	65	VITROT	1	A			Rsw2
3-1	35	65	UNISEE	4	AA			Rsw2
3-1	35	65	CRIAME	3	B			Rsw2
3-1	35	65	IMPIND	9	AA			Rsw2
3-1	35	65	THESER	1	A			Rsw2
3-1	35	65	HYDSPP	1	A			Rsw2
3-1	36	75	SAUCER	3	B	DCB		Rsw1
3-1	36	75	CRIAME	4	B			Rsw1
3-1	36	75	THEINT	6	B			Rsw1
3-1	36	75	ANNGLA	1	A			Rsw1
3-1	37	85	CRIAME	5	BBB	CB		Rsw2
3-1	37	85	HYDSPP	5	B			Rsw2
3-1	37	85	FRACAR	7	B			Rsw2
3-1	37	85	THEINT	10	B			Rsw2
3-1	38	95	THEINT	8	BB	BAB		Rsw2
3-1	38	95	THESER	5	BB			Rsw2
3-1	38	95	IMPIND	4	A			Rsw2
3-1	38	95	CRIAME	5	B			Rsw2
3-1	38	95	ITEVIR	2	B			Rsw2
3-1	38	95	LUDSEE	1	A			Rsw2
3-1	39	105	SAUCER	19	BB	ABC	B	Rsw2
3-1	39	105	IMPIND	3	BA			Rsw2
3-1	39	105	THEINT	40	DBB			Rsw2
3-1	39	105	FRACAR	4	B			Rsw2
3-1	39	105	UNISEE	2	A			Rsw2
3-1	39	105	ANNGLA	1	A			Rsw2
3-1	39	105	LUDSEE	1	A			Rsw2

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
3-2	40	5	URELOB	106	CBB	ABB		Upla /HHam
3-2	40	5	VITROT	6	AAB			Upla /HHam
3-2	40	5	RUBTRI	3	BA			Upla /HHam
3-2	40	5	APIAME	2	AA			Upla /HHam
3-2	40	5	HYPALA	5	B			Upla /HHam
3-2	40	5	SMIBON	4	BB			Upla /HHam
3-2	40	5	TOXRAD	1	B			Upla /HHam
3-2	40	5	UNISEE	3	AA			Upla /HHam
3-2	40	5	UNIPOA	25	A			Upla /HHam
3-2	40	5	THEPAL	8	B			Upla /HHam
3-2	40	5	DICSPP	2	B			Upla /HHam
3-2	40	5	ACERUB	4	AA			Upla /HHam
3-2	40	5	LYGMIC	1	A			Upla /HHam
3-2	40	5	MIMQUA	1	A			Upla /HHam
3-2	40	5	CHAFAS	3	AB			Upla /HHam
3-2	40	5	EREHIE	3	A			Upla /HHam
3-2	40	5	UNICYP	1	A			Upla /HHam
3-2	40	5	HYPSPP	1	A			Upla /HHam
3-2	40	5	UNIPOA	2	C			Upla /HHam
3-2	41	15	DISCPP	3	DDC	BBB	B	Rblh2
3-2	41	15	RHYINU	6	BB			Rblh2
3-2	41	15	SAGLAT	1	B			Rblh2
3-2	41	15	ACERUB	18	BBB			Rblh2
3-2	41	15	BOECYL	2	B			Rblh2
3-2	41	15	URELOB	6	BB			Rblh2
3-2	41	15	MICGLO	35	A			Rblh2
3-2	41	15	COMDIF	3	B			Rblh2
3-2	41	15	TOXRAD	1	A			Rblh2
3-2	41	15	SAUCER	1	B			Rblh2
3-2	41	15	SCHTER	1	A			Rblh2
3-2	41	15	PSYSUL	1	A			Rblh2
3-2	41	15	LUDSEE	2	A			Rblh2
3-2	41	15	UNISEE	1	A			Rblh2
3-2	41	15	MIKSCA	1	A			Rblh2
3-2	41	15	BACSPP	1	A			Rblh2
3-2	41	15	QUEVIR	1	A			Rblh2
4-1	42	5	LYGMIC	10	B	CCB		Mham
4-1	42	5	UNISEE	1	A			Mham
4-1	42	5	UNIPOA	1	A			Mham
4-1	42	5	QUEVIR	1	A			Mham
4-1	42	5	UNIPOA	1	A			Mham
4-1	42	5	SMISEE	1	A			Mham
4-1	42	5	SERREP	1	A			Mham

Transcept No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
4-1	43	15	THEINT	26	BB	ABB		Rsw1
4-1	43	15	ACERUB	2	AA			Rsw1
4-1	43	15	SAUCER	1	A			Rsw1
4-1	43	15	DICSPP	14	AB			Rsw1
4-1	43	15	THEINT	1	C			Rsw1
4-1	43	15	THESER	13	C			Rsw1
4-1	43	15	LYGMIC	48	BB			Rsw1
4-1	43	15	URELOB	13	AB			Rsw1
4-1	43	15	CYPSEE	1	A			Rsw1
4-1	43	15	UNISEE	5	A			Rsw1
4-1	43	15	SMISEE	1	A			Rsw1
4-1	43	15	CARAQU	2	A			Rsw1
4-1	44	25	THEINT	20	BBB	CBB		Rsw1
4-1	44	25	BLESER	8	BBB			Rsw1
4-1	44	25	ITEVIR	4	AB			Rsw1
4-1	44	25	SAUCER	1	A			Rsw1
4-1	44	25	ACERUB	1	A			Rsw1
4-1	44	25	UNIXYR	1	A			Rsw1
4-1	44	25	OSMREG	9	C			Rsw1
4-1	44	25	THEDEN	27	B			Rsw1
4-1	44	25	DISCPP	1	A			Rsw1
4-1	45	35	THEINT	10	BAB	BBA		Rblh2
4-1	45	35	BLESER	2	B			Rblh2
4-1	45	35	ACERUB	1	A			Rblh2
4-1	45	35	DISCPP	28	ABB			Rblh2
4-1	45	35	PSYSUL	5	B			Rblh2
4-1	45	35	SAUCER	1	A			Rblh2
4-1	45	35	UNISEE	2	A			Rblh2
4-1	45	35	PARQUI	1	A			Rblh2
4-1	46	45	CRIAME	6	C	CBB	B	Rsw1
4-1	46	45	SAUCER	5	BA			Rsw1
4-1	46	45	ITEVIR	6	AAB			Rsw1
4-1	46	45	LIMSES	5	A			Rsw1
4-1	46	45	LUDREP	1	A			Rsw1
4-1	46	45	THEINT	27	CC			Rsw1
4-1	47	55	CRIAME	11	BBB	BC	B	Rsw1
4-1	47	55	SAUCER	19	BBB			Rsw1
4-1	47	55	THEINT	12	AAB			Rsw1
4-1	47	55	DICSPP	9	B			Rsw1
4-1	47	55	CARAQU	1	A			Rsw1
4-1	47	55	TOXRAD	5	B			Rsw1

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
4-1	48	65	CRIAME	11	BB	C		Rsw1
4-1	48	65	THEINT	12	BBB			Rsw1
4-1	48	65	SAUCER	10	BAA			Rsw1
4-1	48	65	DICSPP	4	AA			Rsw1
4-1	48	65	BOECYL	1	A			Rsw1
4-1	48	65	LUDREP	2	AA			Rsw1
4-1	48	65	PARQUI	1	A			Rsw1
4-1	48	65	IPOIND	1	A			Rsw1
4-1	48	65	BLESER	3	B			Rsw1
4-1	48	65	POASEE	1	A			Rsw1
4-1	48	65	SABPAL	1	B			Rsw1
4-1	49	75	DICSPP	10	B	CCB	B	Rblh2
4-1	49	75	SAUCER	4	B			Rblh2
4-1	49	75	PANRIG	1	B			Rblh2
4-1	49	75	THEINT	3	BB			Rblh2
4-1	50	85	URELOB	1	B	EAA		Rbhlh3
4-1	50	85	BLESER	11	BCB			Rbhlh3
4-1	50	85	THEINT	18	BCB			Rbhlh3
4-1	50	85	PSYNER	1	A			Rbhlh3
4-1	50	85	CRIAME	1	B			Rbhlh3
4-1	50	85	DICSPP	3	A			Rbhlh3
4-1	51	95	THEINT	26	BBD	BAA		Rsw2
4-1	51	95	SAUCER	3	AA			Rsw2
4-1	51	95	UNISEE	4	AA			Rsw2
4-1	51	95	BLESER	8	ACB			Rsw2
4-1	51	95	PSYSUL	4	B			Rsw2
4-1	51	95	CRIAME	1	A			Rsw2
4-1	51	95	DICSPP	1	A			Rsw2
4-1	52	105	BLESER	22	BB	AD		Rsw1
4-1	52	105	THEINT	14	BBB			Rsw1
4-1	52	105	HYDSPP	11	AA			Rsw1
4-1	52	105	ACERUB	1	A			Rsw1
4-1	52	105	DICSPP	7	B			Rsw1
4-1	52	105	UNISEE	1	A			Rsw1
4-1	52	105	ITEVIR	1	B			Rsw1
4-1	53	115	SMIBON	4	B	AA	C	Rblh2
4-1	53	115	THEINT	30	EE			Rblh2
4-1	53	115	DICSPP	2	B			Rblh2
4-1	53	115	TOXRAD	4	A			Rblh2
4-1	53	115	BOECYL	2	B			Rblh2
4-1	53	115	UNISEE	1	A			Rblh2

Transcept No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
5-1	54	5	BLESER	3	A	AAA	ABA	MHam
5-1	54	5	SERREP	4	A			MHam
5-1	54	5	UNISEE	1	A			MHam
5-1	54	5	BLESER	3	A			MHam
5-1	54	5	QUESEE	1	A			MHam
5-1	54	5	TILSET	1	A			MHam
5-1	54	5	TILFAS	1	A			MHam
5-1	55	15	PSYSUL	6	AA	ABE	AAA	HH/Rblh3
5-1	55	15	SMIBON	4	A			HH/Rblh3
5-1	55	15	RAPPUN	1	A			HH/Rblh3
5-1	55	15	PSYNER	8	AA			HH/Rblh3
5-1	55	15	BLESER	4	A			HH/Rblh3
5-1	55	15	ARDESC	1	A			HH/Rblh3
5-1	55	15	UNISEE	13	A			HH/Rblh3
5-1	55	15	DICCOM	2	AA			HH/Rblh3
5-1	55	15	THEINT	2	A			HH/Rblh3
5-1	55	15	TOXRAD	1	A			HH/Rblh3
5-1	55	15	ITEVIR	1	A			HH/Rblh3
5-1	56	25	TOXRAD	3	A	CAA	AAA	Rblh3
5-1	56	25	ITEVIR	2	A			Rblh3
5-1	56	25	BLESER	11	B			Rblh3
5-1	56	25	THEINT	35	BBB			Rblh3
5-1	56	25	PSYSUL	9	AAA			Rblh3
5-1	56	25	DICCOM	17	BBB			Rblh3
5-1	56	25	CARLUP	3	A			Rblh3
5-1	57	35	BLESER	31	AAB	AAA	ABA	Rsw1
5-1	57	35	THEINT	21	B			Rsw1
5-1	57	35	PSYSUL	2	A			Rsw1
5-1	57	35	ITEVIR	11	BAA			Rsw1
5-1	57	35	CARAQU	1	A			Rsw1
5-1	57	35	HYGPOL	3	A			Rsw1
5-1	57	35	TOXRAD	5	A			Rsw1
5-1	57	35	BACGLO	1	A			Rsw1
5-1	57	35	PSYNER	2	A			Rsw1
5-1	57	35	DICCOM	13	BBB			Rsw1
5-1	57	35	CARLUP	1	A			Rsw1
5-1	57	35	COMDIF	4	A			Rsw1
5-1	58	45	THEINT	12	B	ABB	AAA	Rsw1 / Rblh2
5-1	58	45	CARAQU	15	AA			Rsw1 / Rblh2
5-1	58	45	DICCOM	6	ABB			Rsw1 / Rblh2
5-1	58	45	COMDIF	18	A			Rsw1 / Rblh2
5-1	58	45	BLESER	63	DBB			Rsw1 / Rblh2
5-1	58	45	ACERUB	1	A			Rsw1 / Rblh2

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
5-2	59	5	UNIPOA	12	AAB	FCC	BAA	Rblh1
5-2	59	5	THEINT	19	BA			Rblh1
5-2	59	5	HYDSPP	4	A			Rblh1
5-2	59	5	CARAQU	1	A			Rblh1
5-2	59	5	BLESER	1	A			Rblh1
5-2	59	5	DICCOM	1	A			Rblh1
5-2	59	5	IPOIND	1	A			Rblh1
5-2	60	15	UNIPOA	12	C	AAA	BAA	Rsw1
5-2	60	15	BLESER	5	B			Rsw1
5-2	60	15	BISJAV	6	A			Rsw1
5-2	60	15	THEINT	4	A			Rsw1
5-2	61	25	UNIPOA	14	CDA	AAA	CAA	Rsw1
5-2	61	25	DICCOM	5	A			Rsw1
5-2	61	25	CARAQU	1	A			Rsw1
5-2	61	25	UNISEE	4	A			Rsw1
5-2	61	25	COMDIF	6	A			Rsw1
5-2	61	25	THEDEN	4	A			Rsw1
5-2	61	25	BLESER	1	A			Rsw1
5-2	61	25	BOECYL	1	A			Rsw1
5-2	61	25	ACERUB	1	A			Rsw1
5-2	61	25	CARLUP	1	A			Rsw1
5-2	61	25	THEINT	1	A			Rsw1
5-2	62	35	COMDIF	11	BBB	BBB		Rsw1
5-2	62	35	UNIPOA	12	BDA			Rsw1
5-2	62	35	ACERUB	1	A			Rsw1
5-2	62	35	DICSPP	11	DBD			Rsw1
5-2	62	35	PSYNER	1	A			Rsw1
5-2	62	35	SAUCER	3	A			Rsw1
5-2	62	35	BOECYL	5	B			Rsw1
5-2	62	35	QUESEE	1	A			Rsw1
5-2	62	35	THEINT	2	B			Rsw1
5-2	62	35	PSYSUL	6	B			Rsw1
5-2	62	35	UNISEE	1	A			Rsw1

Transcept No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
5-2	63	45	URELOB	11	CBB	BAC		Rblh2
5-2	63	45	COMDIF	55	BBB			Rblh2
5-2	63	45	ACERUB	1	A			Rblh2
5-2	63	45	CARAQU	4	AB			Rblh2
5-2	63	45	BOECYL	34	BB			Rblh2
5-2	63	45	UNIPOA	4	B			Rblh2
5-2	63	45	UNISEE	1	A			Rblh2
5-2	63	45	UNISPP	4	ABB			Rblh2
5-2	63	45	DICCOM	61	CDB			Rblh2
5-2	63	45	PSYSUL	3	BB			Rblh2
5-2	63	45	LUDSEE	1	A			Rblh2
5-2	63	45	BIDALB	2	B			Rblh2
5-2	64	55	UNIPOA	3	B	CDC		Rblh2
5-2	64	55	PSYSUL	6	BA			Rblh2
5-2	64	55	UNICYP	2	AA			Rblh2
5-2	64	55	BLESER	31	BB			Rblh2
5-2	64	55	FRACAR	1	B			Rblh2
5-2	64	55	BOECYL	3	A			Rblh2
5-2	64	55	QUESEE	2	A			Rblh2
5-2	64	55	CARAQU	4	AA			Rblh2
5-2	64	55	COMDIF	23	BAB			Rblh2
5-2	64	55	DICSPP	18	AAB			Rblh2
5-2	64	55	URELOB	1	A			Rblh2
5-2	64	55	UNISPP	2	A			Rblh2
5-2	64	55	EUPMIK	1	B			Rblh2
5-2	64	55	ACERUB	2	AB			Rblh2
5-2	64	55	SABAL	1	A			Rblh2
5-2	65	65	BLESER	57	CBB	CEC		Rblh2
5-2	65	65	THEINT	7	B			Rblh2
5-2	65	65	DICSPP	12	BAA			Rblh2
5-2	65	65	CARAQU	3	AA			Rblh2
5-2	65	65	BOECYL	4	B			Rblh2
5-2	65	65	UNISEE	1	A			Rblh2
5-2	65	65	SIDACU	1	A			Rblh2
5-2	66	75	THEINT	22	BA	CFC	B	Rblh2
5-2	66	75	CARAQU	2	A			Rblh2
5-2	66	75	COMDIF	4	AA			Rblh2
5-2	66	75	DICSPP	5	AAA			Rblh2
5-2	66	75	UNISEE	1	A			Rblh2
5-2	66	75	BOECYL	1	B			Rblh2
5-2	66	75	BLESER	29	C			Rblh2
5-2	66	75	SMIBON	1	A			Rblh2
5-2	66	75	MYRCER	1	A			Rblh2

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
5-2	67	85	SAUCER	1	A	EDB		Rblh2
5-2	67	85	BLESER	13	B			Rblh2
5-2	67	85	SMIBON	8	B			Rblh2
5-2	67	85	COMDIF	2	A			Rblh2
5-2	67	85	IPOIND	4	B			Rblh2
5-2	67	85	UNISEE	1	A			Rblh2
6-1	68	5	BEJRAC	2	A	AAA		Upla
6-1	68	5	LYOLUC	4	B			Upla
6-1	68	5	SERREP	1	A			Upla
6-1	68	5	QUEVIR	19	B			Upla
6-1	68	5	DICSPP	2	A			Upla
6-1	69	15	LYGMIC	8	B	AAA		Upla
6-1	69	15	BLESER	12	BCA			Upla
6-1	69	15	LYOLUC	6	B			Upla
6-1	69	15	IPOIND	3	A			Upla
6-1	69	15	THEPAL	8	C			Upla
6-1	69	15	QUESEE	2	A			Upla
6-1	69	15	SMIBON	1	A			Upla
6-1	69	15	SERREP	1	A			Upla
6-1	70	25	OSMREG	1	BA	AAA		Rsw1
6-1	70	25	BLESER	9	BBA			Rsw1
6-1	70	25	THEINT	3	A			Rsw1
6-1	71	35	BLESER	8	ABB	AAC		UTsw3
6-1	71	35	ANNGLA	1	A			UTsw3
6-1	71	35	THEINT	7	BB			UTsw3
6-1	71	35	UNISEE	1	A			UTsw3
6-1	71	35	LAGRAC	1	A			UTsw3
6-1	71	35	RHIMAN	1	A			UTsw3
6-1	72	45	ANNGLA	3	AA	AAB		UTsw3
6-1	72	45	BLESER	7	BBB			UTsw3
6-1	72	45	THEINT	13	BB			UTsw3
6-1	72	45	ACRDAN	7	BB			UTsw3
6-1	72	45	BACMON	4	A			UTsw3
6-1	72	45	UNISEE	1	A			UTsw3
6-1	72	45	RHIMAN	5	AAA			UTsw3
6-1	72	45	LYGMIC	1	A			UTsw3
6-1	73	55	CRIAME	15	B	AAA		UTsw3
6-1	73	55	THEINT	18	BBA			UTsw3
6-1	73	55	ANNGLA	3	AAA			UTsw3
6-1	73	55	BACMON	13	AA			UTsw3
6-1	73	55	BLESER	5	BB			UTsw3
6-1	73	55	TOXRAD	1	A			UTsw3
6-1	73	55	ACRDAN	4	B			UTsw3

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
6-1	74	65	RHABIF	2	AA	AAA	BA	UTsw3
6-1	74	65	ANNGLA	7	AAA			UTsw3
6-1	74	65	BLESER	9	BBB			UTsw3
6-1	74	65	TOXRAD	2	B			UTsw3
6-1	74	65	BACMON	24	B			UTsw3
6-1	74	65	ELEBAL	5	A			UTsw3
6-1	74	65	SCHTER	2	A			UTsw3
6-1	74	65	UNISEE	2	A			UTsw3
6-1	74	65	RHIMAN	2	A			UTsw3
6-1	74	65	ACRDAN	6	B			UTsw3
6-1	74	65	THEINT	7	B			UTsw3
6-1	75	75	BLESER	10	BB	ABA		UTsw3
6-1	75	75	ANNGLA	2	A			UTsw3
6-1	75	75	RHIMAN	6	AA			UTsw3
6-1	75	75	BACMON	42	BA			UTsw3
6-1	75	75	UNISEE	5	AAA			UTsw3
6-1	75	75	RHABIF	1	A			UTsw3
6-1	75	75	SCHTER	1	A			UTsw3
6-1	76	85	BLESER	5	BB	BBA	B	UTmix
6-1	76	85	SARCLA	2	A			UTmix
6-1	76	85	PSINUD	1	A			UTmix
6-1	76	85	RHIMAN	4	B			UTmix
6-1	76	85	LAGRAC	1	A			UTmix
6-1	77	95	ACRDAN	4	BA	AAA	B	UTsw1
6-1	77	95	ANNGLA	3	AA			UTsw1
6-1	77	95	RHIMAN	1	AA			UTsw1
6-1	77	95	BLESER	2	BA			UTsw1
6-1	77	95	HYDSPP	2	A			UTsw1
6-1	77	95	LAGRAC	9	B			UTsw1
6-1	77	95	PSINUD	8	B			UTsw1
6-1	78	105	RHIMAN	22	ABB	AAA		UTsw1
6-1	78	105	LAGRAC	3	A			UTsw1
6-1	78	105	ANNGLA	1	A			UTsw1
6-1	78	105	CEPOCC	2	B			UTsw1
6-1	78	105	BLESER	1	B			UTsw1
6-1	78	105	SARCLA	2	AA			UTsw1
6-1	78	105	ACRDAN	1	B			UTsw1
6-1	79	115	ACRDAN	7	B	AAA	C	UTsw1
6-1	79	115	TOXRAD	1	A			UTsw1
6-1	79	115	RHIMAN	6	A			UTsw1
6-1	79	115	RHABIF	1	A			UTsw1
6-1	79	115	CRIAME	2	B			UTsw1
6-1	79	115	ANNGLA	1	A			UTsw1
6-1	79	115	SARCLA	1	A			UTsw1

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
6-1	80	125	LAGRAC	3	AA	BAA	B	UTsw1
6-1	80	125	RHABIF	6	AAA			UTsw1
6-1	80	125	RHIMAN	5	AA			UTsw1
6-1	80	125	CRIAME	2	B			UTsw1
6-1	80	125	ANNGLA	2	A			UTsw1
6-1	80	125	TOXRAD	2	A			UTsw1
6-2	81	5	CRIAME	4	BB	AAA	BB	UTsw3
6-2	81	5	ACRDAN	1	A			UTsw3
6-2	81	5	LAGRAC	5	AA			UTsw3
6-2	81	5	RHIMAN	4	AA			UTsw3
6-2	81	5	SARCLA	2	A			UTsw3
6-2	81	5	RHABIF	5	AA			UTsw3
6-2	81	5	ANNGLA	1	A			UTsw3
6-2	82	15	RHABIF	7	AA	AAA	A	UTsw1
6-2	82	15	RAPPUN	1	A			UTsw1
6-2	82	15	ANNGLA	5	A			UTsw1
6-2	82	15	SCHTER	2	A			UTsw1
6-2	82	15	MYRCER	3	A			UTsw1
6-2	82	15	SARCLA	1	A			UTsw1
6-2	82	15	BLESER	1	A			UTsw1
6-2	82	15	ACRDAN	1	A			UTsw1
6-2	83	25	RHIMAN	3	A	AAA	B	UTsw1
6-2	83	25	SAMVAL	1	A			UTsw1
7-1	84	5	SABPAL	1	A	AAB	A	MHam / Rsw1
7-1	84	5	OSMCIN	8	CB			MHam / Rsw1
7-1	84	5	QUESEE	15	AB			MHam / Rsw1
7-1	84	5	LYOLUC	13	BA			MHam / Rsw1
7-1	84	5	VITROT	3	AA			MHam / Rsw1
7-1	84	5	ILEGLA	8	B			MHam / Rsw1
7-1	84	5	SMIBON	6	A			MHam / Rsw1
7-1	84	5	DICSPP	3	A			MHam / Rsw1
7-1	84	5	UNISEE	3	AA			MHam / Rsw1
7-1	84	5	AMOFRU	1	A			MHam / Rsw1
7-1	84	5	SAUCER	12	B			MHam / Rsw1
7-1	84	5	SYZCUM	1	A			MHam / Rsw1
7-1	84	5	TOXRAD	9	B			MHam / Rsw1

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
7-1	85	15	RAPPUN	1	A	AAA	AAA	Rsw1
7-1	85	15	TOXRAD	5	B			Rsw1
7-1	85	15	BLESER	16	BBC			Rsw1
7-1	85	15	BOECYL	2	A			Rsw1
7-1	85	15	SAUCER	22	BAA			Rsw1
7-1	85	15	DICSPP	2	A			Rsw1
7-1	85	15	ACRDAN	1	A			Rsw1
7-1	85	15	CEPOCC	1	A			Rsw1
7-1	85	15	OSMREG	2	BA			Rsw1
7-1	85	15	THEPAL	8	A			Rsw1
7-1	85	15	BACMON	1	A			Rsw1
7-1	85	15	SYZCUM	1	A			Rsw1
7-1	85	15	PSYNER	1	A			Rsw1
7-1	85	15	OSMCIN	8	B			Rsw1
7-1	85	15	HYDSPP	9	A			Rsw1
7-1	85	15	THEINT	3	A			Rsw1
7-1	85	15	SARCLA	1	A			Rsw1
7-1	86	25	CEPOCC	1	B	AAA	BA	Rsw1
7-1	86	25	OSMREG	13	BBB			Rsw1
7-1	86	25	TOXRAD	3	A			Rsw1
7-1	86	25	BLESER	11	BB			Rsw1
7-1	86	25	AMOFRU	2	A			Rsw1
7-1	86	25	SAUCER	2	AA			Rsw1
7-1	86	25	SARCLA	1	A			Rsw1
7-1	86	25	UNISEE	1	A			Rsw1
7-1	87	35	BLESER	6	BB	AAA	ABD	Rmix
7-1	87	35	BOECYL	1	A			Rmix
7-1	87	35	SAUCER	5	BA			Rmix
7-1	87	35	BACGLO	4	AB			Rmix
7-1	87	35	ANNGLA	2	B			Rmix
7-1	87	35	HYPALA	1	A			Rmix
7-1	87	35	ITEVIR	1	A			Rmix
7-1	87	35	LUDREP	3	A			Rmix
7-1	87	35	TOXRAD	10	B			Rmix
7-1	87	35	UNIPOA	2	B			Rmix
7-1	88	45	BLESER	8	AB	AAA	AAA	Rmix
7-1	88	45	LUDREP	7	AA			Rmix
7-1	88	45	TOXRAD	1	A			Rmix
7-1	88	45	MITPET	4	A			Rmix
7-1	88	45	CEPOCC	1	A			Rmix
7-1	88	45	HYDSPP	2	A			Rmix
7-1	88	45	SAUCER	2	A			Rmix
7-1	88	45	PSYNER	1	A			Rmix

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
7-1	89	55	SAUCER	15	AAA	AAA	AAA	Rmix
7-1	89	55	TOXRAD	3	A			Rmix
7-1	89	55	THEINT	2	A			Rmix
7-1	89	55	JUVFER	1	A			Rmix
7-1	89	55	CEPOCC	1	A			Rmix
7-1	89	55	UNISPP	1	A			Rmix
7-1	89	55	UNISEE	1	A			Rmix
7-1	89	55	OSMREG	22	AC			Rmix
7-1	89	55	CRIAME	1	B			Rmix
7-1	90	65	SAUCER	11	AB	AAA	AAA	Rmix
7-1	90	65	TOXRAD	2	A			Rmix
7-1	90	65	CRIAME	4	B			Rmix
7-1	90	65	SARCLA	3	AA			Rmix
7-1	90	65	MIKSCA	3	A			Rmix
7-1	90	65	UNISEE	1	A			Rmix
7-1	90	65	BACMON	1	A			Rmix
7-1	91	75	SYZCUM	8	B	AAA	AAA	Rmix
7-1	91	75	OSMREG	1	B			Rmix
7-1	91	75	SAUCER	5	AA			Rmix
7-1	91	75	LAGRAC	1	A			Rmix
7-1	91	75	BLESER	1	A			Rmix
7-1	91	75	ACRDAN	1	B			Rmix
7-1	91	75	LUDSEE	2	B			Rmix
7-1	91	75	TOXRAD	1	A			Rmix
7-1	91	75	CRIAME	6	B			Rmix
7-1	91	75	MIKSCA	1	A			Rmix
7-1	92	85	LUDREP	12	A	CAA	AAA	UTsw1
7-1	92	85	ACRDAN	2	AA			UTsw1
7-1	92	85	TOXRAD	1	A			UTsw1
7-1	92	85	SARCLA	1	A			UTsw1
7-1	92	85	LAGRAC	1	A			UTsw1
7-1	93	95	TOXRAD	2	A	AAA	AAA	UTsw1
7-1	93	95	LAGRAC	1	A			UTsw1
7-1	93	95	SARCLA	3	AA			UTsw1
7-1	93	95	CRIAME	3	B			UTsw1
7-1	94	105	SALCAR	2	A	AAA	BAA	UTsw1
7-1	94	105	TOXRAD	4	A			UTsw1
7-1	94	105	BLESER	1	A			UTsw1
7-1	94	105	CRIAME	1	B			UTsw1
7-1	94	105	LUDREP	1	A			UTsw1
7-1	94	105	UNISEE	1	A			UTsw1
7-1	94	105	POLPUN	3	A			UTsw1
7-1	94	105	SARCLA	1	A			UTsw1

Transcept No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
7-1	95	115	SARCLA	3	A	ABB	ACA	UTsw1
7-1	95	115	TOXRAD	1	A			UTsw1
7-1	96	125	ACRDAN	1	A	BAA	BAA	UTsw2
7-1	96	125	RHIMAN	2	B			UTsw2
7-1	96	125	UNISEE	1	A			UTsw2
7-1	96	125	CRIAME	1	A			UTsw2
7-1	96	125	SARCLA	6	AA			UTsw2
7-1	96	125	LAGRAC	1	B			UTsw2
7-1	96	125	ANNGLA	1	A			UTsw2
7-1	96	125	RHABIF	1	A			UTsw2
7-1	97	135	ACRDAN	7	BA	AAA	AAA	UTsw2
7-1	97	135	SARCLA	6	AAA			UTsw2
7-1	97	135	RHABIF	2	AA			UTsw2
7-1	97	135	RHIMAN	1	A			UTsw2
7-1	97	135	TOXRAD	1	A			UTsw2
7-1	97	135	LUDREP	7	B			UTsw2
7-1	97	135	ITEVIR	1	A			UTsw2
7-1	98	145	SARCLA	3	A	AAA	AAA	UTsw2
7-1	98	145	RHIMAN	1	A			UTsw2
7-1	98	145	CRIAME	1	A			UTsw2
8	99	5	LYGMIC	25	F	AFA		Rmix
8	100	15	LYGMIC	11	BB	BCB	ABA	HHam
8	100	15	TOXRAD	4	A			HHam
8	100	15	SAUCER	5	AA			HHam
8	100	15	LUDREP	1	A			HHam
8	100	15	BLESER	20	BBC			HHam
8	100	15	OSMREG	8	AC			HHam
8	101	25	BLESER	3	B	CBC	AAA	Rmix
8	101	25	SAUCER	3	AA			Rmix
8	101	25	OSMREG	7	BB			Rmix
8	101	25	TOXRAD	6	BA			Rmix
8	101	25	NEPEXA	1	A			Rmix
8	101	25	ACRDAN	1	A			Rmix
8	101	25	MIKSCA	2	A			Rmix
8	101	25	CEPOCC	1	A			Rmix
8	102	35	OSMREG	1	A	DCB	AAA	UTmix
8	102	35	SAUCER	6	B			UTmix
8	102	35	BLESER	14	BBC			UTmix
8	102	35	BOECYL	1	A			UTmix
8	102	35	TOXRAD	1	A			UTmix
8	102	35	ANNGLA	1	A			UTmix
8	102	35	BACGLO	1	B			UTmix
8	102	35	THEINT	1	AB			UTmix
8	102	35	MIKSCA	1	A			UTmix

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
8	103	45	PERBAR	1	A	DDD	AAA	UTmix
8	103	45	TOXRAD	5	AA			UTmix
8	103	45	MIKSCA	6	AAB			UTmix
8	103	45	POLPUN	1	A			UTmix
8	103	45	ANNGLA	2	AA			UTmix
8	103	45	RAPPUN	1	A			UTmix
8	103	45	BACMON	10	B			UTmix
8	103	45	SAUCER	28	BB			UTmix
8	103	45	LUDSEE	4	BB			UTmix
8	103	45	OSMREG	2	B			UTmix
8	103	45	BLESER	6	B			UTmix
8	104	55	SAUCER	28	BBC	BBB	AEA	UTsw1
8	104	55	LUDREP	3	A			UTsw1
8	104	55	LAGRAC	5	B			UTsw1
8	104	55	BACMON	30	BB			UTsw1
8	104	55	POLPUN	1	A			UTsw1
8	104	55	ANNGLA	4	AAA			UTsw1
8	104	55	HYDSPP	7	AA			UTsw1
8	104	55	TOXRAD	6	BA			UTsw1
8	104	55	LUDOCT	1	B			UTsw1
8	104	55	THEINT	6	B			UTsw1
8	104	55	BLESER	2	B			UTsw1
8	104	55	BOECYL	3	B			UTsw1
8	105	65	SAUCER	52	BB	CCB	ABC	UTmix
8	105	65	HYDSPP	16	B			UTmix
8	105	65	CRIAME	8	BB			UTmix
8	105	65	LAGRAC	4	B			UTmix
8	105	65	LUDSEE	5	A			UTmix
8	105	65	BACMON	12	B			UTmix
8	105	65	BACGLO	3	AB			UTmix
8	105	65	OSMREG	4	B			UTmix
8	105	65	ANNGLA	8	BB			UTmix
8	105	65	BLESER	1	A			UTmix
8	105	65	MYRCER	1	B			UTmix
8	105	65	TOXRAD	3	B			UTmix

Transcect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
8	106	75	MIKSCA	1	B	CBB	AAC	UTsw1
8	106	75	LAGRAC	10	BAC			UTsw1
8	106	75	ANNGLA	14	BB			UTsw1
8	106	75	HYDSPP	43	BBB			UTsw1
8	106	75	CRIAME	3	B			UTsw1
8	106	75	BACMON	29	AC			UTsw1
8	106	75	UNISPP	3	B			UTsw1
8	106	75	UNIPOA	3	B			UTsw1
8	106	75	TAXDIS	1	A			UTsw1
8	106	75	BACGLO	2	BC			UTsw1
8	106	75	BOECYL	1	A			UTsw1
8	106	75	LUDREP	1	A			UTsw1
8	106	75	RHYINU	4	C			UTsw1
8	106	75	SAUCER	1	A			UTsw1
8	106	75	SAGLAT	1	A			UTsw1
8	107	85	LUDREP	353	EAD	BBB	AAA	UTmix
8	107	85	SAUCER	6	BB			UTmix
8	107	85	LAGRAC	37	BBB			UTmix
8	107	85	HYDSPP	22	AAB			UTmix
8	107	85	ANNGLA	3	BB			UTmix
8	107	85	RHYINU	13	BC			UTmix
8	107	85	BACMON	92	ABB			UTmix
8	107	85	CRIAME	13	BBB			UTmix
8	107	85	MIKSCA	1	B			UTmix
8	107	85	LUDSEE	20	CB			UTmix
8	107	85	ACRDAN	2	B			UTmix
8	107	85	UNIPOA	2	B			UTmix
8	108	95	LAGRAC	1	B	BBB	ACA	UTsw1
8	108	95	CRIAME	6	BBB			UTsw1
8	108	95	BACMON	13	BB			UTsw1
8	108	95	SAMVAL	6	BA			UTsw1
8	108	95	SAUCER	9	B			UTsw1
8	108	95	LUDREP	1	A			UTsw1
8	109	105	LAGRAC	5	AA	CBA	AAA	UTsw1
8	109	105	BACMON	1	A			UTsw1
8	109	105	UNISEE	2	A			UTsw1
8	109	105	HYDSPP	17	B			UTsw1
8	109	105	BACMON	4	B			UTsw1
8	109	105	UNIPOA	9	A			UTsw1

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
8	110	115	PANRIG	3	A	CCC	AAA	UTsw1
8	110	115	CRIAME	7	B			UTsw1
8	110	115	SAUCER	2	A			UTsw1
8	110	115	LAGRAC	2	A			UTsw1
8	110	115	POLPUN	1	B			UTsw1
8	110	115	RHIMAN	1	A			UTsw1
9	111	5	ABRPRE	37	BBB	AAC		Upla
9	111	5	VITROT	6	B			Upla
9	111	5	QUEMYR	4	BAA			Upla
9	111	5	MIMQUA	2	A			Upla
9	111	5	CHRICA	15	BB			Upla
9	111	5	SABPAL	2	AA			Upla
9	111	5	UNIPOA	20	AB			Upla
9	111	5	DESTRI	3	A			Upla
9	112	15	ACRDAN	29	D	ADB		HHam
9	112	15	CHRICA	24	AB			HHam
9	112	15	ABRPRE	2	AA			HHam
9	112	15	UNIPOA	1	A			HHam
9	112	15	BLESER	1	B			HHam
9	112	15	SERREP	2	B			HHam
9	113	25	ACRDAN	2	B	ABB		LTsw2
9	113	25	LAGRAC	9	A			LTsw2
9	113	25	ANNGLA	5	AA			LTsw2
9	113	25	RHIMAN	1	A			LTsw2
9	114	35	LAGRAC	12	AAA	BBA	AC	LTsw2
9	114	35	ANNGLA	28	AA			LTsw2
9	114	35	RHABIF	2	AA			LTsw2
9	114	35	SABPAL	1	A			LTsw2
9	115	45	LAGRAC	8	AAA	BBB	CB	LTsw2
9	115	45	ANNGLA	3	AA			LTsw2
9	115	45	ACRDAN	1	A			LTsw2
9	115	45	SABPAL	1	A			LTsw2
9	115	45	RHABIF	1	A			LTsw2
9	116	55	ANNGLA	12	AAA	CDA	C	LTmix
9	116	55	LAGRAC	2	AA			LTmix
9	116	55	RHABIF	1	A			LTmix
9	116	55	BACMON	1	A			LTmix
9	117	65	SABPAL	5	AAA	ECC	C	HHam/LTsw2
9	117	65	BACMON	65	BBC			HHam/LTsw2
9	117	65	ANNGLA	13	AAA			HHam/LTsw2
9	117	65	RHABIF	6	AAA			HHam/LTsw2
9	117	65	CHRICA	3	A			HHam/LTsw2

Transcect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
9	118	75	RHABIF	1	A	BAB		LTsw2
9	118	75	LAGRAC	4	AAA			LTsw2
9	118	75	SABPAL	6	A			LTsw2
9	118	75	BACMON	32	D			LTsw2
9	119	85	LAGRAC	4	AAA	BAB	BCA	LTsw2
9	119	85	ANNGLA	11	AAA			LTsw2
9	119	85	DALECA	2	AA			LTsw2
9	119	85	RHABIF	1	A			LTsw2
9	119	85	SABPAL	3	A			LTsw2
9	120	95	SABPAL	1	A			LTsw2
9	120	95	RHABIF	4	A			LTsw2
9	120	95	ANNGLA	8	AA			LTsw2
9	120	95	LAGRAC	1	A			LTsw2
9	121	105	RHABIF	2	BA	BAA	BCB	LTsw2
9	121	105	LAGRAC	6	AAA			LTsw2
9	121	105	ANNGLA	9	BAA			LTsw2
9	122	115	LAGRAC	2	AA	AAA	AAA	LTsw2
9	122	115	ACRDAN	2	AB			LTsw2
9	122	115	ANNGLA	1	A			LTsw2
9	123	125	ANNGLA	4	A	AAA	BBC	LTsw2
9	123	125	RHIMAN	1	A			LTsw2
9	124	135	ANNGLA	1	A	BAA	ABC	LTsw2
9	124	135	LAGRAC	1	A			LTsw2
9	125	145	LAGRAC	16	B	AAA	AAA	LTsw2
9	125	145	ANNGLA	1	A			LTsw2
9	126	155	ACRDAN	3	B	ACC	AAA	LTsw2
9	126	155	LAGRAC	4	AAA			LTsw2
9	126	155	SABPAL	5	AA			LTsw2
9	126	155	RHIMAN	6	AA			LTsw2
9	126	155	ANNGLA	1	A			LTsw2
9	127	165	LAGRAC	41	BBA	DCB	AAA	LTsw1
9	127	165	RHIMAN	9	ABB			LTsw1
9	127	165	CYPLIG	1	B			LTsw1
9	127	165	BACMON	2	A			LTsw1
9	127	165	RHABIF	1	B			LTsw1
9	128	175	RHIMAN	16	BBB	BBB	AAA	LTsw1
9	128	175	LAGRAC	6	AA			LTsw1
9	129	185	RHIMAN	5	BAA	BDC	AAA	LTsw1
9	129	185	LAGRAC	3	AAA			LTsw1
9	130	195	LAGRAC	2	AA	BBC	ADA	LTsw1
9	130	195	RHIMAN	3	AB			LTsw1
10	131	5	BLESER	3	B	AAA	AAA	HH/Marsh
10	131	5	POLHYD	1	A			HH/Marsh

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
10	132	15	SERREP	1	A	AAA	AAA	Marsh
10	132	15	PSINUD	1	A			Marsh
10	132	15	PLEPOL	1	A			Marsh
10	132	15	BLESER	1	B			Marsh
10	132	15	ANNGLA	1	A			Marsh
10	133	25	CRIAME	7	BB	AAA	AAA	UTsw2
10	133	25	CYPHAS	1	A			UTsw2
10	133	25	LAGRAC	4	BA			UTsw2
10	133	25	TOXRAD	4	B			UTsw2
10	133	25	ANNGLA	3	BA			UTsw2
10	133	25	POLHYD	6	B			UTsw2
10	133	25	MIKSCA	2	B			UTsw2
10	133	25	RHABIF	1	A			UTsw2
10	133	25	HYDSPP	17	B			UTsw2
10	133	25	BLESER	2	B			UTsw2
10	133	25	SCHTER	9	A			UTsw2
10	133	25	LYGMIC	2	A			UTsw2
10	133	25	MYRCER	1	A			UTsw2
10	134	35	BLESER	9	B	AAA	ABA	Utmix
10	134	35	ANNGLA	1	A			Utmix
10	134	35	LAGRAC	1	A			Utmix
10	134	35	CLAJAM	2	B			Utmix
10	134	35	BLESER	8	BB			Utmix
10	134	35	CYPHAS	1	A			Utmix
10	134	35	BACMON	15	D			Utmix
10	134	35	LAGRAC	9	B			Utmix
10	134	35	SARCLA	1	A			Utmix
10	135	45	ANNGLA	3	B	AA	AA	HH
10	135	45	LAGRAC	5	B			HH
10	135	45	BLESER	4	B			HH
10	136	55	LUDREP	12	B	BAA	AAA	UTmix
10	136	55	POLHYD	8	B			UTmix
10	136	55	ANNGLA	6	AAA			UTmix
10	136	55	BLESER	18	BAB			UTmix
10	136	55	LAGRAC	2	AA			UTmix
10	136	55	UNICYP	1	A			UTmix
10	136	55	MIKSCA	1	A			UTmix
10	136	55	SCHTER	1	A			UTmix
10	136	55	SARCLA	1	A			UTmix
10	136	55	BACMON	2	A			UTmix
10	136	55	TOXRAD	1	A			UTmix
10	136	55	UNIPOA	1	A			UTmix

Transect No.	Plot No.	Distance	Species Code[a]	Stem Count	% Cover	% Open Ground	% Fallen Log	Forest Type
10	137	65	BLESER	23	BBB	AAA	AAA	UTmix
10	137	65	ANNGLA	15	BB			UTmix
10	137	65	BACMON	27	BB			UTmix
10	137	65	SCHTER	4	A			UTmix
10	137	65	BACGLO	5	A			UTmix
10	137	65	UNIPOA	1	A			UTmix
10	137	65	POLHYD	6	ABA			UTmix
10	137	65	SABPAL	1	A			UTmix
10	137	65	LAGRAC	19	AB			UTmix
10	137	65	PSICAT	1	B			UTmix
10	137	65	SARCLA	1	A			UTmix
10	138	75	CRIAME	5	BB	BAA	AAA	UTmix
10	138	75	BACMON	7	B			UTmix
10	138	75	SCHTER	4	AA			UTmix
10	138	75	ANNGLA	2	AA			UTmix
10	138	75	PANVIR	3	BB			UTmix
10	138	75	SARCLA	2	AA			UTmix
10	138	75	RHABIF	4	A			UTmix

[a] Species code list is provided in **Appendix C**

A=0-5% (2.5%) B=5-25% (10%) C=25-50% (37.5%) D=50-75% (62.5%) E=75-95% (85.0%) F=95-100% (87.5%)

Table E-20. Transect 1 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)							
	U (0.5)	RMH (2)	RHH (2.5)	Rblh3	Rblh2	Rblh1 (1)	Rsw2	Rsw1 (9)
Abrus precatorius		**1**						
Acer rubrum		**1**				**1**		
Acrostichum danaeifolium								**3**
Alternanthera philoxeroides			**1**					**1**
Alternanthera sessilia								**3**
Annona glabra								**3**
Ardisia escallonioides								
Blechnum serrulatum		**1**	**3**					
Boehmeria cylindrica								**2**
Callicarpa americana			**1**					
Carex lupuliformis								**2**
Colocasia esculenta								**1**
Commelina diffusa						**1**		**3**
Crinum americanum			**1**			**1**		**7**
Dichanthelium commutatum			**1**					
Fern seedling			**1**					**1**
Hydrocotyle spp.								**5**
Ludwigia seedling								**1**
Osmunda regalis		**1**						
Parthenocissus quinquefolia		**1**	**1**					**1**
Psychotria nervosa			**2**			**1**		**1**
Psychotria sulzneri			**1**					
Quercus seedling		**1**	**1**					
Quercus laurifolia		**1**						
Sabal palmetto		**1**	**3**					**1**
Saururus cernuus						**1**		**6**
Senna pendula						**1**		
Smilax bona-nox			**1**					
Sphagneticola trilobata								**1**
Syngonium podophyllum								**2**
Thelypteris dentata		**1**						**1**
Thelypteris interrupta		**1**				**1**		**6**
Thelypteris serrata								**1**
Tillandsia fasciculate		**1**						
Toxicodendron radicans		**1**	**1**					
Unidentified seedling	**1**	**2**	**1**					**8**
Unidentified spp.		**1**						**1**
Urena lobata		**2**	**2**					
Vitis rotundifolia		**2**						

Table E-21. Transect 2 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)							
	U	RMH (3)	RHH (3.5)	Rblh3	Rblh2	Rblh1 (1)	Rsw2 (0.5)	Rsw1 (5.5)
Acrostichum danaeifolium								**1**
Annona glabra								
Ardisia escallonioides		**2**	**1**					
Blechnum serrulatum		**2**	**3**			**1**		**2**
Boehmeria cylindrica								
Callicarpa americana		**3**				**1**		
Carya aquatica			**2**			**1**		
Commelina diffusa			**2**					**3**
Crinum americanum						**1**		**4**
Cyperus retrorsus		**1**						
Dichanthelium spp.		**3**	**1**					
Fern seedling								**1**
Hydrocotyle spp.			**2**					**2**
Ipomoea indica								**1**
Itea virginica						**1**		**3**
Mikania scandens			**1**					**1**
Nephrolepis exaltata						**1**		
Osmunda regalis								**1**
Parthenocissus quinquefolia						**1**		
Psychotria nervosa			**3**					**1**
Psychotria sulzneri			**1**					
Sabal palmetto		**2**	**1**					
Saururus cernuus						**1**		**5**
Serenoa repens								
Taxodium distichum						**1**		
Thelypteris dentata								**1**
Thelypteris interrupta			**2**			**1**	**1**	**4**
Thelypteris serrata							**1**	**5**
Unidentified seedling		**3**	**3**					**2**
Urena lobata		**2**						
Vitis rotundifolia		**1**						

Table E-22. Transect 3 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)							
	U (0.5)	RMH	RHH (0.5)	Rblh3 (1)	Rblh2 (2)	Rblh1	Rsw2 (7)	Rsw1 (2)
Acer rubrum			**1**		**1**			
Annona glabra							**1**	**1**
Apios americana			**1**					
Baccharis spp.					**1**			
Blechnum serrulatum				**1**	**1**		**2**	
Boehmeria cylindrica					**1**		**1**	
Canna flaccida					**1**			
Chamaecrista fasciculata	**1**							
Commelina diffusa					**1**		**1**	
Crinum americanum							**4**	**1**
Dichanthelium spp.			**1**	**1**	**2**		**1**	
Erechtites hieraciifolius			**1**					
Fraxinus caroliniana							**3**	
Galactia spp.								
Hydrocotyle spp							**2**	
Hypericum spp.			**1**	**1**				
Hyptis alata			**1**					
Ipomoea indica							**2**	**1**
Itea virginica							**2**	
Ludwigia repens							**1**	
Ludwigia seedling					**1**		**2**	
Lygodium microphyllum			**1**					
Melanthera nivea			**1**					
Micranthemum glomeratum					**1**			
Mikania scandens					**1**			
Mimosa quadrivalvis	**1**							
Osmunda regalis								
Panicum rigidulum								**1**
Pontederia cordata					**1**			
Psychotria nervosa					**1**			
Psychotria sulzneri				**1**	**2**		**2**	**1**
Quercus seedling					**1**			
Quercus laurifolia					**1**			
Rapanea punctata								
Rhynchospora inundata					**1**			
Rhynchospora rariflora					**1**			
Rubus trivialis			**1**		**1**			
Sabal palmetto					**1**			
Sarcostemma clausum								
Saururus cernuus				**1**	**2**		**5**	**2**

Groundcover Species	U (0.5)	RMH	RHH (0.5)	Rblh3 (1)	Rblh2 (2)	Rblh1	Rsw2 (7)	Rsw1 (2)
	Forest Type (# plots)							
Schinus terebinthifolius				**1**	**1**			**1**
Smilax auriculata			**1**	**1**	**1**			
Thelypteris interrupta				**1**	**1**		**7**	**2**
Thelypteris palustris			**1**					
Thelypteris serrata							**4**	**1**
Toxicodendron radicans			**1**		**1**			
Unid. Cyperaceae			**1**					**1**
Unid. Poaceae	**1**							
Unidentified seedling			**1**	**1**	**2**		**3**	
Unidentified spp.								
Urena Lobata			**1**	**1**	**2**			
Vitis rotundifolia			**1**				**1**	**1**

Table E-23. Transect 4 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)							
	U	RMH (1)	RHH	Rblh3 (1)	Rblh2 (3)	Rblh1	Rsw2 (1)	Rsw1 (6)
Acer rubrum					**1**			**3**
Blechnum serrulatum				**1**	**1**		**1**	**3**
Boehmeria cylindrica					**1**			**1**
Carya aquatica								**2**
Crinum americanum				**1**			**1**	**3**
Dicanthelium spp.				**1**	**3**		**1**	**5**
Hydrocotyle spp.								
Ipomoea indica								**1**
Itea virginica								**3**
Limnophila sessiliflora								**1**
Ludwigia repens								**2**
Lygodium microphyllum		**1**						**1**
Osmunda regalis								**1**
Panicum rigidulum					**1**			
Parthenocissus quinquefolia					**1**			**1**
Pleopeltis polypodioides								
Psychotria nervosa				**1**				
Psychotria sulzneri					**1**		**1**	
Quercus virginiana		**1**						
Sabal palmetto					**1**			**1**
Sagittaria latifolia								
Saururus cernuus					**2**		**1**	**5**
Serenoa repens		**1**						
Smilax bona-nox					**1**			
Smilax spp.		**1**						**1**
Thelypteris dentata								**1**
Thelypteris interrupta				**1**	**3**		**1**	**6**
Thelypteris serrata								**1**
Toxicodendron radicans					**1**			**1**
Unidentified cyperaceae								**1**
Unidentified Poaceae		**1**						**1**
Unidentified seedling		**1**			**2**		**1**	**2**
Unidentified Xyris								**1**
Urena lobata				**1**				**1**

Table E-24. Transect 5 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)							
	U	RMH (1)	RHH	Rblh3 (1)	Rblh2 (6.5)	Rblh1 (1)	Rsw2	Rsw1 (4.5)
Acer rubrum					**3**			**2**
Ardisia escallonioides								
Baccharis glomeruliflora			**1**					**1**
Bidens alba					**1**			
Bischofia javanica								**1**
Blechnum serrulatum		**1**		**2**	**5**	**1**		**2**
Boehmeria cylindrica					**4**			**2**
Carex lupuliformis				**1**				**2**
Carya aquatica					**5**	**1**		**1**
Chromolaena odorata					**1**			
Commelina diffusa					**5**			**3**
Dichanthelium commutatum		**1**	**1**		**2**	**1**		**1**
Dichanthelium spp.					**3**			**1**
Fraxinus caroliniana					**1**			
Hydrocotyle spp						**1**		
Hygrophila polysperma								**1**
Ipomoea indica					**1**	**1**		
Itea virginica		**2**						**1**
Ludwigia seedling					**1**			
Myrica cerifera					**1**			
Psychotria nervosa			**1**					**2**
Psychotria sulzneri				**2**	**2**			**1**
Quercus seedling		**1**			**1**			**1**
Rapanea punctata				**1**				
Sabal palmetto					**1**			
Saururus cernuus					**1**			**1**
Serenoa repens		**1**						
Sida acuta					**1**			
Smilax bona-nox				**1**	**2**			
Thelypteris dentata								**1**
Thelypteris interrupta		**1**		**2**	**3**	**1**		**3**
Tillandsia fasciculate		**1**						
Tillandsia setacea		**1**						
Toxicodendron radicans		**2**						**1**
Unid. Cyperaceae					**1**			
Unid. Poaceae					**2**	**1**		**3**
Unidentified seedling		**1**	**1**		**4**			**3**
Unidentified spp.					**2**			
Urena lobata					**2**			

Table E-25. Transect 6 – Frequency of Groundcover by Forest Type

	Forest Type (# plots)									
Groundcover Species	**U (2)**	**UTMH**	**UTHH**	**UTmix (1)**	**Rmix**	**UTsw3 (6)**	**UTsw2**	**Marsh**	**UTsw1 (6)**	**Rsw1 (1)**
Acrostichum danaeifolium						**4**			**5**	
Annona glabra						**6**			**5**	
Bacopa monnieri						**4**				
Bejaria racemosa	**1**									
Blechnum serrulatum	**1**			**1**		**5**			**3**	**1**
Cephalanthus occidentalis									**1**	
Crinum americanum						**2**			**2**	
Dichanthelium spp.	**1**									
Eleocharis baldwinii						**1**				
Hydrocotyle spp.									**1**	
Ipomoea indica	**1**									
Laguncularia racemosa				**1**		**2**			**3**	
Lygodium microphyllum	**1**					**1**				
Lyonia lucida	**2**									
Myrica cerifera									**1**	
Osmunda regalis										**1**
Psilotum nudum				**1**					**1**	
Quercus seedling	**1**									
Quercus virginiana	**1**									
Rapanea punctata									**1**	
Rhabdadenia biflora						**3**			**3**	
Rhizophora mangle				**1**		**5**			**5**	
Samolus valerandi									**1**	
Sarcostemma clausum				**1**		**1**			**3**	
Schinus terebinthifolius						**2**			**1**	
Serenoa repens	**2**									

Groundcover Species	Forest Type (# plots)									
	U (2)	UTMH	UTHH	UTmix (1)	Rmix	UTsw3 (6)	UTsw2 (1)	Marsh	UTsw1 (6)	Rsw1 (1)
Smilax bona-nox	**1**									
Thelypteris interrupta						**4**				**1**
Thelypteris palustris	**1**									
Toxicodendron radicans						**2**			**2**	
Unidentified seedling						**4**				

Table E-26. Transect 7 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)									
	U	UTMH (0.5)	UTHH	UTmix (5)	Rmix	UTsw3	UTsw2 (3)	Marsh	UTsw1 (4)	Rsw1 (2.5)
Acrostichum danaeifolium				**1**			**2**		**1**	**1**
Amorpha fruticosa		**1**								**1**
Annona glabra				**1**			**1**			
Baccharis glomeruliflora				**1**						
Bacopa monnieri				**1**						**1**
Blechnum serrulatum				**3**					**1**	**2**
Boehmeria cylindrica				**1**						**1**
Cephalanthus occidentalis				**2**						**2**
Crinum americanum				**3**			**2**		**2**	
Dichanthelium spp.		**1**								**1**
Fern seedling				**1**						
Hydrocotyle spp.				**1**						**1**
Hyptis alata				**1**						
Ilex glabra		**1**								
Itea virginica				**1**			**1**			
Laguncularia racemosa				**1**			**1**		**2**	
Ludwigia repens				**2**			**1**		**2**	
Ludwigia seedling				**1**						
Lyonia lucida		**1**								
Mikania scandens				**2**						
Mitreola petiolata							**1**			
Osmunda cinnamomea										**2**
Osmunda regalis				**2**						**2**
Polygonum hydropiperodies									**1**	

Groundcover Species	Forest Type (# plots)									
	U	UTMH (0.5)	UTHH	UTmix (5)	Rmix	UTsw3	UTsw2 (3)	Marsh	UTsw1 (4)	Rsw1 (2.5)
Psychotria nervosa				**1**						**1**
Quercus seedling		**1**								
Rapanea punctata										**1**
Rhabdadenia biflora							**2**			
Rhizophora mangle							**3**			
Sabal palmetto		**1**								
Salix caroliniana									**1**	
Sarcostemma clausum							**3**		**4**	**2**
Saururus cernuus				**6**						**3**
Smilax laurifolia		**1**								
Syzgium cumini				**1**						**2**
Thelypteris interrupta				**1**						**1**
Thelypteris palustris										**1**
Toxicodendron radicans		**1**		**5**			**1**		**4**	**2**
Unid. Poaceae				**1**						
Unidentified seedling		**1**		**2**			**1**		**1**	**1**
Unidentified spp.				**1**						
Vitis rotundifolia		**1**								

Table E-27. Transect 8 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)									
	U	UTMH	UTHH (1)	UTmix (3)	Rmix (2)	UTsw3	UTsw2	Marsh	UTsw1 (6)	Rsw1
Acrostichum danaeifolium					**1**				**1**	
Annona glabra				**3**					**3**	
Baccharis glomeruliflora				**2**					**1**	
Bacopa monnieri				**2**					**6**	
Blechnum serrulatum			**1**	**3**	**1**				**1**	
Boehmeria cylindrica				**1**					**2**	
Cephalanthus occidentalis				**1**	**1**					
Crinum americanum				**1**					**4**	
Hydrocotyle spp.				**1**					**4**	
Laguncularia racemosa				**1**					**6**	
Ludwigia octovalvis									**1**	
Ludwigia repens			**1**						**4**	
Ludwigia seedling				**2**					**1**	
Lygodium microphyllum			**1**		**1**					
Mikania scandens				**2**	**1**				**2**	
Myrica cerifera				**1**						
Nephrolepis exaltata					**1**					
Osmunda regalis			**1**	**3**	**1**					
Panicum rigidulum									**1**	
Persea borbonia				**1**						
Polygonum hydropiperoides				**1**					**2**	
Rapanea punctata				**1**						
Rhizophora mangle									**1**	
Rhynchospora inundata									**2**	

Groundcover Species	Forest Type (# plots)									
	U	UTMH	UTHH (1)	UTmix (3)	Rmix (2)	UTsw3	UTsw2	Marsh	UTsw1 (6)	Rsw1
Sagittaria latifolia									**1**	
Samolus valerandi									**1**	
Saururus cernuus			**1**	**3**	**1**				**5**	
Taxodium distichum									**1**	
Thelypteris interrupta				**1**					**1**	
Toxicodendron radicans			**1**	**3**	**1**				**1**	
Unid. Poaceae									**3**	
Unidentified seedling									**2**	
Unidentified spp.										

Table E-28. Transect 9 – Frequency of Groundcover by Forest Type

Groundcover Species	Forest Type (# plots)				
	U (1)	LTHH (1.5)	LTmix (1)	LTsw2 (12.5)	LTsw1 (4)
Abrus precatorius	**1**	**1**			
Acrostichum danaeifolium		**1**		**4**	
Annona glabra			**1**	**12**	
Bacopa monnieri			**1**	**2**	**1**
Blechnum serrulatum		**1**			
Chrysobalanus icaco	**1**	**2**			
Cyperus ligularis					**1**
Dalbergia ecastaphyllum				**1**	
Desmodium triflorum	**1**				
Laguncularia racemosa			**1**	**11**	**4**
Mimosa quadrivalvis	**1**				
Quercus myrtifolia	**1**				
Rhabdadenia biflora			**1**	**7**	**1**
Rhizophora mangle				**3**	**4**
Sabal palmetto	**1**	**1**		**6**	
Serenoa repens		**1**			
Unid. Poaceae	**1**	**1**			
Vitis rotundifolia	**1**				

Table E-29. Transect 10 – Frequency of Groundcover by Forest Type

	Forest Type (# plots)									
Groundcover Species	**U**	**UTMH**	**UTHH (1.5)**	**UTmix (4)**	**Rmix**	**UTsw3**	**UTsw2 (1)**	**Marsh (1.5)**	**UTsw1**	**Rsw1**
Annona glabra			**1**	**3**			**2**	**1**		
Ardisia escallonioides										
Baccharis glomeruliflora							**1**			
Bacopa monnieri			**1**	**1**			**2**			
Blechnum serrulatum			**3**	**1**			**2**	**1**		
Cladium jamaicense				**1**						
Crinum americanum							**2**			
Cyperus haspan				**1**			**1**			
Hydrocotyle spp.							**1**			
Laguncularia racemosa			**2**	**1**			**2**			
Ludwigia repens			**1**							
Lygodium microphyllum							**1**			
Mikania scandens			**1**				**1**			
Myrica cerifera							**1**			
Panicum virgatum							**1**			
Pleopeltis polypodioides								**1**		
Polygonum hydropiperoides			**1**				**2**	**1**		
Psidium cattleianum							**1**			
Psilotum nudum								**1**		
Rhabdadenia biflora							**2**			
Sabal palmetto				**3**						
Sarcostemma clausum			**1**	**1**			**2**			
Schinus terebinthifolius			**1**	**1**			**2**			
Serenoa repens								**1**		
Toxicodendron radicans			**1**				**1**			
Unid. Cyperaceae			**1**							
Unid. Poaceae			**1**				**1**			

Table E-30. Frequency of Groundcover Species for all Transects by Forest Type

Groundcover Species	Forest Type (# plots)										
	Marsh (1.5)	U (4)	MH (8.5)	HH (10.5)	Blh3 (3)	Blh2 (9.5)	Blh1 (4)	Mix (14)	Sw3 (6)	Sw2 (27.5)	Sw1 (49.5)
Abrus precatorius		**1**	**1**	**1**							
Acer rubrum		**0.5**	**2**	**0.5**		**4.5**	**1**				**5.5**
Acrostichum danaeifolium				**1**				**4**	**3**	**6**	**13**
Alternanthera philoxeroides											**1**
Alternanthera sessilia				**0.5**							**3.5**
Amorpha fruticosa			**0.5**								**1.5**
Annona glabra	**1**			**2.5**				**7**	**5**	**17.5**	**12**
Apios americana		**0.5**		**0.5**							
Ardisia escallonioides			**2**	**2**	**0.5**						**0.5**
Baccharis glomeruliflora								**3**		**1**	**2**
Bacopa monnieri				**1**				**6**	**4**	**4**	**7**
Bejaria racemosa		**1**									
Bidens alba						**1**					
Bischofia javanica											**1**
Blechnum serrulatum	**1.5**	**1.5**	**6.5**	**9**	**3**	**6.5**	**2**	**10**	**5**	**4.5**	**17.5**
Boehmeria cylindrica			**0.5**			**6**		**3**		**1**	**11.5**
Callicarpa americana		**0.5**	**3**	**0.5**			**1**				
Canna flaccida						**1**					
Carex lupuliformis			**1**								**5**
Carya aquatica				**1.5**		**4.5**	**2**				**4**
Cephalanthus occidentalis								**3**			**3**
Chamaecrista fasciculate		**0.5**		**0.5**							
Chrysobalanus icaco		**1**		**1**						**1**	
Cladium jamaicense								**1**			
Commelina diffusa				**1**		**5.5**	**1**				**10.5**
Crinum americanum				**1**	**1**		**2**	**5**	**1**	**7**	**23**

	Forest Type (# plots)										
Groundcover Species	**Marsh (1.5)**	**U (4)**	**MH (8.5)**	**HH (10.5)**	**Blh3 (3)**	**Blh2 (9.5)**	**Blh1 (4)**	**Mix (14)**	**Sw3 (6)**	**Sw2 (27.5)**	**Sw1 (49.5)**
Cyperus haspan								**1**		**1**	
Cyperus ligularis											**1**
Cyperus retrorsus			**1**								
Dalbergia ecastaphyllum										**1**	
Desmodium triflorum		**1**									
Dicanthelium commutatum			**1**	**1**	**1**	**1.5**	**1**				**1.5**
Dicanthelium spp.		**1.5**	**3.5**	**1**	**2**	**8**				**2**	**8**
Eleocharis baldwinii									**1**		
Erechtites hieraciifolia		**0.5**		**0.5**							
Eupatorium mikanioides						**1**					
Fern seedling				**1**				**1**			**2**
Fraxinus caroliniana						**1**				**3**	
Galactia sp.		**0.5**		**0.5**							
Grass seedling											**1**
Hydrocotyle spp				**1**			**1**	**3**		**2**	**14**
Hygrophila polysperma											**1**
Hypericum spp.		**0.5**		**0.5**	**1**						
Hyptis alata		**0.5**		**0.5**				**1**			
Ilex glabra			**0.5**								**0.5**
Ipomoea indica		**1**				**1**	**1**			**2**	**3**
Itea virginica			**1**		**1**	**1**	**1**	**1**		**3**	**8**
Laguncularia racemosa				**2**				**6**	**1**	**14**	**15**
Limnophila sessiliflora											**1**
Ludwigia octovalvis											**1**
Ludwigia repens				**2**				**4**		**2**	**7**
Ludwigia seedling						**2**		**4**		**2**	**1**
Lygodium microphyllum		**1.5**	**1**	**1.5**				**1**	**1**	**1**	**1**

	Forest Type (# plots)										
Groundcover Species	**Marsh (1.5)**	**U (4)**	**MH (8.5)**	**HH (10.5)**	**Blh3 (3)**	**Blh2 (9.5)**	**Blh1 (4)**	**Mix (14)**	**Sw3 (6)**	**Sw2 (27.5)**	**Sw1 (49.5)**
Lyonia lucida		**2**	**0.5**								**0.5**
Melanthera nivea		**0.5**		**0.5**							
Micranthemum glomeratum						**1**					
Mikania scandens				**1.5**		**1**		**6**		**1**	**2.5**
Mimosa quadrivalvis		**1.5**		**0.5**							
Moss spp.			**1**								**1**
Myrica cerifera						**1**		**1**		**1**	**1**
Nephrolepis exaltata							**1**	**1**			
Osmunda cinnamomea			**0.5**								**1.5**
Osmunda regalis			**1**	**1**	**1**	**1**		**7**			**5**
Panicum rigidulum						**1**					**2**
Panicum virgatum										**1**	
Parthenocissus quinquefolia		**0.5**	**1**	**0.5**		**1**	**1**				**2**
Persea borbonia								**1**			
Pleopeltis polypodioides	**1**					**1**					
Polygonum hydropiperoides	**0.5**			**1.5**						**2**	
Polygonum punctatum								**1**			**3**
Psidium cattleianum										**1**	
Psilotum nudum	**1**							**1**			**1**
Psychotria nervosa		**0.5**		**3.5**	**2**	**1**	**1**	**1**		**0.5**	**5.5**
Psychotria sulzneri			**2**	**1**	**2**	**5**				**3**	**3**
Quercus myrtifolia		**1**									
Quercus seedling		**1**	**2.5**	**1**		**2**					**1.5**
Quercus virginiana		**1**	**2**			**1**					
Rapanea punctata					**1**	**1**		**1**			**2**
Rhabdadenia biflora								**1**	**2**	**11**	**5**
Rhizophora mangle								**1**	**4**	**6**	**11**

	Forest Type (# plots)										
Groundcover Species	**Marsh (1.5)**	**U (4)**	**MH (8.5)**	**HH (10.5)**	**Blh3 (3)**	**Blh2 (9.5)**	**Blh1 (4)**	**Mix (14)**	**Sw3 (6)**	**Sw2 (27.5)**	**Sw1 (49.5)**
Rhynchospora inundata						**1**		**1**			**1**
Rhynchospora rariflora						**1**					
Rubus trivialis		**0.5**		**0.5**		**1**					
Sabal palmetto		**1.5**	**3.5**	**2.5**		**3**				**7**	**3.5**
Sagittaria latifolia						**1**					**2**
Salix caroliniana											**1**
Samolus valerandi											**2**
Sarcostemma clausum				**1**				**2**		**6**	**10**
Saururus cernuus			**0.5**	**2**	**1**	**5**	**2**	**10**		**4**	**23.5**
Schinus terebinthifolius				**1**	**1**	**1**			**2**	**3**	**2**
Sedge seedling											
Senna pendula							**1**				
Serenoa repens	**1**	**2**	**3**	**1**							
Sida acuta						**1**					
Smilax bona-nox		**3**	**0.5**	**2**	**2**	**4**					**0.5**
Smilax seedling			**1**								**1**
Syngonium podophyllum											**2**
Syzgium cumini			**0.5**					**1**			**1.5**
Taxodium distichum							**1**				**1**
Thelypteris dentata			**1**	**0.5**							**3.5**
Thelypteris interrupta			**2**	**3**	**3**	**7.5**	**3**	**2**	**4**	**6.5**	**24**
Thelypteris palustris		**1.5**		**0.5**							**1**
Thelypteris serrata				**1.5**						**3.5**	**6**
Tillandsia fasciculata			**2**								
Tillandsia setacea			**1**								
Toxicodendron radicans		**0.5**	**2.5**	**3.5**	**1**	**2**		**9**	**2**	**2**	**10.5**
Unid. Cyperaceae		**0.5**		**1.5**		**1**					**1**

Groundcover Species	Forest Type (# plots)										
	Marsh (1.5)	U (4)	MH (8.5)	HH (10.5)	Blh3 (3)	Blh2 (9.5)	Blh1 (4)	Mix (14)	Sw3 (6)	Sw2 (27.5)	Sw1 (49.5)
Unid. Poaceae		**2**	**1**	**3**		**2**	**1**	**2**		**1**	**5**
Unidentified seedling		**1**	**7.5**	**3**	**2**	**8**		**2**	**4**	**4.5**	**20**
Unidentified spp.			**1**			**2**		**1**			**2**
Unidentified Xyris											**1**
Urena lobata		**1**	**4**	**2**	**2**	**5**					**1**
Vitis rotundifolia		**2**	**3.5**	**1**							**1.5**
Wedelia trilobata											**1**
Xanthosoma sagittifolium											**1**

APPENDIX F

TAYLOR ALEXANDER'S 1967 VEGETATION STUDY ON THE LOXAHATCHEE RIVER

Introduction

Dr. Taylor R. Alexander was one of Florida's outstanding and earliest environmentalists, publishing some of the first detailed descriptions of southern Florida's plant communities. He was born and raised in Arkansas and received his Ph.D. from the University of Chicago in 1941. His long association with the University of Miami began in 1940 as an assistant professor, botanist, then Professor, then Chairman of the Department of Botany and lastly as a Professor of Botany and ended when he retired in 1977. He authored two books on Botany and Ecology, and published over 30 scientific reports, almost all pertaining to southern Florida.

Dr. Alexander extensively studied the plant communities within Jonathan Dickinson State Park in the late 1960s and again in the 1970s with Alan Crook. They utilized a combination of 1940 and 1970 aerial photographs and ground-truthing techniques to study the plant communities along the Northwest Fork of the Loxahatchee River and Kitching Creek and documented the decline of bald cypress forests due to changes in salinity on the Loxahatchee River. They concluded that since 1940, wet prairie and swamp hardwoods had lost ground to pineland and mangrove communities due to a lowering of the groundwater table, increase in salinities and decrease of freshwater flows. This information was published in their 1973 and 1975 reports, "Recent and Long Term Vegetational Changes and Patterns in South Florida." These two publications were the area's most comprehensive ecological evaluations that concentrated on changes occurred from 1940 into the mid-1970s.

Prior to his death in 2005, Dr. Alexander provided Richard E. Roberts (one of the major authors of this report) with his original field notes and photographs to assist in the current study of the Loxahatchee River floodplain (**Figure F-1**).

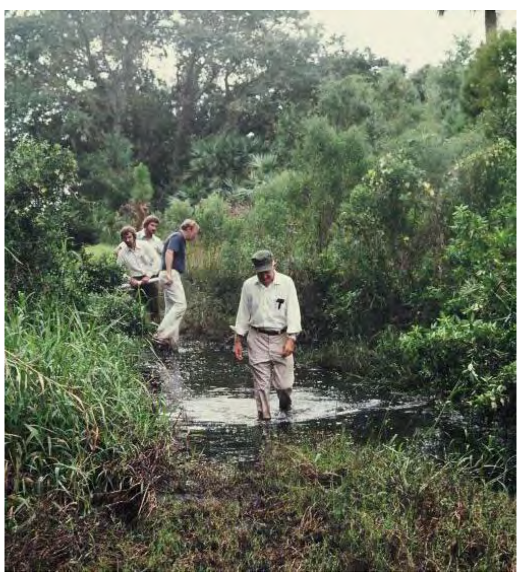


Figure F-1. Photograph of Dr. Taylor Alexander in the field with consultants within the Loxahatchee River floodplain.

Background and Methods

During April 1967, Taylor Alexander established vegetation quadrats along a transect on the Northwest Fork of the Loxahatchee River on a peninsula near the Jonathan Dickinson State Park boat ramp (RM 6.46). The peninsula had apparently escaped lumbering and appeared to have a substantial community of old and very large bald cypress (**Figure F-2**). The current authors adopted this historical transect as Transect 9 in the 2003 Loxahatchee Floodplain Vegetation Study.

Dr. Alexander considered it a rare opportunity to study temperate and sub-tropical species in combination with salt-tolerant and non-salt tolerant species in such a limited area. His transect contained dead, sick but living, and healthy cypress trees. His transect was 137 m (450 feet) long with 36 5 m^2 quadrats along a transect. In the 1967 quadrat survey data, the frequency (how often it occurred in one of the quadrats) and density (how many times each individual occurred in the quadrat) of each species were recorded. To provide a historical reference, both live and dead species were recorded. Water and soil samples were analyzed for pH, electrical conductivity, and chloride content. Dr. Alexander presented this information as a paper at the 1971 Annual Meeting of the Florida Academy of Sciences.

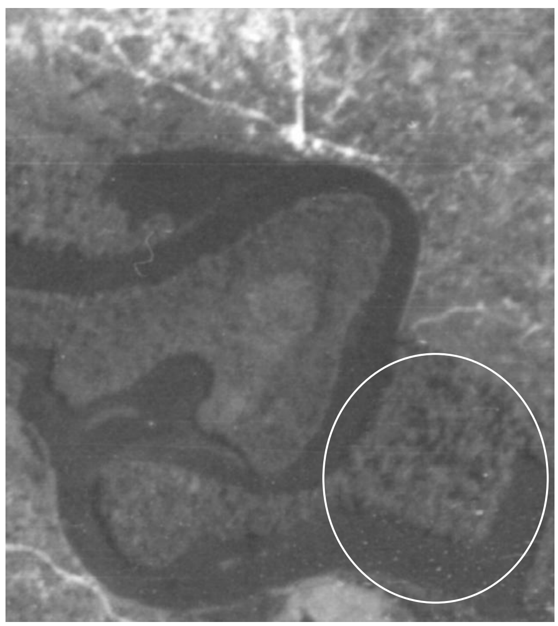


Figure F-2. 1940 Aerial Photograph of Taylor Alexander’s transect (study area circled).

Results and Discussion

Figure F-3 is an original drawing of Taylor Alexander’s of the vegetative communities present on the floodplain in April, 1967. The overstory canopy was dominated by bald cypress and cabbage palm. The community of bald cypress can be seen in the 1968 photograph taken by Bill Lund (**Figure 11** of the main document). Dr. Alexander’s survey notes indicate that the majority of the canopy trees were either stressed or had died (**Table F-1**). The transect data showed that about 67% of the canopy bald cypress and 12.5% of the cabbage palms had died due to saltwater intrusion. Other freshwater species counted but not listed in the table included red maple, red bay, pop ash, and wax myrtle, poison ivy, royal fern, salt bush and false indigo.

In the 1967 examination of live trees only, the frequency and density of cabbage palm was 55.5 percent with a density of 1.75 within his 5 x 5m quadrats while live bald cypress was 22.2 percent and a density of 0.39 (**Table F-1**). Pond apple was at a frequency and density of 16.7 percent and 0.19. Also in the 1967 study, pond apple was a scarce species with only 7 individual plants reported. The frequency and density of leather fern was 52.8 percent and density of 1.81. Red mangroves were present more frequently than white mangrove, (52.8 versus 36.1 percent); however, white mangroves were denser than red mangroves (1.31 versus 2.64). No exotic or nuisance species were recorded in the 1967 data.

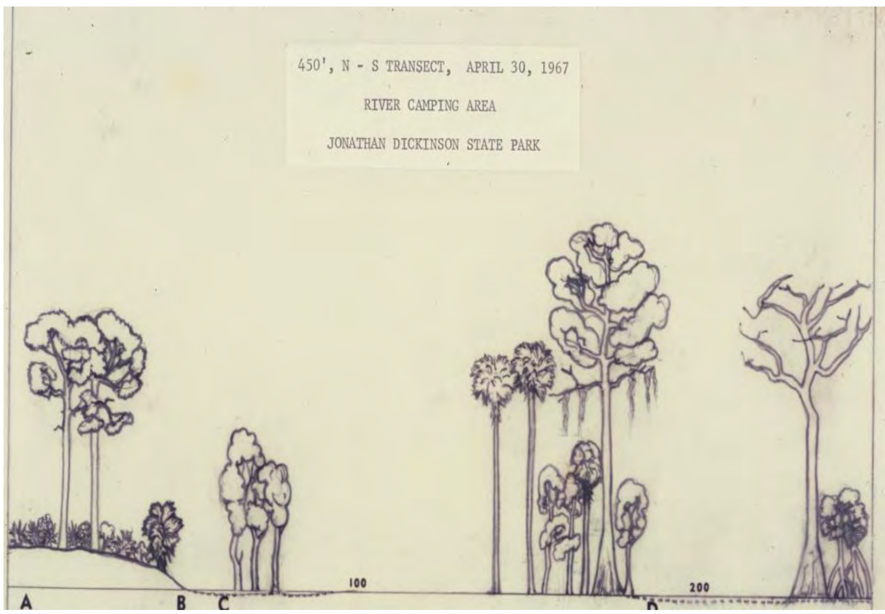


Figure F-3. Taylor Alexander's original field note from April 30, 1967.

Salt concentrations in the 1967 soil study were 9.75 ppt chloride in the white mangrove zone (C) and 3.95 ppt chloride in the cypress zone (D) (**Table F-2**). In the past the floodplain in this region has been impacted by the placement of an elevated trail that encircles a portion of the peninsula. During the occurrence of extreme high tides, the trail acts as a barrier, trapping saltwater in this wetland. Evidently with the higher evaporation and only occasional inundation by tides, the salinity has increased. This gradual progression to a more saline environment along with the low floodplain elevation at this segment of the river had lead to the invasion of red and white mangroves.

Table F-1. Taylor Alexander's 1967 Vegetation Results.

SPECIES	FREQUENCY	DENSITY
1. Sabal palmetto	69.4*	2.00*
2. Taxodium distichum	69.4*	1.17*
3. Acrostichum danaeifolium	52.8	1.81
4. Rhizophora mangle	52.8	1.31
5. Laguncularia racemosa	36.1	2.64
6. Rhabdadenia biflora	33.3	0.33
7. Cladium jamaicense	19.4	2.81
8. Chrysobalanus icaco	19.4	0.31
9. Annona glabra	16.7	0.19
10. Bacopa monnieri	8.3	----
11. Crinum americanum	8.3	0.14
12. Cephalanthus occidentalis	5.6	0.08
live sapa=55.5/1.75; live tadi=22.2/0.39		

Table F-2. 1967 Water Quality Results.

Site		pH	EMC	Cl ppt
A	Top Ridge	3.8	0.11	0.145
B	Base Slope	5.1	0.85	0.560
C	White Mangrove	5.9	29.00	9.75
D	Cypress	6.1	7.90	3.95
EMC=Soil Electrical Conductivity				

Although in 1967 the peninsula had already been impacted by saltwater intrusion, the ongoing changes in lowered groundwater levels, and decreasing freshwater flows, there were 23 wetland native species found and no exotic plants. The floodplain vegetation community has continued to shift at this site from a predominantly freshwater community to a lower tidal brackish water community.

LITERATURE CITED

Alexander, Taylor R. 1967. Bald cypress and mangrove complex of Jonathan Dickinson State Park, Florida. Paper presented at the Annual meeting of the Florida Academy of Sciences, March 25-27, 1971.

Alexander, Taylor R. and Alan G. Crook. 1973. Recent and long-term vegetation changes and patterns in South Florida. Final Report, Part 1. Mimeo Rep. (EVER-N-51) U.S. Department of Interior, National Park Service, 215p., NTIS No. PB 231939.

Alexander, Taylor R. and Alan G. Crook. 1975. Recent and long-term vegetation changes and patterns in South Florida. Final Report, Part 2. Mimeo Rep. (EVER-N-51) U.S. Department of Interior, National Park Service, 865p., NTIS No. PB 264462.

APPENDIX G

1984-1985 VEGETATION STUDIES ALONG THE NORTHWEST FORK OF THE LOXAHATCHEE RIVER

Introduction

The Loxahatchee River is a subtropical riverine swamp unique to South Florida. The drainage basin of the river originally included the Loxahatchee and Hungryland Sloughs lying east and west of State Road 710. In 1958, flood control Canal 18 (C-18) was constructed within this natural drainage basin. Canal 18 redirected flow from the Northwest Fork to the Southwest Fork of the Loxahatchee River and downstream estuary. In 1974, C-14 and G-92 Structure were constructed to re-divert water from the C-18 Canal back to the Northwest Fork. G-92 was designed for a maximum flow of 100 cfs and was hand operated. In 1987, G-92 was replaced with a gated control structure that is capable of passing up to 400 cfs and is remotely operated from the SFWMD Operations Control Room.

In the early 1980s, local concern over environmental changes resulting from the redistribution in flow prompted the U.S. Army Corps of Engineers to evaluate alternatives that would (1) increase flow through the original river corridor along the Northwest Fork; (2) reduce direct freshwater discharges from C-18 into the estuary; and, (3) maintain local flood protection. In response, a number of environmental studies were implemented by both state and federal agencies. However, information about the current environmental status of the river corridor was lacking. This SFWMD study concentrated on the upper reaches of the river corridor that were acquired under the “Save Our Rivers Program”.

The objectives of the 1984-1985 investigation were to collect baseline characteristics of the river corridor. This report summarizes the baseline vegetation and water quality data collected from the upper reach of the Northwest Fork of the Loxahatchee River. Data were collected on the riverine plant community composition and structure, the dead cypress/mangrove ecotone, water quality (salinity and dissolved oxygen); surface hydrology (elevation contours), and floodplain inundation (height and elevation of cypress knees).

Additional tasks during this 1984-1985 investigation included collecting baseline information about submerged seagrasses in the estuary, river stage (USGS sites; SFWMD 2002), stream flow, seasonal surface flow (Russell and McPherson 1984), particulate transport, and soil characteristics. This information is not included in this report.

Methods

River Corridor and Floodplain Forest Community

In 1983, five transects (**Figure G-1**) were established on both the east and west banks of the Northwest Fork of the Loxahatchee River extending from the river’s edge to the adjacent low pinelands transition zone. Transect 5 was established inside lower Cypress Creek (east of the Turnpike). A sixth tidal transect was established on a large peninsular just downstream of the mouth of Kitching Creek on the Northwest Fork. Transect lengths varied from between 400-1000 feet depending upon their location. Transects were established above and below the existing weir structures (Lainhart and Masten Dams) since the structures hydrologically segment the river into two basins. Each transect was permanently marked with stakes made of PVC pipe placed at 25 ft intervals throughout their length. Vegetation data was collected between the months of January and June 1984. Transitions in plant community composition were referenced to elevation and respective distance from the river. Dominant vegetation species were noted. Tree species frequencies were determined based on diameter at breast height (dbh) size classes (5-20 cm, 21-40 cm, 41-60 cm, 61-80 cm, and 81-99+ cm). These size classes were created to monitor recruitment of younger trees and general age groups of canopy species. In order to compare the 1984 data with the 1995 and 2003 Loxahatchee River studies, only those trees with a dbh equal to or greater than 5 cm were included in the size class frequency analysis.

Within each plant community, 5 nested quadrats 3 x 10 m were established offset 1 m north of the line and perpendicular to the transect. Within the quadrats, data was collected on herbaceous species cover and frequency (placed in the corners and center of each 3 x 10 m quadrat for a total of 25 sampling sites); density of tree species greater than 1 m in height in each 3 x 10 m quadrat; density of sapling trees less than 1.0 m in height; basal diameter of all tree species greater than 1 m in height; percent woody shrub cover using line intercept method; and canopy height. Ground elevation contours were measured (ft. NGVD29) along transects to relate river stage with depth and duration of flooding within the swamp floodplain. Existing USGS water level recording gauges and other land marks of know elevations were used as benchmarks to obtain local ground elevations. Conductivity and dissolved oxygen were taken every half meter at ten locations and (**Figure G-1**) on October 10, 1985 along the river corridor.

Dead Cypress and Mangrove Ecotone

Tidal influence in the Loxahatchee River presently extends upstream to about where Cypress Creek enters the river at Rivermile (RM) 10. Increased salinity in this area has killed many of the bald cypress trees bordering the river and permitted mangroves to become established. An increased freshwater flow down the Loxahatchee River would push the salinity gradient seaward and create more favorable conditions for the re-establishment of bald cypress trees. A baseline study of 5 nested quadrats was made within a series of permanently marked vegetative plots distributed along the east and west shoreline of the river in the tidal reach (**Figure G-1**). The plots (5 x 10 m) included areas of predominantly dead trees and where living trees were under stress from periodic salinity exposure. The following data evaluated for these plots: density of dead and live cypress trees; density of bald cypress seedlings; density of saplings; diameter at breast height (dbh); percent cover of shrub species from a line intercept; and herbaceous species cover and frequency. This baseline information provides evidence of the health of these communities during the mid-1980s.

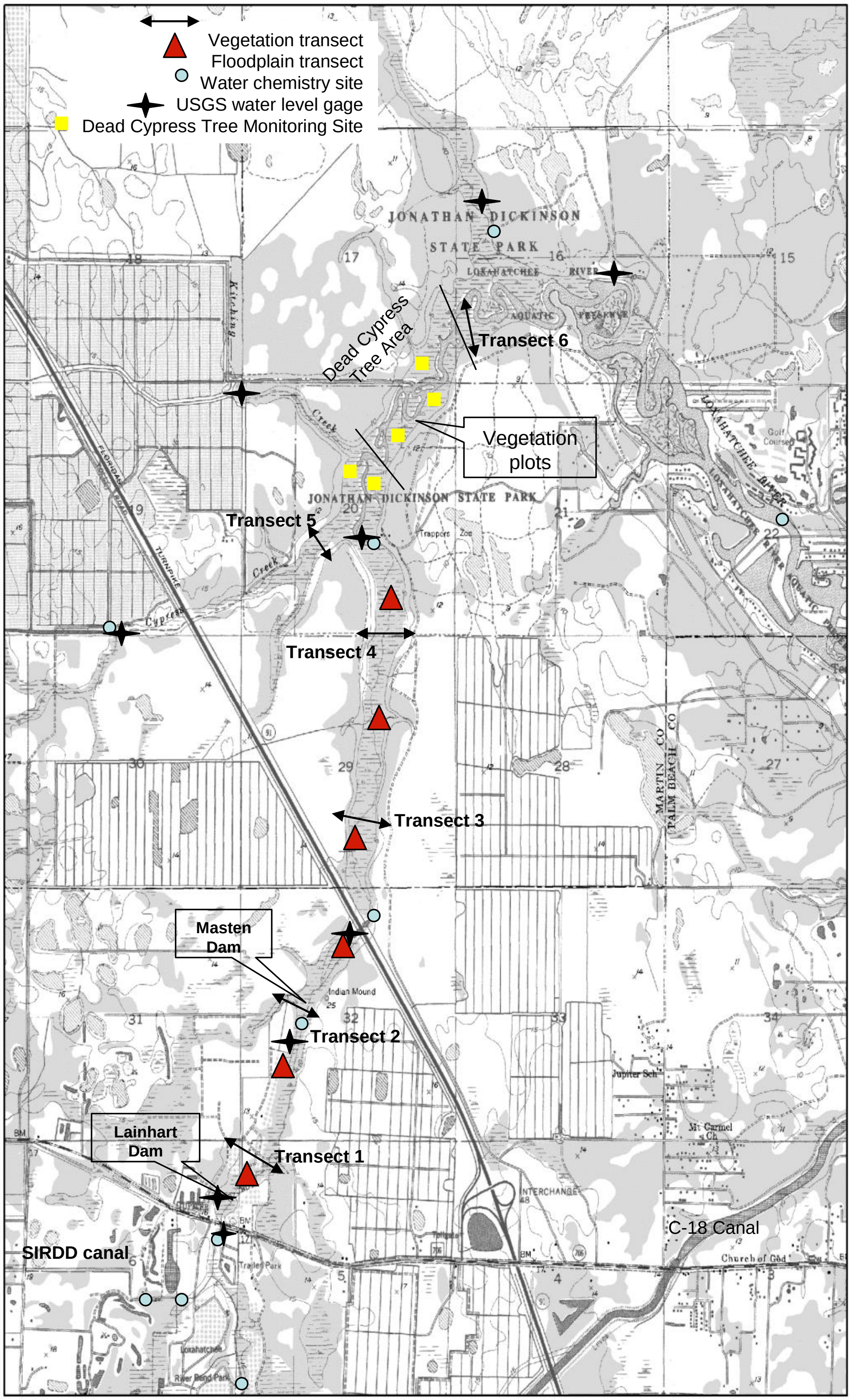


Figure G-1. Vegetation Transects of the 1984/85 SFWMD Dewey Worth and USGS Loxahatchee Study Sites.

RESULTS

Water Quality and Flows

Based on Table 7-4 (SFWMD 2006) the mean flow at Lainhart Dam for the year 1985 was 61 cfs while the mean monthly flow for October 1985 (when water quality data were collected) was 110 cfs. Rainfall for the year totaled 50 inches (Figure 2-3, SFWMD, 2006). In accordance with the established flow and stage relationships for the Northwest Fork (SFWMD 2006), 90 cfs over Lainhart Dam provides a top of bank condition at Transect 1 while a flow of 110 cfs provides total inundation of the floodplain swamp community.

Conductivity and dissolved oxygen water quality data is summarized in **Table G-1.** Ten stations were sampled on October 10, 1985 between 5:00 and 7:00 pm. Conductivity was measured in (µS/cm) while dissolved oxygen was measured in mg/L. Conductivities ranged from less than 400 µS/cm (approximately 0.2 ppt salinity) in C-14 south of Indiantown Road near G-92 (RM 16.5, Station 1) to 14,390 µS/cm (approximately 8 ppt) near what is today Island Way Bridge (RM 5, Station 10). With the exception of Station 10, the water quality parameters were well within the freshwater ranges for a riverine system. Conductivity increased with depth at each station. Data from Station 10 suggest the presence of a saltwater wedge in the water column. Conductivities at this station ranged from 1,819 µS/cm at the surface to 14,390 µS/cm at the 4m depth. Dissolved oxygen ranged from 2.5 mg/L at Station 10 (4 m depth) to 4.8 mg/L (2m depth). Since this study was completed, freshwater tidal influence has been documented at Transect 3 (RM13.4) and below Masten Dam at Transect 2-2 (RM13.6) on the Northwest Fork (SFWMD 2006).

Table G-1. Dissolved oxygen (D.0.) and conductivity (Cond.) data collected October 10, 1985 at 10 stations.

Depth (m)	Station 1 5:00 pm		Station 2 5:10 pm		Station 3 5:20 pm		Station 4 5:35 pm		Station 5 5:47 pm	
	D.O.	Cond.	D.O.	Cond.	D.O.	Cond.	D.O.	Cond.	D.O.	Cond.
0	4.0	414	4.6	413	4.7	412	4.6	410	4.1	409
0.5	3.9	414	4.7	413	4.7	412	4.5	411	4.1	409
1	3.9	414	4.8	413	4.7	412	4.5	411	4.0	409
1.5	--	--	4.8	413	4.7	412	4.5	411	4.0	411
2	--	--	4.8	415	4.8	414	--	--	3.9	412
2.5	--	--	--	--	--	--	--	--	3.9	416
3	--	--	--	--	--	--	--	--	3.8	421

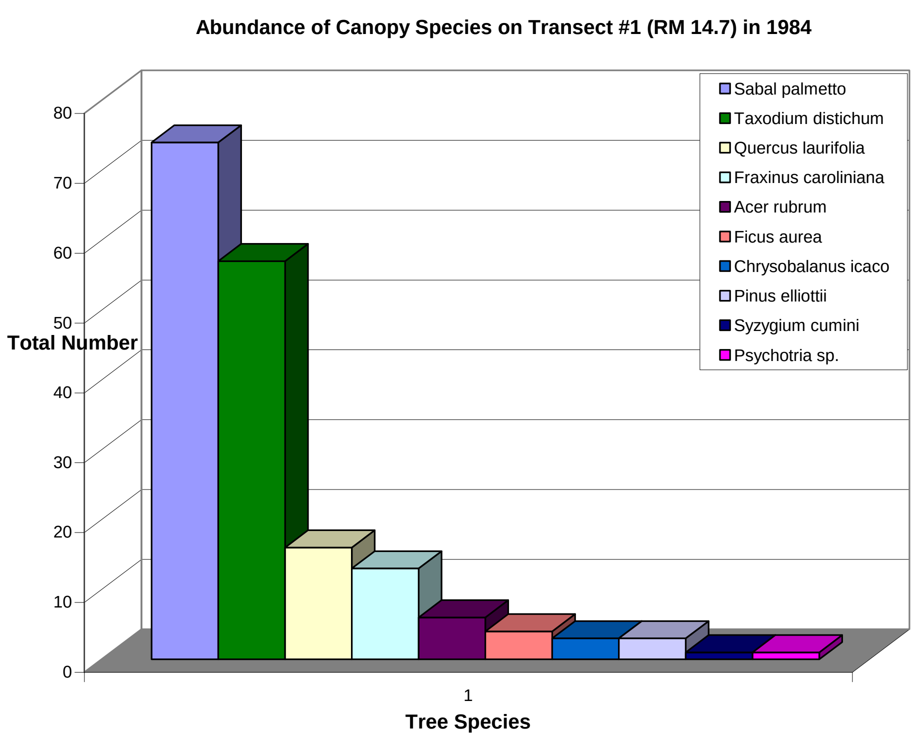
Depth (m)	Station 6 6:01 pm		Station 7 6:19 pm		Station 8 6:25 pm		Station 9 6:39 pm		Station 10 6:48 pm	
	D.O.	Cond.	D.O.	Cond.	D.O.	Cond.	D.O.	Cond.	D.O.	Cond.
0	3.9	429	4.2	430	3.7	415	3.9	509	4.0	1819
0.5	3.9	429	4.1	430	3.7	423	3.6	516	3.6	1934
1	3.8	429	4.0	432	3.6	429	3.5	534	3.4	2250
1.5	3.8	430	3.9	435	3.6	433	3.4	598	3.3	3300
2	3.7	430	3.8	441	3.6	444	3.3	601	3.1	3980
2.5	3.7	433	--	--	3.7	456	3.2	626	2.7	5060
3	3.6	440	--	--	3.7	461	3.2	670	2.5	11010
3.5	3.6	440	--	--	--	--	3.1	706	2.5	14210
4	--	--	--	--	--	--	3.1	722	2.5	14390

A small flow study was conducted on the agricultural ditch on the east side of Transect 1 from January through December of 1984. No flows were recorded between January and early March. A few small flows between 2 and 5 cfs were recorded between mid March and mid June. Two larger flow events were evident around September 15th (17 cfs) and from the end of November to the first week of December (31 cfs, November 15th and 1-31 cfs between November 25th to December 10th, 1984. Based on **Table 6-7** (SFWMD 2006), the mean flow at Lainhart Dam in March 1984 was 127 cfs while February and April averaged 86 and 84 cfs, respectively. The mean flow in September 1984 averaged 179 cfs following low flows of 65 and 48 cfs in July and August. Flows during October, November and December of 1984 averaged 120, 196 and 150 cfs at Lainhart Dam.

River Corridor and Floodplain Forest Community

The five riverine and one tidal transect were examined for canopy tree abundance, diameter at breast height (dbh) size class frequencies, total basal area, relative basal area, density and relative density. In 1984, the canopy at Transect #1 (RM 14.7) was dominated by *Sabal palmetto* (cabbage palm) in the hammock area and *Taxodium distichum* (bald cypress) in the swamp (**Figure G-2**). Ten species were present including *Psychotria* sp. (wild coffee), which is actually a shrub. Cabbage palm was present in three size classes (5-20, 21-40 and 41-60 cm dbh) while bald cypress was present in all five size classes (**Figure G-3**). Historical river records do not show any lumbering in this area. *Fraxinus caroliniana* (pop ash) and *Acer rubrum* (red maple) were present in the two smaller size classes. Bald cypress accounted for 65 percent of the basal area and had a relative density of 32 percent of the canopy community at Transect 1 (**Table G-2**). Sabal palm accounted for 28 percent of the basal area and a density of 42 percent.

Figure G-2. Canopy species abundance on Transect #1.



DBH Size Classes at Transect #1(RM 14.7) in 1984

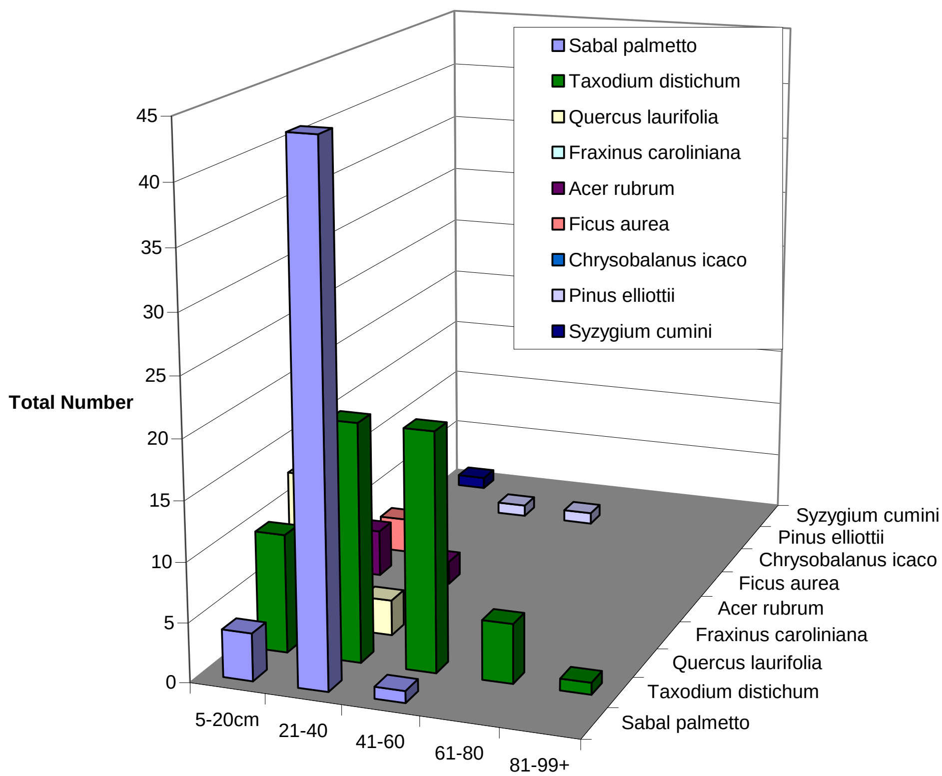


Figure G-3. DBH size class frequency at Transect #1.

Table G-2. Total area and density of canopy species on Transects 1-5 in 1984.

Species	Transect 1				Transect 2				Transect 3				Transect 4				Transect 5			
	Total Area	%Area	Density	%Density	Total Area	%Area	Density	%Density	Total Area	%Area	Density	%Density	Total Area	%Area	Density	%Density	Total Area	%Area	Density	%Density
Acer rubrum	2207.6	1.8	6	3.4	13977.1	9.1	34	11	23288.6	23.2	45	8.9	15324.5	23.2	44	15.3	9734.6	15.3	50	20.4
Annona glabra					1583.7	1	26	8.4	7336.6	7.3	177	35	431.6	0.7	3	1	131.2	0.2	5	2
Carya aquatica					66.3	0	4	1.3					17228	26.1	30	10.4	11723.3	18.4	25	10.2
Cephalanthus occidentalis					24.4	0	1	0.3	32.1	0	2	0.4	47.2	0.1	4	1.4	18.7	0	2	0.8
Chrysobalanus icaco	53.1	0	3	1.7	1468.3	1	30	9.7												
Citrus sp.									125.3	0.1	9	1.8								
Ficus aurea	405.4	0.3	4	2.2	8	0	1	0.3	1685.9	1.7	10	2								
Fraxinus caroliniana	1160	0.9	13	7.3	5472.1	3.6	94	30.4	29130.5	29	227	45	11515.7	17.5	170	59.4	6176.7	9.7	79	32.3
Ilex cassine									15.7	0	2	0.4								
Laguncularia racemosa																	26.2	0	2	0.8
Myrica cerifera									94.5	0.1	3	0.6	26.2	0	2	0.7				
Persea borbonia																	103.1	0.2	1	0.4
Pinus elliottii	3399.7	2.8	3	1.7																
Psychotria sp.	4.5	0	1	0.6	453.4	0.3	2	0.6									7.2	0	1	0.4
Quercus laurifolia	1782.7	1.4	16	9	822.6	0.5	4	1.3	3031.7	3	5	1	118.8	0.2	3	1	10971.1	17.2	28	11.4
Quercus virginiana					45.3	0	9	2.9												
Rapanea punctata																	55.8	0.1	5	2
Rhizophora mangle																				
Sabal palmetto	34588.5	28	74	41.6	59468.8	38.7	65	21	9467.7	9.4	14	2.8	2295.5	3.5	3	1.4	4560.5	7.1	15	6.1
Syzygium cumini	23	0	1	0.6																
Taxodium districhum	79903.8	64.6	57	32	70528.3	45.7	39	12.6	26088.1	26	11	2.2	18993.5	28.8	27	9.4	19967.8	31.3	30	12.2
Unknown																	92	0.1	1	0.4

Table G-3. Species occurrence, frequency, basal area, and total area at Transect #6 in 1984.

Transect 6

Species	Species Occurrence	Species Frequency	# Trees/100m2	Basal Area cm	Total Area for Species	Freq Species Areas
Acer rubrum	2	0.017	0.58	0	443.23	1.05
Annona glabra	32	0.276	9.24	5122.1	15594.54	37.08
Cephalanthus occidentalis	1	0.009	0.29	0	190.64	0.45
Fraxinus caroliniana	6	0.052	1.73	960.02	6834.15	16.25
Myrica cerifera	1	0.009	0.29	0	96.06	0.023
Rhizophora mangle	30	0.259	8.67	127.32	4392.82	10.45
Sabel palmetto	14	0.121	4.04	7979.89	7979.89	18.98
Schinus terebinthifolius	9	0.078	2.6	223.69	2423.69	5.76
Laguncularia racemosa	21	0.181	6.07	1071.43	4097.74	9.74
Totals	**116**	**1**	**33.51**	**15484.46**	**42052.76**	**100**

Mean Species Distribution 1.728
100/<Mean Species Distribution> 2:33.51

A total of ten canopy species were observed at Transect 2 (RM 13.5) in 1984 with pop ash and sabal palm the most abundant species (**Table G-2** and **Figure G-4**). The pop ash (approximately 90) were all in the 5-20 cm size class. Cocoplum and *Cephalanthus occidentalis* (buttonbush) were also present in the canopy. Bald cypress was present at all 5 size classes (**Figure G-5**) and accounted for 46 percent of the canopy area (**Table G-2**) while cabbage palm accounted for 39 percent of the canopy area. Pop ash had the highest species density at 30.4 percent; however, they only accounted for 4 percent of the canopy cover since they were all in the 5-20 cm dbh size class frequency.

Figure G-4. Canopy species abundance on Transect #2.

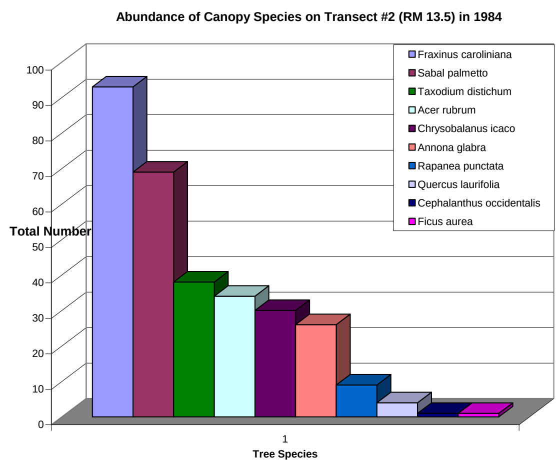
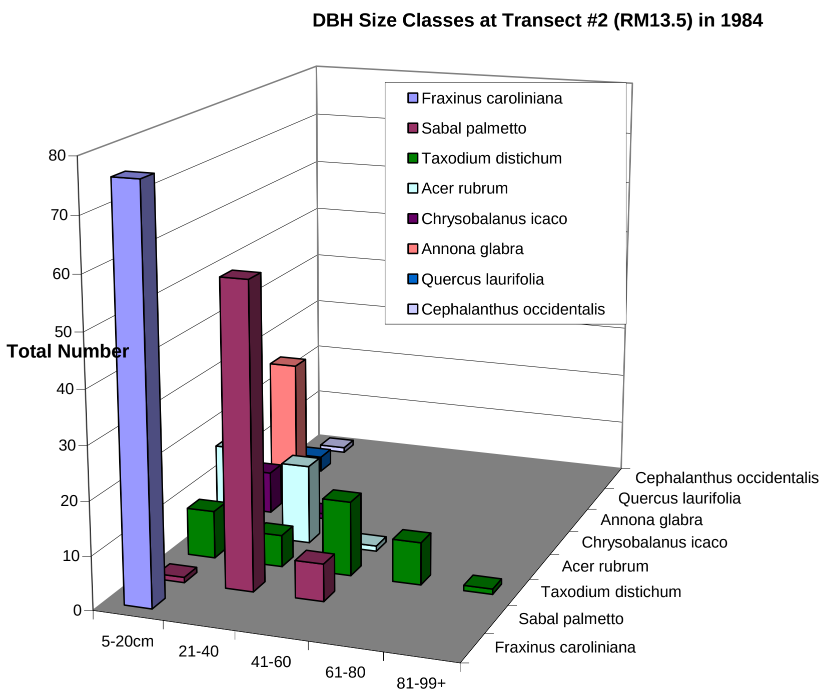


Figure G-5. DBH size class frequency at Transect #2.



Pop ash, pond apple, and red maple were the most abundant species at Transect 3 (RM 12) in 1984 (**Table G-2** and **Figure G-6**). Eleven canopy species were present including wild citrus and water hickory. Pop ash, bald cypress, and red maple accounted for 78 percent of the canopy area (**Table G-2**). Pop ash was the densest species at 45 percent and had the highest canopy area (29 percent). Bald cypress trees were few in number on Transect 3 but they were present in all 5 size classes in 1984 (**Figure G-7**). Bald cypress accounted for 26 percent of the canopy area and was present at a density of only 2.2 percent. Pond apple accounted for 7.3 percent of the canopy area; however, they were present at a density of 35 percent of the area.

Figure G-6. Canopy species abundance on Transect #3.

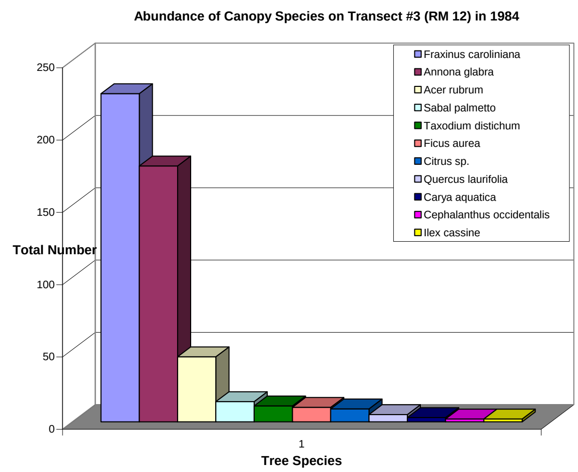
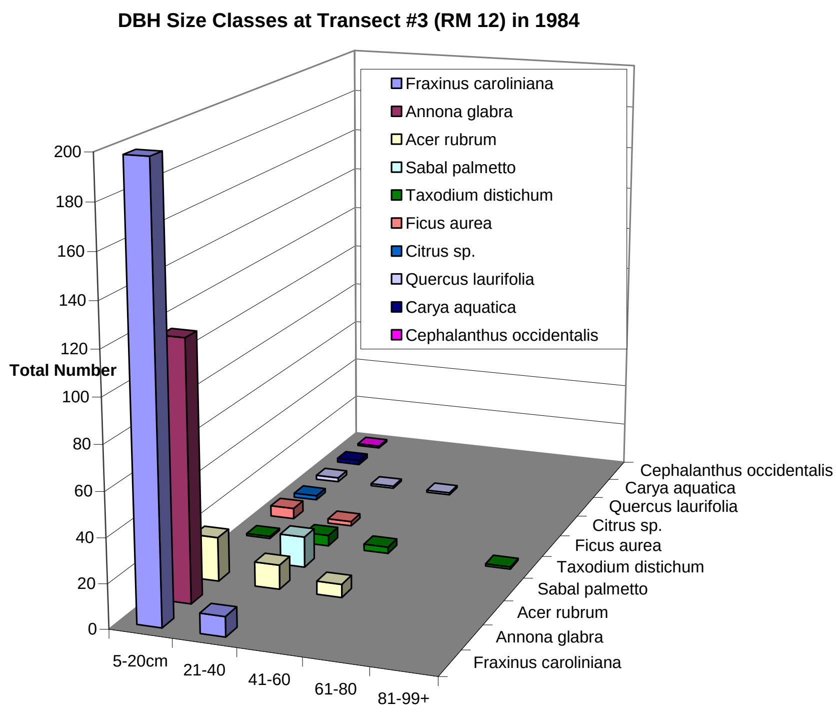


Figure G-7. DBH size class frequency at Transect #3.



In 1984, the most abundant canopy species at Transect 4 (RM 11.81) were pop ash, red maple, water hickory, and bald cypress (**Table G-2** and **Figure G-8**). Pop ash was only present in the two smaller size classes (5-20 and 21-40 cm) (**Figure G-9**). Red maple was present in the 3 smaller size classes. Water hickory and bald cypress were present in the 4 smaller class sizes. With regards to percent canopy area, pop ash (17.5 percent), bald cypress (28.8 percent), and red maple (23.2 percent) accounted for 70 percent of the canopy (**Table G-2**). The species with the highest densities were pop ash (59.4 percent), red maple (15.3 percent) and water hickory (10.4 percent).

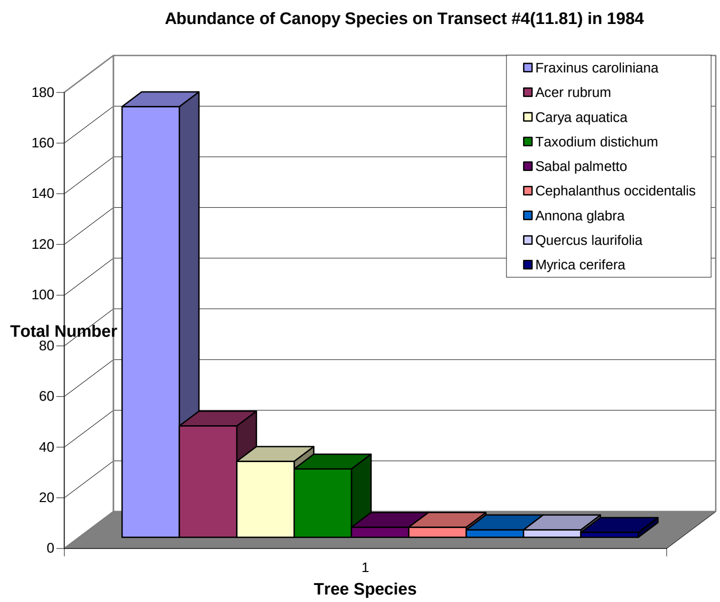


Figure G-8. Canopy species abundance on Transect #4.

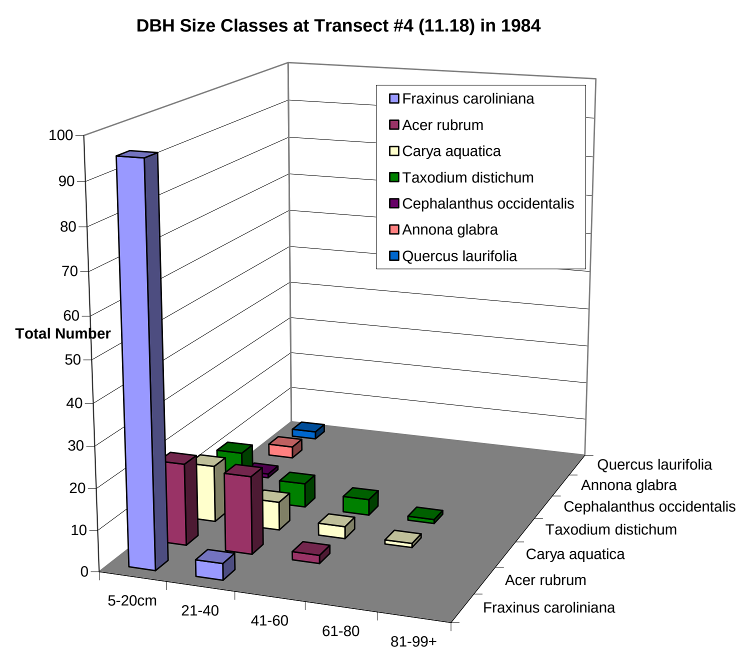


Figure G-9. DBH size class frequency at Transect #4.

Transect 5 on Cypress Creek is at a higher elevation than Transects 3 and 4 on the Northwest Fork of the Loxahatchee River. This may account for the wider distribution of canopy species and more abundant bottomland hardwood species. There were 13 species and one unknown reported in 1984 (**Table G-2**). The most abundant canopy species were pop ash, red maple, bald cypress, laurel oak, and water hickory (**Figure G-10**). Pop ash was present in the 3 smaller size classes but mainly occurred in the 5-20 cm size class (**Figure G-11**). Red maple was present in the 2 smaller size classes (5-20 and 21-40 cm). Bald cypress and laurel oak were present in the 4 smaller size classes in 1984. Some of the largest water hickory trees observed in the floodplain were found on Transect 5 (Cypress Creek). In 1984, water hickory was only found in the 3 smaller size classes. Sabal palm was only found in the 5-20 and 21-40 cm size classes. Those species with the largest percent canopy area were bald cypress (31.3 percent), water hickory (18.4 percent), laurel oak (17.2 percent), and red maple (15.3 percent) and they accounted for approximately 80 percent of the canopy cover (**Table G-2**). However, the species with the highest densities were pop ash (32.3 percent), red maple (20.4 percent), bald cypress (12.2 percent), and laurel oak (11.4 percent).

Figure G-10. Canopy species abundance on Transect #5.

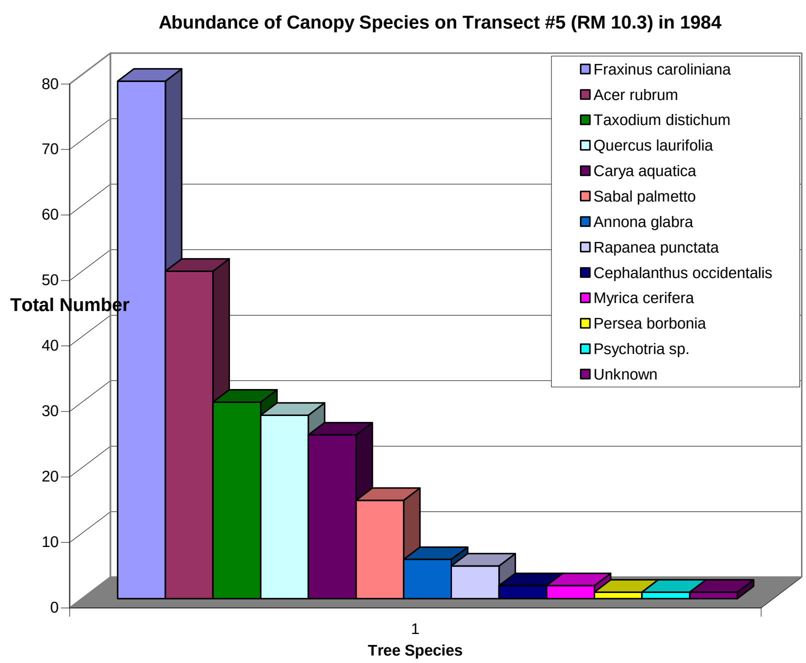
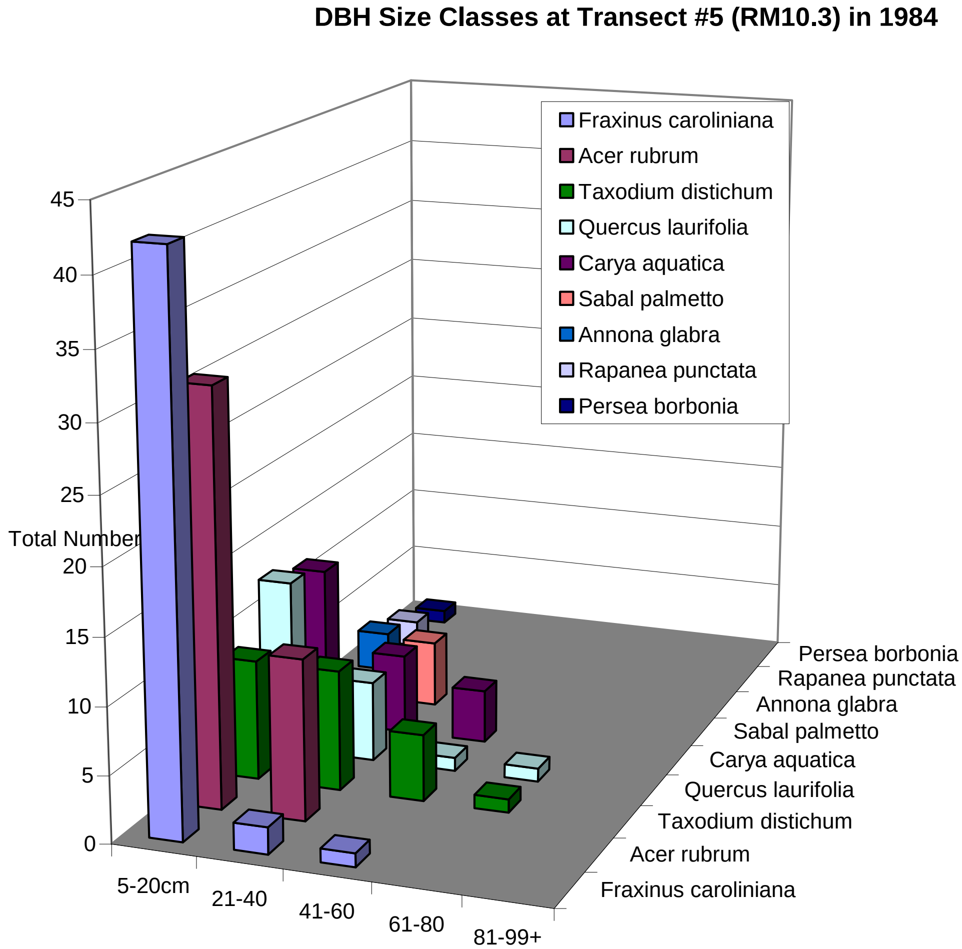


Figure G-11. DBH size class frequency at Transect #5.



Transect 6 was located on a peninsular in the mid Northwest Fork of the Loxahatchee River downstream of Kitching Creek at RM 8.5. This tidal transect is within the zone of the river effected by saline waters and had been selectively lumbered in the past. In 1984, 12 canopy species were reported. The most abundant woody species (and leather fern) were red mangrove, pond apple, leather fern, white mangrove, and Brazilian pepper (**Figure G-12**). Red mangrove pond apple and white mangrove were the species with the highest density. Canopy cover was dominated by pond apple, sabal palm, pop ash, and red and white mangrove (**Table G-3**). Red mangrove, pond apple, leather fern, white mangrove, and Brazilian pepper were the dominant woody species with regards to frequency of occurrence (**Figure G-13**).

Figure G-12. Woody species and leather fern abundance on Transect #6 at RM 8.43 in 1984.

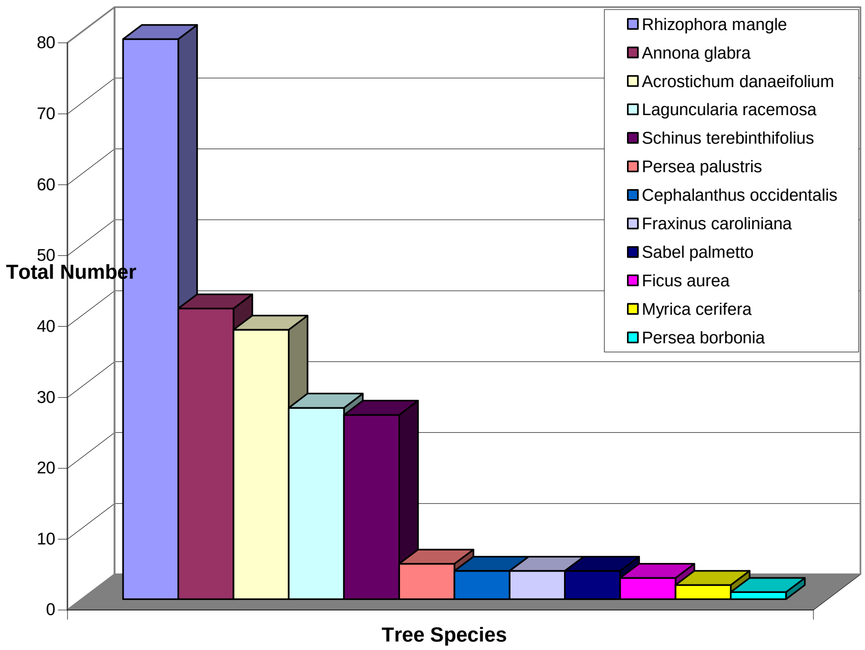
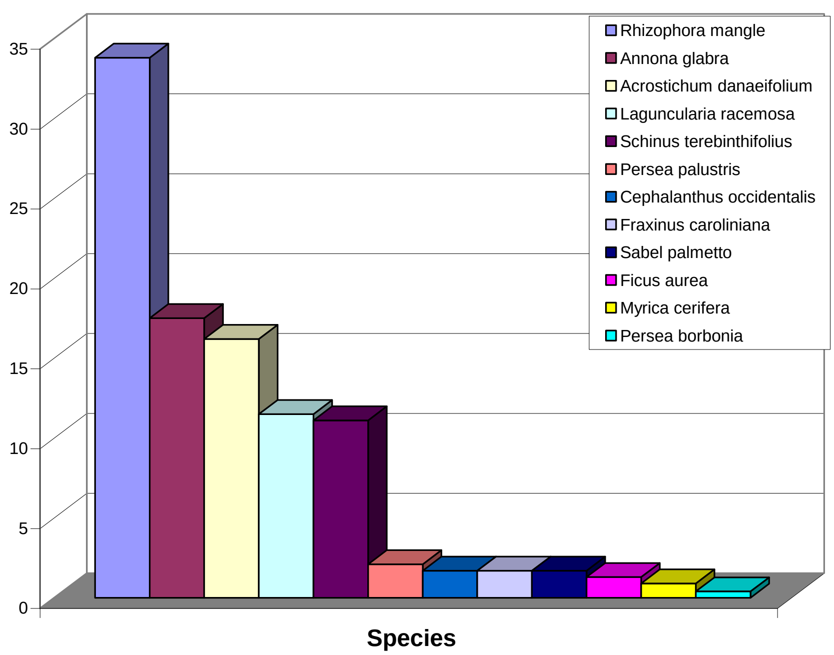


Figure G-13. Frequency of occurrence of woody species and leather fern at Transect #6 in 1984.



Dead Tree Survey

In 1984, dead canopy trees were surveyed for occurrence and dbh on all 5 transects (**Table G-4**). Six dead trees were present on Transect 1. Both the pop ash and laurel oak were small with dbhs of 6.7 and 5.1 cm. The four dead bald cypress trees had an average dbh of 30.6 cm. Twelve dead canopy trees were observed on Transect 2. Two laurel oaks averaged about 40 cm while 4 red maples averaged 17 cm in dbh. The pop ash and pond apple were small with dbhs under 10 centimeters. Twelve small pop ash and 5 small pond apple were recorded as dead on Transect 3. Transect 4 had the highest number of dead trees with 30 dead trees recorded. Forty-seven percent of these were pond apple with an average dbh of 10.8 cm. Other species included red maple (6), strangler fig (1), popash (6) and bald cypress (3). The bald cypress averaged 24.8 cm in dbh. Transect 5 had 14 dead trees consisting of 3 red maple, 2 pond apple, 3 water hickory, 5 pop ash and one laurel oak (35.3 cm).

Dead trees are a sign of stress within plant communities. Along the Northwest Fork of the Loxahatchee River and Cypress Creek, the stress could have been caused by inadequate inundation, prolonged flooding, high salinity, fire, lightening strike, or insect infestations. High salinity and prolonged flooding would have stressed all individuals that are not salt or flood tolerant. Most of dead trees were fairly small (dbh less than 10 cm).

Table G-4. 1984 Survey of dead trees at Transects 1-5.

Species (Dead Trees)	Transect 1		Transect 2		Transect 3		Transect 4		Transect 5	
	Total #	Ave. DBH	Total #	Ave. DBH	Total #	Ave. DBH	Total #	Ave. DBH	Total #	Ave. DBH
Acer rubrum			4	17			6	9.7	3	4
Annona glabra			1	8	5	7.4	14	10.8	2	3.4
Carya aquatica									3	22.6
Ficus aurea							1	16.9		
Fraxinus caroliniana	1	6.7	4	7.6	12	8.9	6	9	5	6.4
Quercus laurifolia	1	5.1	2	37.9					1	35.3
Taxodium districhum	4	30.6	1				3	24.8		

Tree Elevations by Transect

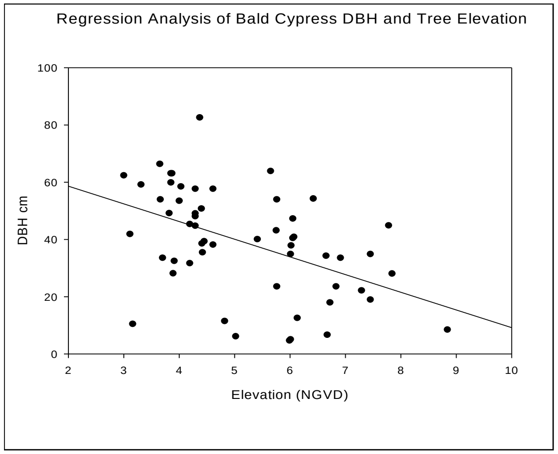
In 1984, elevations of the base of several tree species were measured within Transects 1 through 5. The average elevation by species by transect is summarized in **Table G-5** and scatterplots are presented for bald cypress (**Figure G-14**) and pop ash (F**igure G-15)**. It appears that the 1984 survey measurements were off for Transects 1 and 5 because the recorded measurements do not occur within the range of the survey data for those two transects. In accordance with the survey data for Transect 1, there is only a one foot difference in elevation in the swamp community and it occurs between 10.44 and 9.44 ft. Similarly on Transect 5, elevations in the floodplain ranged from 10.08 to 6.08 ft in the survey data while the average elevation of several species of trees ranged from 2.51 to 4.81 ft. (**Table G-5**). In general, bald cypress and pop ash occurred at the lowest elevations on Transects 1, 2, 3, and 4. In fact, pop ash occurred at the lowest elevation of any floodplain canopy species. On Transects 2, 3, and 4, pop ash occurred at the average elevations of 7.56, 4.25 and 2.08 ft, while bald cypress averaged 7.96, 4.5 and 2.55 ft. respectively.

When dbh and base elevation were plotted for bald cypress on all 5 transects, the resulting regression lines indicated a general trend towards larger dbhs at lower elevation (**Figures G-14 A-D**). Conversely, pop ash demonstrated a general trend towards smaller dbhs with lower elevations in Transects 1-4. Yet for pop ash in Transect 5, there was a trend toward larger dbhs with lower elevations (**Figures G-15- A-D**). Pop ash rarely exceeded a dbh of 30 cm whereas bald cypress dbh commonly exceeded 40+ cm. There also appeared to be an expression of preference in elevation ranges among the tree species by transect with some overlap. For example at Transects 2 and 3, bald cypress ranged in elevation from 7.2 to 9.7 ft at (Transect 2) and 3.2 to 5.7 ft (Transect 3) while pop ash ranged from 7.1 to 8.5 ft (T-1) to 2.7 to 5.4 ft (Transect 3).

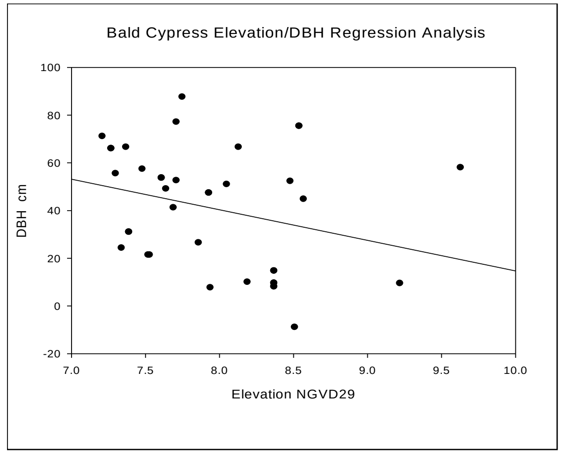
Table G-5. Average elevation of the canopy species by transect.

Species*	**Average Elevation (ft. NGVD) by Transect in 1984**				
	Transect 1	**Transect 2**	**Transect 3**	**Transect 4**	**Transect 5**
Acer rubrum	5.93	8.12	4.77	2.47	3.44
Annona glabra		7.89	4.52	2.22	2.51
Carya aquatica		8.3	4.78	2.87	3.75
Cephalanthus occidentalis		8.16	3.87	2.34	4.63
Chrysobalanus icaco	5.72	8.54			
Citrus sp.			5.46		
Ficus aurea	10.07	8.05	4.22		
Fraxinus caroliniana	4.07	7.56	4.25	2.08	3.58
Ilex cassine			4.72		
Myrica cerifera				2.71	4.81
Persea borbonia					3.38
Pinus elliottii	4.02				
Psychotria sp.	6.5	8.83			3.87
Quercus laurifolia	5.02	8.45	5.05	2.64	3.54
Rapanea punctata		9.45			3.43
Sabal palmetto	5.23	9.45	5.07	2.66	3.12
Salix caroliniana					
Schinus terebinthifolius					
Syzygium cumini	5.08				
Taxodium districhum	5.26	7.96	4.5	2.55	3.9
Unknown					3.67

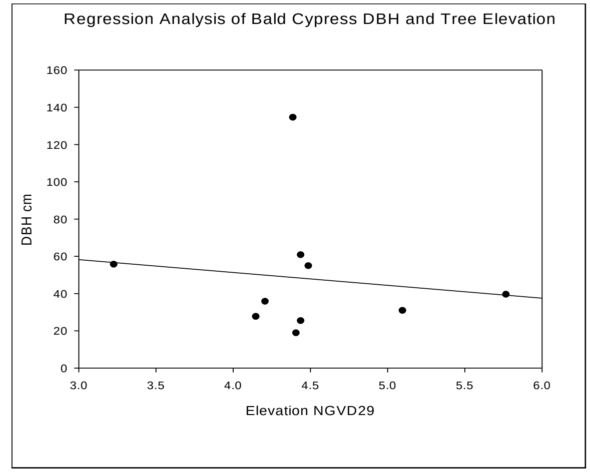
Figure G-14 A-D. Scatterplots of bald cypress elevation and DBH at Transect 1-5.



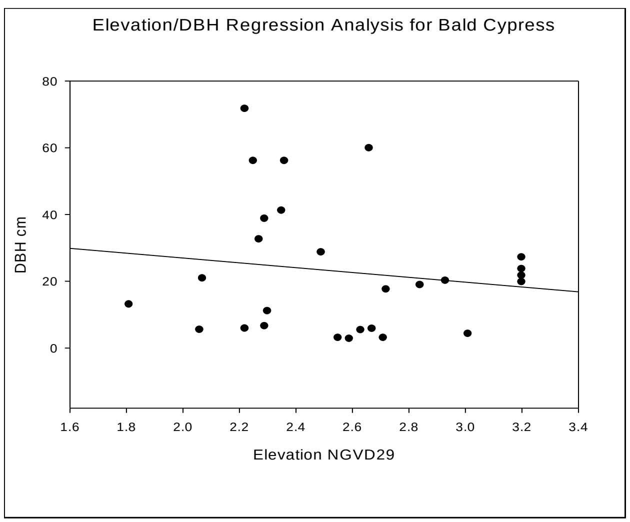
Transect 1



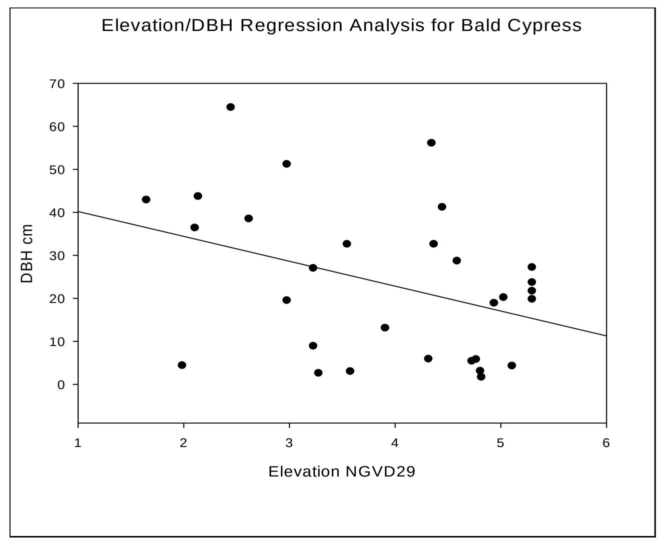
Transect 2



Transect 3

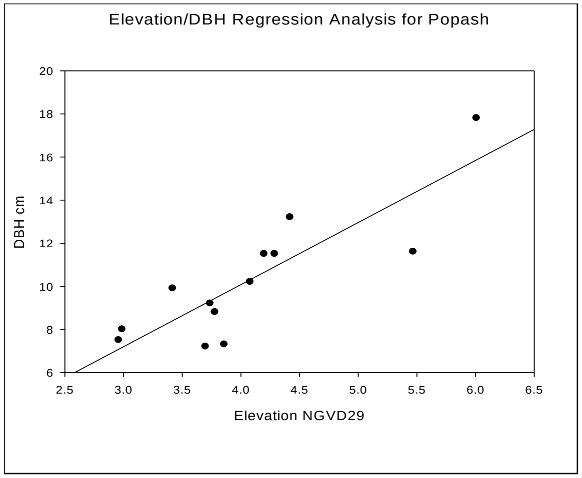


Transect 4

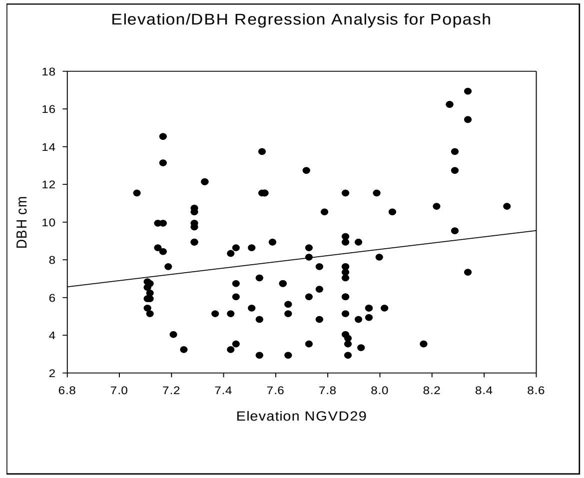


Transect 5

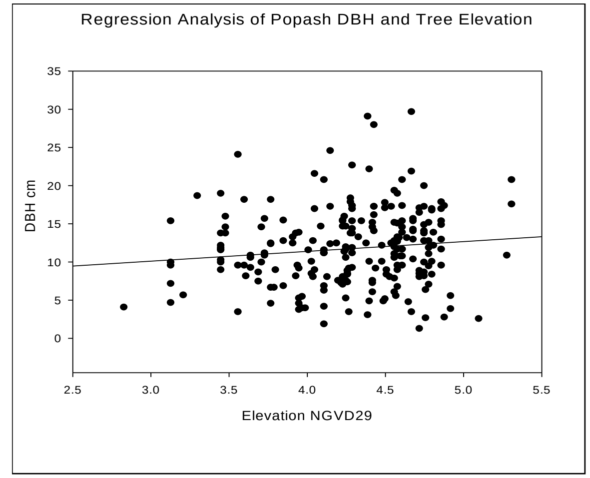
Figure G-15 A-D. Scatterplots of pop ash elevation and DBH for Transects 1-5 in 1984.



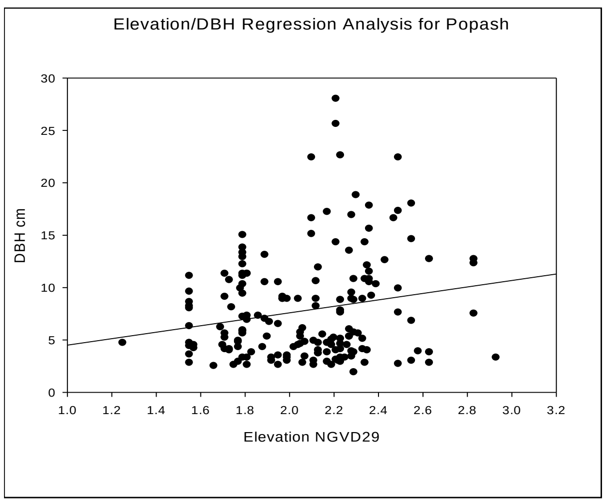
Transect 1



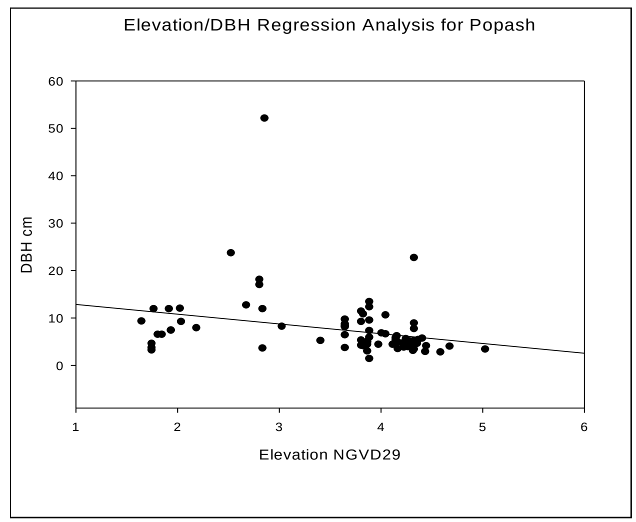
Transect 2



Transect 3



Transect 4



Transect 5

1.1.

Cypress Knee Height and Ground Elevations

A study was conducted on the cypress knee height and ground elevations at the five vegetative transects. Brown (1984) had cited Wilson and others in explaining the function of cypress knees. Wilson (1889) had suggested that the knee is a pneumatophore that serves as a "breathing organ" for roots. Lamborn (1890) concluded that they serve two purposes: to increase the supply of oxygen for the roots and strengthening basal support. In a field experiment using isolated cypress knees, Kramer et al. (1952) concluded that there was no evidence that they played a role in aerating the roots. Cowles (1975) showed that cypress knees are rich in starch and store glucose and other compounds made in the leaves. As the tree needs the starch, it is converted back to glucose. The height of knees has long been associated with high water stage and flooding levels. Brown (1984) had suggested that the common concept was that the average height of the knees would be slightly above the high water stage and flooding above the tops of the knees would not only kill them but also the tree that produced them. However she found knees that were 1.5- 3 meters tall in areas that were seldom flooded as much as 1.8m and were attached to trees estimated at 400 to 600 years old. However shorter knees were attached to trees that were in the 100- 200 year old bracket suggesting further growth with age.

In 1984, a total of 599 cypress knees were examined at the five transects on the Northwest Fork of the Loxahatchee River and Cypress Creek. The average elevation of the ground (NGVD ft) and average cypress knee height (ft) elevation are presented in **Figure G-16**. At an overall average ground elevation of 7.03 ft. cypress knee elevations averaged 7.82 ft with a range of 2.44 to 12.90 ft. By transect cypress knee elevations averaged 10.78 (T-1), 9.13 (T-2), 5.46 (T-3) 3.42 (T-4) and 3.73 (T-5, Cypress Creek). In a regression analysis of ground elevation and cypress knee elevation, the Pearson correlation coefficient (r^2) was 0.83 with a P of <0.0001.

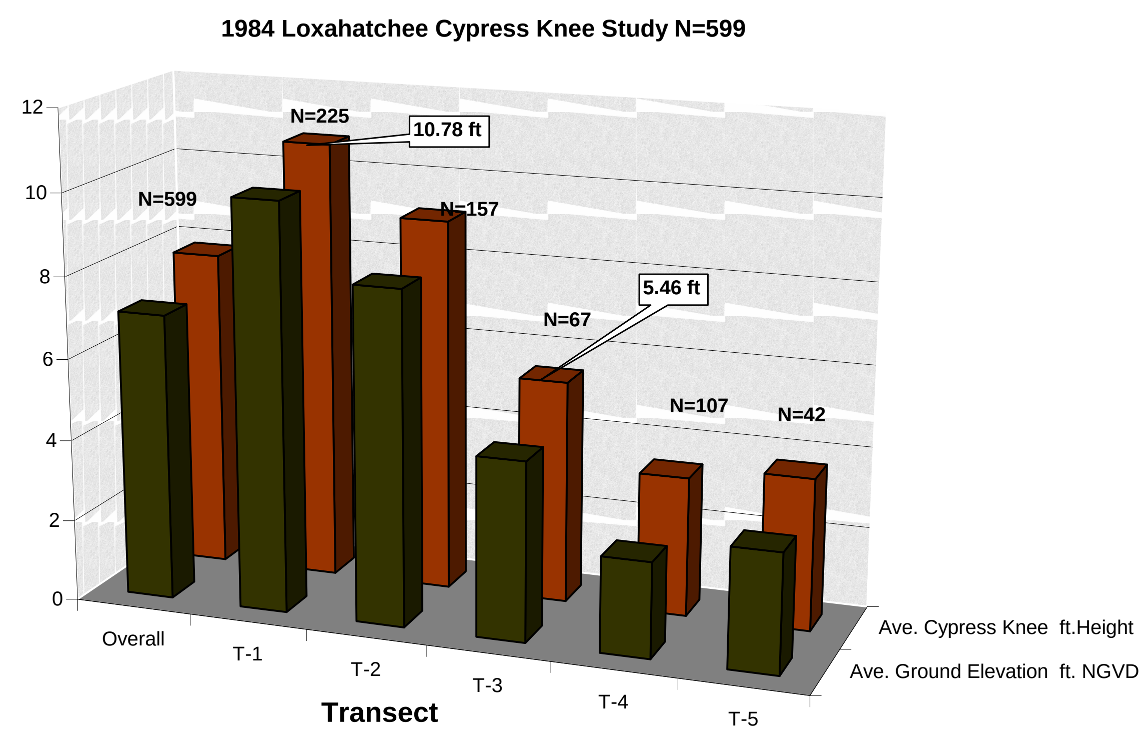


Figure G-16. Average bald cypress knee heights and ground elevations at Transects 1-5.

Shrub and Groundcover Plot Summary

Five vegetative plots were examined for analysis of live and dead trees, large shrubs and herbaceous species. These data are summarized in **Tables G-6 and G-7** as density of stems/hectare (ha), basal area (m^2/hectare), percent importance value (IP%), percent frequency of occurrence, and percent mean cover. Cabbage palm and bald cypress had the highest densities of stems/ha at Plot #1 (**Table G-6**) with percent importance values of 71.4 and 99.2, respectively. Of the 5 plots, the highest stem densities were pop ash on Plots #3 and #5 (1221.1/ha and 600.3/ha), and pond apple on Plot #3 (952.1/ha). Other species of high importance value included bald cypress and cabbage palm on Plot #2, pond apple and bald cypress on Plot # 3, red maple and bald cypress on Plot #4, and bald cypress, pop ash and red maple on Plot #5. In the dead species category, red maple was the highest with a 123 percent importance value on Plot #3 followed by laurel oak on Plot #2 (76.7 percent), pond apple on Plot #4 (70.9 percent), bald cypress on Plot #1 (66.7 percent) and red maple on Plot #2 (66.3 percent).

Herbaceous species composition and community structure in the 5 vegetative plots is summarized in **Table G-7** by percent frequency of occurrence and percent mean cover. The most frequently encountered of the 17 species on Plot #1 were *Blechnum serrulatum* (swamp fern), *Psychotria nervosa* (wild coffee), *Itea virginica* (Virginia willow), and *Thelypteris interrupta*, (tri-veined fern). Mean percent cover of the most abundant species ranged from 4.1 for swamp fern, 2.9 for Virginia willow, 1.8 for wild coffee, 1.8 tri-veined fern and 1.2 for *Commelina diffusa* (Day flower). Similarly, Plot #2 was dominated by tri-veined fern (80 percent frequency and 11.2 percent cover), wild coffee (66.7 percent frequency and 5.2 percent cover), Day Flower (46.7 percent frequency and 1.7 percent cover), *Thelypteris reticulata* (lattice vein fern), *Thelypteris palustris* (marsh fern, 33.3 percent frequency and 0.3 percent cover) and contained 14 species. Other significant species on Plot #2 included swamp fern and *Saururus cernuus*, (lizard's tail). Lizard's tail and variety of ferns were also significant on Plot #3 which contained 25 total species. The variety of ferns included tri-veined (48.9 percent frequency), swamp (35.6 percent frequency), and lattice ferns along with wild coffee, Virginia willow, and *Toxicodendrun radicans*, (poison ivy). With regards to mean cover, Plot #3 was dominated by tri-veined fern and lizard's tail. Plot #4 also contained a total of 25 species. The most frequently occurring species on Plot #4 were tri-veined fern (69.6), swamp fern (50), *Sacciolepis striata* (American cupscale, 47.8), and *Psychotria sulzneri* (wild coffee, 23.9). Percent mean cover was highest for tri-veined fern (5.4), cupscale (5.2) and swamp fern (3.2). Plot #5 contained the highest number of species at a total of 33. The most frequently occurring species on Plot #5 were *Lygodium microphyllum* (Old World climbing fern, 202), cupscale (60), swamp fern (55.6), tri-veined fern (46.7), poison ivy (35.6), *Hypoxis juncea* (fringed yellow stargrass, 33.3) and *Limnophila sessiliflora* (Asian marshweed, 33.3). Percent mean cover was highest for *Rhynchospora colorata* (starrush whitetop 8.9), tri-veined fern (4.4), swamp fern (3.5), Dayflower (3.5), Asian marshweed (3.3) and cupscale (3.1).

Table G6- 1984 Species Composition and Community Structure of Trees, Shrubs and Herbaceous Species Within Upper River Vegetation Plots 1-5.

Live Trees & Large Shrubs*	**Plot #1**			**Plot #2**			**Plot #3**			**Plot #4**			**Plot #5**		
*<DBH>2.5 cm	**Density Stems/HA**	**Basal Area m2/HA**	**IP%**	**Density Stems/HA**	**Basal Area m2/HA**	**IP%**	**Density Stems/HA**	**Basal Area m2/HA**	**IP%**	**Density Stems/HA**	**Basal Area m2/HA**	**IP%**	**Density Stems/HA**	**Basal Area m2/HA**	**IP%**
Acer rubrum	32.8	1.2	5.3	163.1	6.7	20.1	242.1	12.5	32.1	240	8.4	65.7	379.9	7.4	35.7
Annona glabra	0	0	0	124.8	0.8	9.4	952.1	3.9	42.3	16.4	0.02	3.4	38	0.1	2.2
Carya aquatica	0	0	0	19.2	0	1.3	0	0	0	21.8	0	3.5	190	8.9	28.6
Cephalanthus occidentalis	0	0	0	4.8	0	0.3	10.8	0	0.4	0	0	0	15.2	0	0.8
Chrysobalanus icaco	16.4	0	1.8	144	0.7	10.7	0	0	0	0	0	0	0	0	0
Ficus aurea	21.9	0.2	2.6	4.8	0	0.3	53.8	0.9	3.7	0	0	0	0	0	0
Fraxinus caroliniana	71.1	0.6	8.4	451.1	2.7	34	1221.1	15.7	0.4	0	0	0	600.3	4.7	41.9
Ilex cassine	0	0	0	0	0	0	10.8	0	0	10.9	0	1.8	0	0	0
Myrica cerifera	0	0	0	0	0	0	0	0	0	0	0	0	15.2	0	0.8
Persea borbonia	0	0	0	0	0	0	0	0	0	0	0	0	7.6	0.1	0.6
Psychotria nervosa	5.5	0	0.6	9.6	0.2	0.9	0	0	0	0	0	0	7.6	0	0.4
Quercus laurifolia	87.5	1	10.7	19.2	0.4	1.8	26.9	1.6	4	16.4	0.01	2.8	212.8	8.3	28.7
Rapanea punctata	0	0	0	43.2	0	2.9	0	0	0	0	0	0	38	0	2.1
Sabal palmetto	404.8	18.9	71.4	311.9	28.5	59.7	75.3	5.1	12.2	21.8	1.3	7.6	114	3.5	13.3
Taxodium districhum	311.8	43.6	99.2	187.1	33.7	58.3	59.2	14	28.2	147.3	10.4	57.9	228	15.2	43.6
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	7.6	0.1	0.5
Zanthoxylum fagara	0	0	0	0	0	0	48.4	0.1	1.9	0	0	0	0	0	0
Total/HA	951.87	65.59		1482.74	73.75		2700.36	53.9		638.29	29.71		1854.11	48.3	
DEAD SPECIES															
Acer rubrum	0	0	0	19.2	0	66.3	69.9	0.2	123	32.7	0.7	33.2	22.8	0	18.6
Annona glabra	0	0	0	4.8	0	9.6	26.9	0	18.2	76.4	0	70.9	15.2	0.5	12.2
Carya aquatica	0	0	0	0	0	0	0	0	0	0	0.1	0	22.8	0	32.9
Ficus aurea	0	0	0	0	0.1	0	0	0.5	0	5.5	0.2	7.8	0	0.1	0
Fraxinus caroliniana	5.5	0	16.7	19.2	1.1	39	64.6	0	47	32.7	0	28.9	38	0.7	33.6
Quercus laurifolia	5.5	1.3	16.7	9.6	0	76.7	0	0	0	0	1.3	0	7.6	1.9	28.6
Taxodium districhum	21.9	0	66.7	4.8	0	8.3	21.5	0	11.8	16.4	0	59.1	22.8	0	74
Total/HA	32.82	1.29		57.58	1.21		182.89	0.71		163.67	2.35		129.18	3.25	
IP=Importance Value															

Table G7: Page 1- 1984 Herbaceous Species Composition and Community Structure Within Upper River Vegetation Plots 1-5

HERBACEOUS SPECIES	**Plot 1**		**Plot 2**		**Plot 3**		**Plot 4**		**Plot 5**	
	% Freq.	**%Mean Cover**	**% Freq.**	**%Mean Cover**	**% Freq.**	**%Mean Cover**	**% Freq.**	**%Mean Cover**	**% Freq.**	**%Mean Cover**
Acrostichum danaeifolium	2.2	0.8			2.2	0.1	2.2	0		
Blechnum serrulatum	32.6	4.1	26.7	0.8	35.6	2.6	50	3.2	55.6	3.5
Boehmeria cylindrica	2.2	0			6.7	0.1	6.5	0	4.4	0
Carex lupuliformis	2.2	0			2.2	0	37	1.4	13.3	1.1
Centella asistica									4.4	0
Chrysobalanus icaco	2.2	0.1					2.2	0.1		
Commelina diffusa	8.7	1.2	46.7	1.7	6.7	0.9			31.1	3.5
Crinum americanum					4.4	0	13	1.2	4.4	0.1
Cyperus haspan									8.9	0
Danaeifolium										
Diodia virginiana									17.8	0.5
Eupatorium capillifolium									2.2	0.1
Galium tinctorium									2.2	0
Hydrocotyle umbellatum	10.9	0.4	6.7	0.2	4.4	0	4.3	0.3	11.1	0.2
Hymemocallis sp.	10.9	0.5	6.7	0.2						
Hypericum sp.							2.2	0.1		
Hypoxis juncea									33.3	0.7
Hyptis alata									2.2	0
Ipomoea alba	2.2	0								
Itea virginica	19.6	2.9	6.7	0.2	17.8	1.1	13	0.1	4.4	0.4
Limnophila sessiliflora							2.2	0.8	33.3	3.3
Ludwigia alata					4.4	0.4			24.4	0.6
Ludwigia repens							21.7	2.3		
Lygodium microphyllum					2.2	0	8.7	0	202	0
Micranthemum sp.										
Mikania scandens	2.2	0			6.7	0	10.9	0.4	24.4	0.01
Osmunda sp.			6.7	0	8.9	0.2	15.2	1.5	8.9	0.2
Panicum regidulum							21.7	2	4.4	0.1
Parietaria floridana										
Parthenocissus quinquefolia							4.3	0.1		
Pluchea odorata									8.9	0.2
Polygonum hydropiperoides					13.3	0.6			4.4	0
Polygonum sp.							4.3	0.1		
Pontederia cordata							8.7	1.1	2.2	0.2
Psychotria nervosa	28.3	1.8	66.7	5.2	24.4	0.6	15.2	0.3		
Psychotria sp.					24.4	0.6	15.2	0.3	26.7	0.7

Table G7: Page 2 - 1984 Herbaceous Species Composition and Community Structure Within Upper River Vegetation Plots 1-5

HERBACEOUS SPECIES	**Plot 1**		**Plot 2**		**Plot 3**		**Plot 4**		**Plot 5**	
	% Freq.	**%Mean Cover**	**% Freq.**	**%Mean Cover**	**% Freq.**	**%Mean Cover**	**% Freq.**	**%Mean Cover**	**% Freq.**	**%Mean Cover**
Rhynchospora colorata									0.2	8.9
Rhynchospora inundata					2.2	0.1				
Sabal palmetto			6.7	0						
Sacciolepis striata			6.7	0.2	11.1	0.8	47.8	5.2	60	3.1
Samolus valerandi					4.4	0	8.7	0.1	11.1	0.2
Sarcostemma clausum					4.4	0				
Saururus cernuus	4.3	0.1	26.7	1.6	48.9	5.8	17.4	1.5	4.4	0.1
Smilax laurifolia	2.2	0.1								
Smilax sp.									8.9	0.2
Thelypteris interrupta	19.6	1.8	80	11.2	48.9	6.1	69.6	5.4	46.7	4.4
Thelypteris palustris			33.3	0.3	6.5	0.1				
Thelypteris reticulata	8.7	0.4	40	6.9	15.6	2.2				
Thelypteris sp.					2.2	0				
Toxicodendrun radicans	4.3	0.1	13.3	0.1	22.2	0.6	21.7	0.6	35.6	1.3
Unidentfied *Panicum*									6.7	0
Unidentfied Broadleaf Herb									4.4	0
Unidentified *Echinocholoa*									4.4	0
Unident. Herb (yellow flower)									4.4	0
Unidentified Mint							6.5	0.4		
Unidentified Vine #1					4.4	0.1				
Unidentified Vine #2					11.1	0.1				
Unident. Woody Seedlings										
Vigna luteola									2.2	0
Vitis shuttleworthii					2.2	0				

CONCLUSION AND DISCUSSION

Prior to the mid 1980s the Northwest Fork of the Loxahatchee River was experiencing a very critical and damaging period with regards to very low freshwater flows, hurricane damage (Dennis in 1981), droughts (1980 and 1981), and saltwater intrusion that effected the floodplain plant communities. In 1984, the Florida Department of Natural Resources published a report that stated that the majority of bald cypress trees downstream of RM 7.8 were dead. Our report captures the majority of the data that was collected in 1984 by the South Florida Water Management District staff and provides baseline information on vegetation characteristics and some water quality aspects.

This study provided additional information on the salinity, conductivity, dissolved oxygen and flow regimes exhibited by the river system and supplements that data reported by Russell and McPherson in their 1984 publication “Freshwater Runoff and Salinity Distribution in the Loxahatchee Estuary, southeastern, Florida”. Conductivities ranged from 400 µS/cm at RM 16.5 to 14,390 µS/cm at RM 5.0. Conductivity readings were higher with depth demonstrating that a saltwater wedge does exist and is supported by hydrodynamic salinity models of the river. Dissolved oxygen readings were typical of the South Florida region and ranged from 2.5 to 4.8 mg/L. Flow data collected on the agricultural ditch on Transect 1 provided insight into additional quantities of freshwater runoff entering this segment of the river. Recorded flows ranged from 1 to 31 cfs at the ditch, which could be significant during periods of low freshwater flow.

This study also provides the first vegetation report on the Loxahatchee River to document the deaths of other hardwood species along with the deaths within the bald cypress community. Other recorded deaths included a variety of swamp and bottomland hardwood species. The 1984 survey of dead trees included bald cypress, popash, pond apple, red maple, water hickory, strangler fig, and laurel oak.

Also, this study was the first to investigate elevations of the most common floodplain species and height and elevation of cypress knees within the floodplain. Although there were some problems with survey data at Transects 1 and 5, all of the survey data reflected the decrease in floodplain elevation at each transect as the river travels downstream. For the most part, individual floodplain species were found at elevations equivalent to their primary forest type (i.e. upland, hammock, bottomland hardwood, and swamp). Additionally, there was evidence that pop ash occurs at generally lower elevations than bald cypress in the swamp habitat, which had been suggested by some of the blackwater river literature (Burke et al., 2003). Also, bottomland hardwood and hammock species were found at generally higher elevations than swamp species. This provided us with additional confidence that the forest type communities and indicator species for our 2003 forest type study were accurate for the Loxahatchee River floodplain. The average elevation of cypress knees showed a trend towards greater heights in the upper portions of the river where the floodplain is narrower, flow velocities are probably stronger, and the trees are older.

With regards to the six floodplain transects, some comparisons were possible although the methodology used in 1984 differed from the 1995 and 2003 Loxahatchee River studies. At Transect #1 species composition and structure were similar; however, a few less common species have come and gone like java plum and pop ash. Live oak and pond apple were observed in 2003 but not in 1984. Tree growth (dbh size classes) was evident in bald cypress, cabbage palm, and slash pine. Live oaks appear to have replaced some of the laurel oaks that were found in 1984 but not observed in 2003.

At Transect #2, which is divided by the Masten Dam structure, the greatest change was the drop in the number of pop ash trees from 90 trees in 1984 to 11 remaining trees in 2003. Dbh size class frequencies reflected tree growth in cabbage palms, bald cypress (however with the loss of a few 81-99+ size trees), and laurel oak. One small water hickory, *Carya aquatica,* and three slash pines, *Pinus elliottii*, were present in 2003 but were not observed in 1984. On the other hand, no cocoplum or buttonbush, *Cephalanthus occidentalis,* were present in the canopy in 2003 but were present in 1984.

At Transect #3 there was also a decline in the number (200+ to 60) of pop ash and pond apple (120 to 8) in the 5-20 cm size class between 1984 and 2003. There was also a loss of the older red maples (41-60 cm) and some new recruitment of cabbage palm. The 2003 study recorded a total of 10 canopy species at Transect #3 while the 1984 study recorded 11 species with the presence of wild citrus and water hickory. Slash pine and Brazilian pepper (*Schinus terebinthefolius*) were reported in 2003 but not observed in 1984. Pop ash was present in the 5-20 and 21-40 cm size class in 1984 and 2003, while one tree in 2003 made the 41-60 cm size class group. Bald cypress was few in number on Transect 3 but they were present in all 5 size classes in 1984 and in the three higher size classes in 2003.

At Transect #4, pop ash declined in number from 90+ to 27 individuals between 1984 and 2003. Red maple also showed decline, while water hickory showed increases in numbers at all size classes at Transect #4. In both 1984 and 2003, popash was only present in the two smaller size classes (5-20 and 21-40 cm). Red maple was present in the 3 smaller size classes in 1984; however, in 2003, they were only present in the two smaller size classes. In 1984, water hickory was present in the 4 smaller class sizes while in 1984 they were present in the 5-20, 21-40, 41-60 and 81-99+ cm size classes in 2003. As mentioned in the main document, we noted in the field that large red maple and water hickory had a tendency to fall over presumably due to fact that they become top heavy and produce shallow root systems.

At Transect #5 (Cypress Creek) pop ash declined dramatically between 1984 and 2003. In 1984 they were present in the 5-20, 21-40 and 41-60 cm size classes (approximately 45 individuals) and in 2003 one individual was present in the 5-20 cm size class. In fact, there was a decline in abundance of most of the canopy species at Transect #5. This may be attributed to the fact that Cypress Creek sometimes receives extremely high flows (over 1000 cfs) from upstream agricultural and urban lands that may produce tipovers and stress particularly bottomland hardwood species that might be susceptible to increased periods of flooding.

Upper tidal Transect #6 exhibited increases in red and white mangrove although the most abundant species reversed between 1984 and 2003. In 1984, red mangrove out numbered white mangrove whereas in 2003 white mangrove took a slight lead over red mangrove followed by pond apple. In 2003, 14 canopy species were reported while 12 species were reported in 1984. The additional species observed in 2003 were bald cypress, *Roystonea regia*, royal palm, *Ilex cassine* (dahoon holly), and slash pine. In 2003, a total of 7 live bald cypress were reported on Transect 6 and occurred in the 5-20, 21-40 and 61-80 cm size classes. None had been identified in the 1984 study.

The most common herbaceous species were swamp fern, tri-veined fern, lizard’s tail, wild coffee, and Day flower. *Crinum americanum* (swamp lily) was only reported on Plots # 3, 4 and 5 in 1984. These lilies were generally low in frequency and mean cover. In 2003, swamp lily was one of the most common herbaceous species in the swamp community. Additional ferns were also reported in 2003. These included *Nephrolepis exaltata* (Boston fern), *Thelypteris serrata* (meniscium fern) *Thelypteris kunthii* (maiden fern) and *Thelypteris dentata* (downy shield fern).

A comparison of species richness between the 1984, 1995, and 2003 Loxahatchee River studies is discussed in the Discussion and Results sections of the main document. The number of species does appear to be increasing with time and we have noticed fewer tree deaths associated with saltwater intrusion. This study was able to provide us with a 19-year look back into many of the sites and areas that we had reinvestigated in recent years.

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APPENDIX H

1995 VEGETATION ANALYSIS OF THE LOXAHATCHEE RIVER CORRIDOR

APPENDIX H

1995 Vegetation Analysis of the Loxahatchee River Corridor

Thomas Ward and Richard Roberts

Introduction

Riparian wetland systems in Florida are increasingly being impacted by urban development. Due to these impacts and the introduction of numerous exotic plant species, a need exists to conduct research that will lead to a better understanding of the dynamics of these unique, low-gradient systems. In riparian systems, environmental factors such as hydroperiod, disturbance associated with flooding, edaphic conditions, and light availability are often found to vary along gradients. Ward (1993) surveyed ground layer vegetation at 8 locations within the Wekiva River basin. In each plot, he measured light (Photosynthetically Active Radiation, PAR), elevation, soil pH, soil organic content, and fire history. All 5 of the environmental variables showed significant differences between at least two clusters created by Twinspan (a two-way indicator analysis). Elevation and soil organic content expressed the strongest correlation between the environmental variables.

This study concentrates on the Loxahatchee River which is located in Martin and Palm Beach Counties in Southeast Florida. The river consists of three primary forks: the Southwest, the North Fork, and the Northwest Fork. A portions of the Northwest Fork is designated a National Wild and Scenic River in 1985. Saltwater intrusion due to alterations to the river basin and the invasion of exotic plant species are major management concerns for this section of the river.

The floodplain topography of the Northwest Fork downstream of State Road 706 remains relatively intact. However, two dams were constructed in this section to provide additional floodplain storage. The changes in upstream hydrology have decreased the flows going to the Northwest and have resulted in increased saltwater intrusion in the lower portions of the fork. The increase in salinity has contributed to the conversion of an extensive portion of the freshwater swamp that previously dominated the lower reaches to mangroves (FDEP, 1985).

Another major concern is the increased presence of exotic plants in the river corridor. While a number of exotic plant species are present in Florida, the majority do not pose a major threat to the structure and composition of natural ecosystems. However, a few exotics have the capability to expand into natural areas and displace native species. Brazilian pepper (*Schinus terebinthifolius*), Old World climbing fern (*Lygodium microphyllum)*, arrowhead vine (*Syngonium podophyllum*), East Indian swamp weed, *Hygrophila polysperma* and marsh weed, *Limnophila sessiflora* are exotic plant species that are present on the Loxahatchee River and appear to have the potential to cause major changes to riparian wetland structure and composition. Many other exotics are also present in the river corridor.

The purpose of this investigation was designed to analyze the relationship between the riparian plants on the Loxahatchee River Corridor and selected environmental variables. Permanent transects were established to: (1) characterize relationships between vegetation and various environment variables; (2) compare this data to data collected by Worth in 1984 and to data on other river systems; (3) make recommendations for restoration; (4) provide a baseline to evaluate effects of restoration efforts; (5) determine the effects of dam reconstruction on plant communities; (6) examine the role of exotic plant species in this system; and, (7) attempt to determine the composition and distribution of historic plant communities.

Study Sites

Study site were chosen at six different locations (**Figure H-1**). Five sites were located on the Loxahatchee River and one was located on Cypress Creek. The site locations were originally established for a 1983 study by South Florida Water Management District (SFWMD) (Worth, et al., unpublished). The original benchmarks surveyed by SFWMD were recovered at each site. Exact locations of the SFWMD transects could not always be determined, but an attempt was made to re-establish the original transect location when possible.

Methods

Vegetation and environmental variables were surveyed at six belt transects previously surveyed by SFWMD in 1984 (See: **Appendix G**). Belt transects were positioned perpendicular to the river and the existing elevational gradient. Each belt transect was 10m wide and divided into 10 x 10m plots (See: **Figure 18** of the main document). A total of 79 10 x10 m plots were surveyed at the 6 study sites between October 1993 and January 1994. Transects began where emergent vegetation first occurred on the river's edge and continued inland to the upland edge of the wetland. This edge was determined using visual cues and by examining soils. Transects were marked by PVC pipes.

Environmental sampling

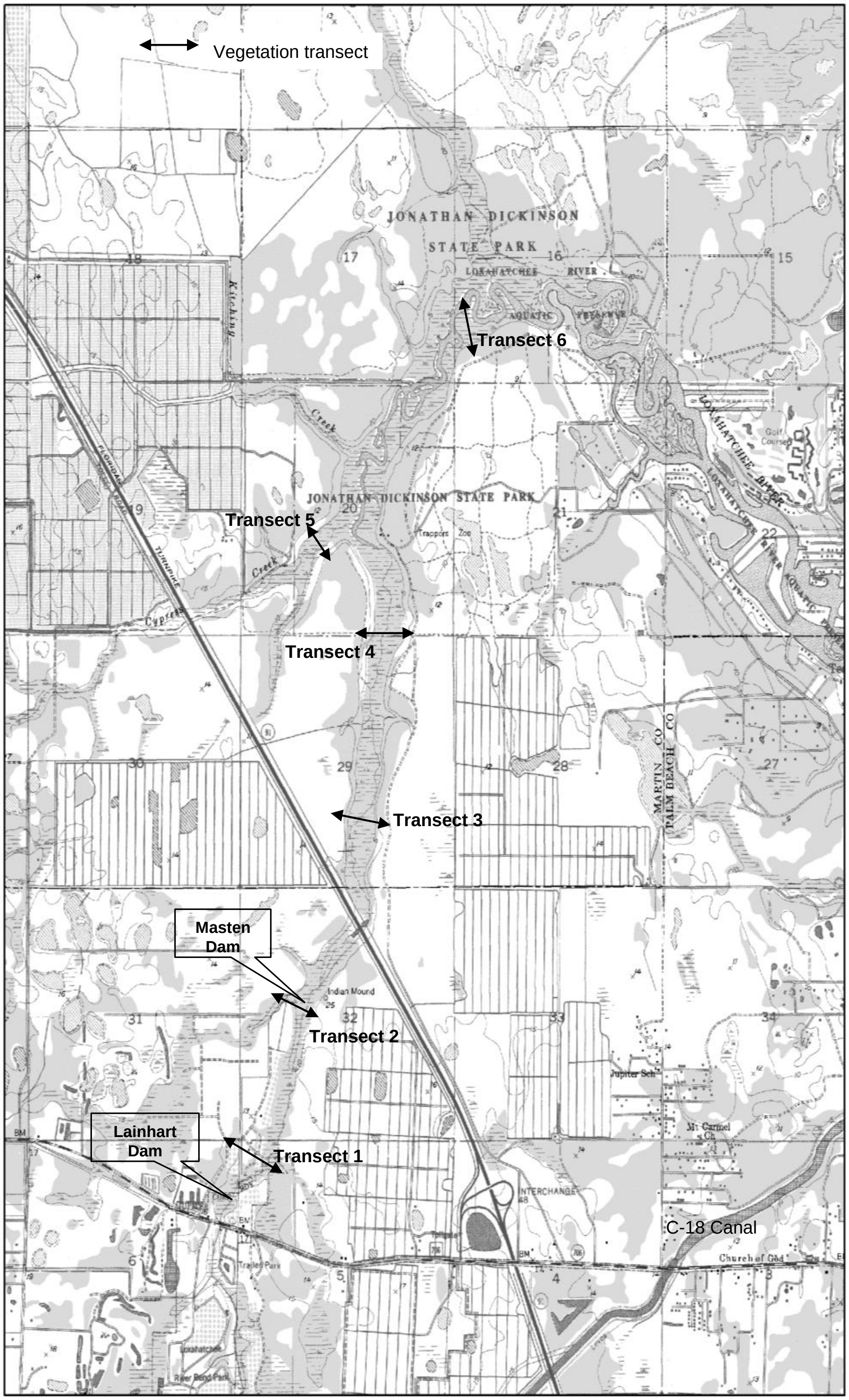
The elevation of each 10 x 10m plot is based on an average of the three 1 x 1m plots. A laser level was used to determine the elevation (feet, mean sea level, MSL) based on permanent benchmarks established by the South Florida Water Management District. Water levels were also recorded to allow elevations to be determined relative to the river level at each transect.

Soil samples were collected from each 1 x 1m plot and combined into a composite sample for each 10 x 10m plot. A soil auger was used to collect the top 20 cm of soil in each 10 x 10m plot. Laboratory analysis of these samples was performed by the University of Florida, Institute of Food and Agricultural Sciences, Soil Science Department, Analytical Research Laboratory. Levels of pH, calcium, magnesium, phosphorus, zinc, copper, and manganese were determined for each sample.

Vegetation Sampling

For sampling purposes, the vegetation was divided into three layers within the plots. Within each 10 x10 m plot, all canopy trees greater than 4 inches (10.2 cm) dbh were identified by species and dbh measured. Canopy cover was estimated at each plot using a densitometer. Cover by species of all woody plants with a height greater than 3 feet (0.9m) and dbh less than 4 inches was measured along a 10m line transect nested within each 10 x 10m plot (**See Figure 22** of the main document). Dominant vegetation species were noted. Cover and stem counts, by species, of all herbaceous plants and woody plants under 3 feet in height was measured in three 1

Figure H-1. Locations of the six vegetation transects.



x 1m quadrats nested within each 10 x 10m plot. In each 1 x 1m plot, canopy cover, elevation, soil characteristics were sampled. Elevation was measured at the location of each 1 x 1m plot.

Plant identification references included Godfrey & Wooden (1979), Godfrey & Wooten (1981), Radford et al. (1968) and Wunderlin (1982). Nomenclature follows Wunderlin (1982). Additional data collected at each plot included presence of hummocks, presence of bald cypress stumps, estimates of percent open ground, percent exposed roots, percent leaf litter, and percent fallen logs.

Size class frequencies of diameter at breast height (dbh) in centimeters were created to observe recruitment of younger trees and general age groups of canopy species. These size classes were established as 5-20 cm, 21-40 cm, 41-60 cm, 61-80 cm, and 81-99+ cm. In order to compare the 1984 data with the 1995 and 2003 Loxahatchee River studies, those trees less than 5 cm were not included in the dbh size class frequency analysis.

Statistical Analysis

A variety of different computational methods were used to analyze the data. A correlation matrix was created to examine relationships among the environmental variables. This was followed by cluster analysis and ordination of vegetative and environmental data.

Sample data were analyzed using a form of cluster analysis known as indicator species analysis (Hill et al. 1975). This classification scheme used reciprocal averaging, an ordination technique discusses in the following paragraph, to produce stand scores on a linear scale. The stands were then divided into two groups at the mean stand score. Certain species tended to occur exclusively near the ends of the linear scale. These species are known as indicator species and should be characteristic of environmental conditions towards the end of the gradient (Causton, 1988). The computer program used to perform this analysis was Twinspan.

In the field of ecology "ordination" has been described as "the collective term for multivariate techniques that arrange sites along axes on the basis of data on species composition" (Jongman et al. 1987). Gauch (1982) stated "Ordination primarily endeavors to represent sample and species relationships as faithfully as possible in a low-dimensional space". According to Ludwig & Reynolds (1988, page 205) "The aim of ordination is to simplify and condense massive datasets in the hope that ecological relationships will emerge". Ordinations of all kinds are generally referred to as gradient analysis (Causton, 1988). Direct gradient analysis is defined as an ordination based directly on environmental factors, while indirect gradient analysis is based on vegetation data (Causton, 1988). In indirect gradient analysis, the ordination axes created from the vegetation data can then be compared to environmental data. A multivariate direct gradient analysis technique called canonical correspondence analysis (CCA) was uses in this study. Ter Braak (1986) devised this procedure based on reciprocal averaging (also called correspondence analysis). This technique "is related conceptually to weighted averages but is computational an eigen analysis problem" (Gauch 1982). This method produces coordinates for both sample units and species so that corresponding sample units and species ordinations can be constructed" Ludwig & Reynolds 1988). This technique selects the linear combination of environmental variables that maximizes the dispersion of the species scores. In other words, CCA chooses the best weights for the environmental variables. This gives the first CCA axis (Jongmann et al., 1987). Second and higher axes are selected in the same manner with the additional constraint of being uncorrelated with previous axes (Jongmann et al. 1987). Canonical correspondence analysis was graphically displayed by an ordination diagram in which species and sites are represented by points and environmental variables are represented by arrows. Such a diagram shows the main pattern of variation in community composition as accounted for by the environmental variables. The computer program used to perform this analysis was CANOCO (Ter Braak, 1986).

In 2004, the Florida Department of Environmental Protection's Florida Park Service (5th District, FDEP) contracted Melanie Darst and Helen Light of the U.S. Geological Survey in Tallahassee, Florida to perform additional analysis of the 1995 canopy dataset. Darst and Light had worked on similar floodplain vegetation studies on the Suwannee River and other northern Florida rivers. For each 10 x 10m plot, they determined Relative Basal Area (RBA) by species by transect. For every species present they assigned a wetland habitat category based on the generally understood ecology from the literature. These were defined as the following:

1. Obligate- only found in wet areas;
2. FACW – under natural conditions exhibit maximum surface water inundation and soil saturation; and
3. Facultative (FAC) – inappropriate for indication of inundation and soil saturation.

They concluded that there were 5 basic forest types present on the 6 transects. By using the RBA of each species, they developed the following rules for determining forest type on the 1995 Loxahatchee River floodplain dataset.

If upland > 50% then type is upland.
If swamp > 50% then:
If swamp >= 74%, then type is sw1.
If swamp < 75%, then type is sw2.
If lo blh >= 50%, then type is lo blh.
If hammock + blh > 50%, then type is hammock.

Based on the results of the forest type analysis, maps of the area, and a site inspection of the 6 sites, they divided the study area of the river into 3 reaches. Transects 1 and 2 were identified as the "Impounded Reach" due to the presence of Lainhart and Masten Dams. Transect 3, 4, and 5 were identified as the "Freshwater Unimpacted Reach" while Transect 6 was identified as the Impacted Reach.

Results

Environmental Variables

Mean and standard deviation values for the environmental variables sampled at the six transects are given in **Table H-1**. As would be expected, mean elevation (ft. MSL) reflected the elevation gradient of the transects along the river. Mean canopy cover was high (89.1 percent to 94.4 percent) at all but Transect 6, which had 75.8 percent canopy cover. Mean pH ranged between 6.03 (Transect 3) and 5.3 (Transect 6). Notable among the soil nutrients sampled was the elevated levels of magnesium and potassium at Transect 6, as well as, the low levels of zinc at this site.

The correlations between the environmental variables sampled are given in **Table H-2** and illustrated in **Figure H-2**. Relative elevation and soil calcium showed the strongest correlation to other variables (r^2=-0.721, $p<0.001$). Relative elevation was negatively correlated to pH (r^2= -

0.598, $p<0.001$) as well as all the soil nutrients but copper. Ph, potassium, zinc, and manganese also showed strong correlation to the other variables.

Two-way indicator species analysis to the dataset divided the samples into 6 different groups (**Table H-3**). An ANOVA was performed to determine how these groupings explained differences in environmental variables between groups. The results of the ANOVA indicated that all possible comparisons between groups showed differences in at least one of the environmental variables ($p<0.05$). Group F was found to be an outlier containing one plot. This plot was located at the upland end of Transect 6. This one plot was consistent with a pine flatwood community. Group B was also small (n=2) and was found to be similar to Group A. The canopy of Group B was dominated by bald cypress while shrub and groundcover species consisted mainly of white mangrove, maiden fern and royal fern. Group E was distinguished by having higher relative elevation than Groups A, B, C, and D and lower levels of soil calcium than Groups A, C, and D. The canopy of Group E was dominated by cabbage palm, water hickory, slash pine and laurel oak with saw palmetto and swamp fern dominating the shrub and groundcover layer. Group A showed significantly higher level of soil potassium than Groups B, C, D, and E. Group A also exhibited higher levels of soil magnesium and lower percent canopy cover than Groups C, D, E, and F. With regards to basal area, the canopy of Group A was dominated by cabbage palms while the shrubs and groundcover were dominated by red mangrove, pond apple, Brazilian pepper and leather fern. Group C was distinguished from Group D by having higher levels of soil calcium, zinc and manganese. The canopy of Group C was dominated by bald cypress with some pop ash while shrub and groundcover was dominated by leather fern and maiden fern. The canopy of Group D was dominated by water hickory and bald cypress with some red maple and cabbage palm. Virginia willow swamp fern and maiden fern dominated the shrub and groundcover of Group D. The relative frequency of each of these groups over the six transects is given in **Table H-4**. Groups A, B, and F were only found at Transect 6. Group D was found at all transect but Transect 6.

Table H-1. Mean and standard deviation for values for the environmental variables.

Average for Environmental Variables Sampled in 1995

Transect #	# of Plots	Ave. Elev. (ft. MSL)	Canopy Cover	Soil pH	Ca (ppm)	Mg (ppm)	K (ppm)
T-1	15	10.89	92.7%	5.85	3261	146.6	37.3
T-2	13	8.47	92.1%	5.71	2578	106.1	26.8
T-3	13	4.52	89.1%	6.03	3081	144.0	40.7
T-4	12	2.37	93.5%	5.88	3048	123.3	39.4
T-5	14	3.50	94.4%	5.49	1777	93.0	33.9
T-6	12	1.99	75.8%	5.30	2331	855.3	80.4
All Transects	79						

Transect #	P (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)
T-1	11.26	6.42	0.21	16.2
T-2	10.92	4.85	0.26	15.9
T-3	12.31	6.35	0.44	22.8
T-4	11.57	2.86	0.28	14.0
T-5	6.93	3.59	0.72	11.9
T-6	14.01	1.01	0.13	12.3
All Transects				

Figure H-2. 1995 Ward and Roberts CCA analysis of environmental variables.

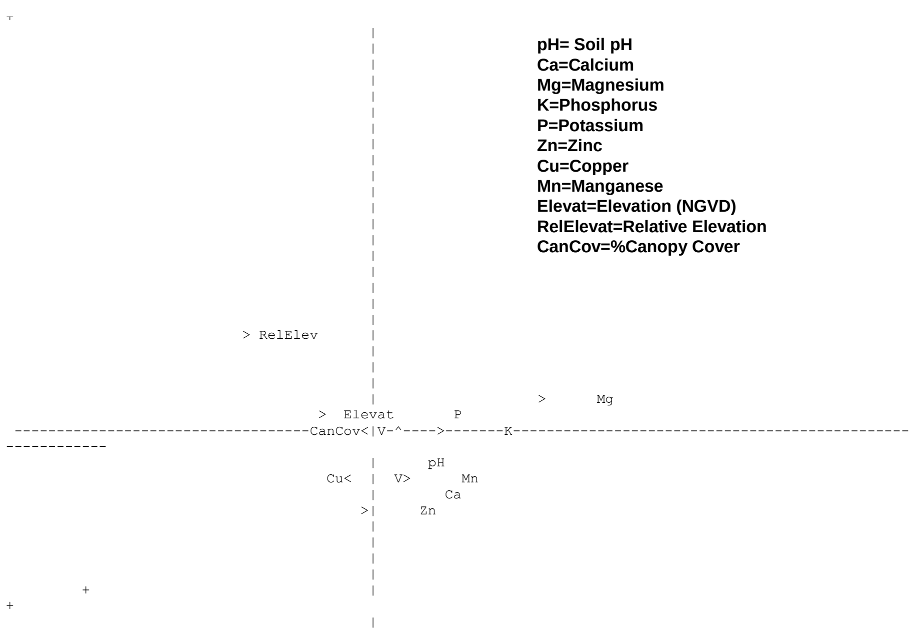


Table H-2. Pearson product moment correlation coefficients for environmental variables at all transects.

	Elevation (ft.)	Canopy Cover	Rel Elev. (ft.)	pH
Elevation (ft. MSL)		0.151	0.288	-0.058
Canopy cover	0.151		-0.013	0.007
Rel. Elev. (ft.)	0.288	-0.013		-0.598
pH	-0.058	0.007	-0.598	
Ca (mg/kg)	-0.056	0.071	-0.721	0.558
Mg (mg/kg)	-0.271	-0.45	-0.283	0.037
K (mg/kg)	-0.311	-0.292	-0.323	0.079
P (mg/kg)	0.018	-0.071	-0.39	0.211
Zn (mg/kg)	0.132	0.136	-0.531	0.491
Cu (mg/kg)	-0.348	0.251	-0.105	0.111
Mn (mg/kg)	-0.037	0.084	-0.437	0.52

	Ca (ppm)	Mg (ppm)	K (ppm)	P (ppm)
Elevation (ft. MSL)	-0.056	-0.271	-0.311	-0.018
Canopy cover	0.071	-0.45	-0.292	-0.071
Rel. Elev. (ft.)	-0.721	-0.283	-0.323	-0.39
pH	0.558	0.037	0.079	0.211
Ca (mg/kg)		0.282	0.56	0.183
Mg (mg/kg)	0.282		0.517	0.234
K (mg/kg)	0.56	0.517		0.066
P (mg/kg)	0.183	0.234	0.066	
Zn (mg/kg)	0.773	0.055	0.338	0.021
Cu (mg/kg)	0.015	-0.182	-0.068	-0.123
Mn (mg/kg)	0.664	0.083	0.365	0.008

	Zn (ppm)	Cu (ppm)	Mn (ppm)
Elevation (ft. MSL)	0.132	-0.348	-0.037
Canopy cover	0.136	0.251	0.084
Rel. Elev. (ft.)	-0.531	-0.105	-0.437
pH	0.491	0.111	0.52
Ca (mg/kg)	0.773	-0.015	0.664
Mg (mg/kg)	0.055	-0.182	0.083
K (mg/kg)	0.338	-0.068	0.365
P (mg/kg)	0.021	-0.123	0.008
Zn (mg/kg)		0.232	0.814
Cu (mg/kg)	0.232		0.223
Mn (mg/kg)	0.814	0.223	

Table H-3. Results of ANOVA comparison of environmental variables by TWINSPAN Groupings with a significant difference of $p<0.05$ (Scheffe's F-test).

	Group A	Group B	Group C	Group D	Group E	Group F
Group A		K	EL,CC,Mg,K,Zn	CC,Mg,K,P	EL,CC,RE,Ca,Mg,K	CC,RE,Mg
Group B	K		Mg,Zn	Mg	RE,Mg	RE,Mg
Group C	EL,CC,Mg,K,Zn	Mg, Zn	Ca,Zn,Mn	Ca,Zn,Mn	RE,pH,Ca,Zn,Mn	RE
Group D	CC, Mg,K,P	Mg, Zn			EL,RE,Ca	CC,RE
Group E	EL,CC,RE,Ca,Mg,K	RE,Mg	RE,pH,Ca,Zn,Mn	EL,RE,Ca		CC
Group F	CC,RE,Mg	RE,Mg	RE	CC,RE	CC	

Abbreviations:
EL - elevation (ft. MSL)
CC - Canopy Cover
RE - Relative Elevation (ft.)
pH - pH
Ca - Ca (mg/kg)
Mg - Mg (mg/kg)
K - K (mg/kg)
P - P (mg/kg)
Zn - Zn (mg/kg)
Cu - Cu (mg/kg)
Mn - Mn (mg/kg)

Table H-4. Relative frequency (%) of TWINSPAN Groupings by site.

	Group A	Group B	Group C	Group D	Group E	Group F
Transect 1			60%	13.30%	26.70%	
Transect 2			46.20%	15.40%	38.50%	
Transect 3			69.20%	23.10%	7.70%	
Transect 4			25.00%	75%		
Transect 5				71.40%	28.60%	
Transect 6	66.70%	16.70%			8.30%	8.30%
All Sites	10.10%	2.50%	34.20%	32.90%	19.00%	1.30%

Vegetation Surveys

A total of 96 plant species were identified in the 79 10mx10m plots located at the six study transects. Fifteen plant species were observed in the canopy layer, 27 plant species were observed in the shrub layer and 83 plant species were observed in the ground layer. With regards to basal area (**Table H-5**), Transects 1 and 2 had the highest tree basal area per $10m^2$ plot ($6353.6cm^2$ and $6425.3cm^2$). Transect 6 had the lowest basal area ($1509.6cm^2$). Bald cypress, *Taxodium distichum*, was the dominant tree species by basal area. Overall, the average shrub cover was 22.4 percent (**Table H-6**). Percent cover was highest at Transect 6 (89.6 percent) and the lowest at Transect 3 (6.7 percent). Pond apple (*Annona glabra*), Virginia willow (*Itea virginica*) and red mangrove (*Rhizophora mangle*) were the species with the highest overall percent cover in the shrub layer. Overall the average ground cover was 68 percent (**Table H-7**). Percent ground cover was highest at Transect 3 (90.8 percent) and the lowest at Transect #1 (45.5 percent). The dominant three plant species found in the ground cover layer were leather fern (*Acrostichum danaeifolium*), swamp fern (*Blechnum serrulatum*) and tri-veined fern (*Thelypteris interrupta*). Together they constituted more than half the total ground cover.

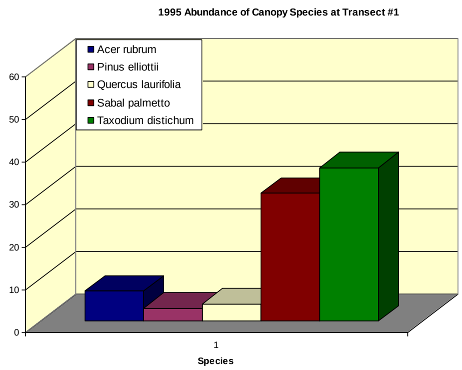
The abundance of canopy species and the frequency of dbh size class frequencies provided a snap shot of plant communities in 1985 (**Figures H-2 through H-7**). Transect #1 consisted of five canopy species dominated by bald cypress in the swamp and cabbage palm in the hammock (**Figure H-2A**). There were four dbh size class frequencies of bald cypress and red maple, which indicated some recruitment and growth within the swamp community (**Figure H-2B**). Most cabbage palms were in the 21-40 cm size range. Cabbage palm was the dominant canopy species on Transect #2, which had a total of nine canopy species and they were all within the same size frequency (21-40cm) (**Figures H-3A and B**). There were three size classes of red maple (5-20, 21-40, and 41-60cm) and bald cypress (41-60, 61-80, and 81-99+ cm). Transect #3 was dominated by pop ash and they were from only two size classes (5-20 and 21-40cm) (**Figures H-4A and B**). Transect #3 contained a total of eight canopy species. As with pop ash, red maples were present in only two size classes (5-20 and 21-40cm) while bald cypress were present in four size classes (21-40, 41-60, 61-80, and 81-99+cm). Transect #4 was also dominated by pop ash from two size classes (5-20 and 21-40cm) and contained seven canopy species(**Figures H-5A and B**). Bald cypress and water hickory were present in four size classes (5-20, 21-40, 41-60,61-80 cm) (5-20, 21-40, 41-60, and 81-99+cm). Red maples were present in three size classes (5-20, 21-40, and 41-60cm). Transect #5 on Cypress Creek contained eight canopy species and was dominated by three species (water hickory, bald cypress, and red maple) (**Figures H-6A and B**). Water hickory were present in all five size classes while bald cypress, red maple and cabbage palm were present in three size classes (5-20, 21-40, 41-60cm). Transect #6, which is saltwater tidal contained nine canopy species. Red and white mangroves were present but not included in the canopy analysis. The most dominant species in the canopy analysis were cabbage palm, pond apple, and bald cypress (**Figures H-7A and B**). Pond apples were present in two size classes (5-20, and 21-40cm). Cabbage palms were only present in the 5-20 cm size class while bald cypress were present in 5-20, 21-40, and 61-80cm size classes.

Table H-5. Summary of Basal Area by transect.

1995 Summary of Average Tree Basal Area (cm2) per 10mx10m plot by Transect							
Species	**Transect 1**	**Transect 2**	**Transect 3**	**Transect 4**	**Transect 5**	**Transect 6**	**Overall Average**
Annona glabra		4				189.24	**27**
Acer rubrum	420.35	241.23	185.14	637.79	558.77	8.64	**354.15**
Carya aquatica		3.49		1929.54	1850.03		**644.94**
Cephalanthus occidentalis				2.68			**0.4**
Ficus aurea		277.44	37.76				**51.87**
Fraxinus caroliniana		75.28	1217.97	657.72	4.73		**313.62**
llex cassine					8.99		**1.71**
Myrica cerifera			3.1			13.44	**2.39**
Persea palustris					29.02	10.28	**6.9**
Pinus elliottii	346.48	165.25				47.53	**99.6**
Quercus laurifolia	150.63	205.73	339.82	8.66	336.99		**183.67**
Quercus virginiana						10.45	**1.46**
Sabal palmetto	1423.88	2685.2	541.88	224.15	334.62	593.9	**981.67**
Schinus terebinthefolius			2.79			18.7	**3.1**
Taxodium distichum	4012.32	2767.72	2250.47	1372.71	1038.85	617.35	**2079.33**
Total	**6353.62**	**6425.34**	**4579.96**	**4833.25**	**4162**	**1509.6**	**4751.8**

Figures H-2. Abundance and dbh at Transect #1.

A



B

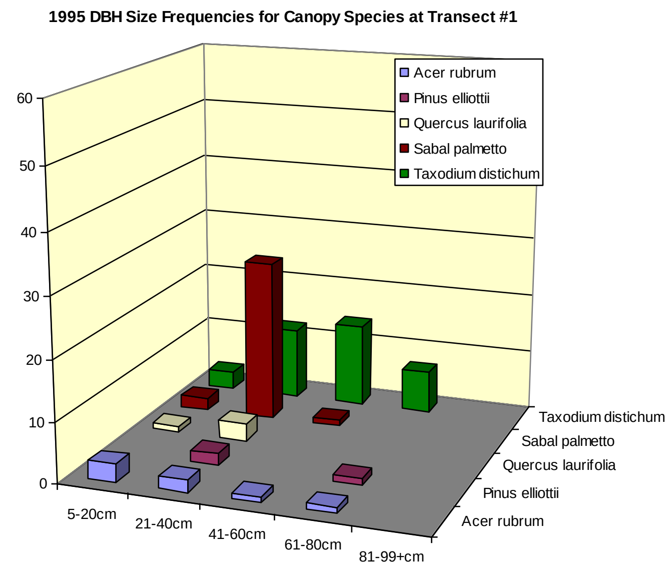
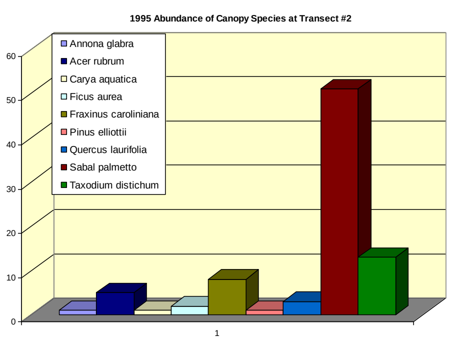


Figure H-3. Abundance and dbh at Transect #2.

Total Number



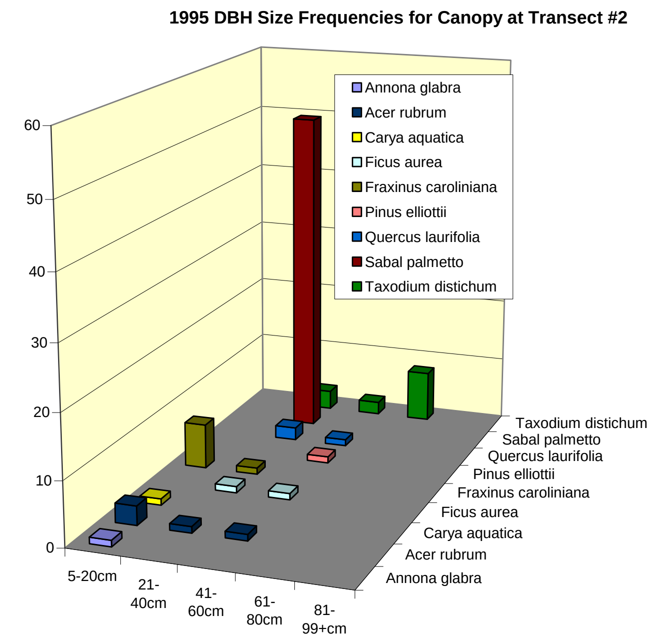
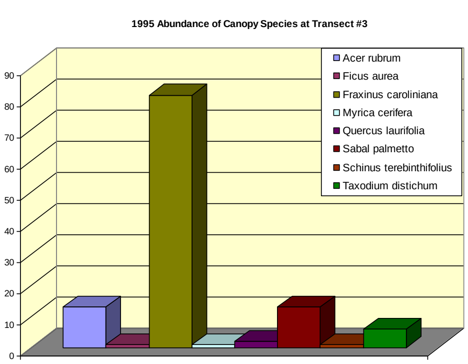


Figure H-4. Abundance and dbh at Transect #3.



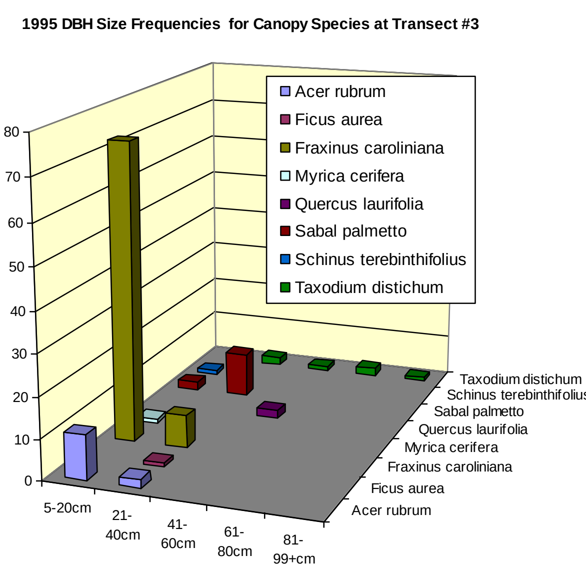
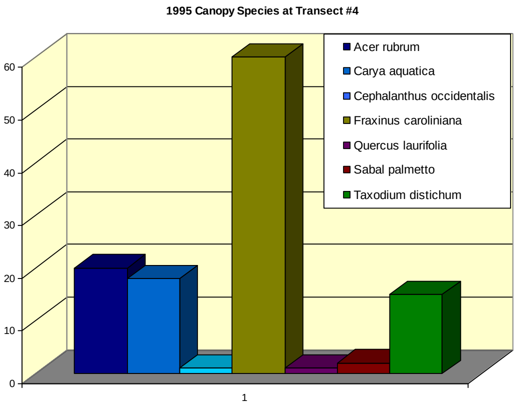


Figure H-5. Abundance and dbh at Transect #4.



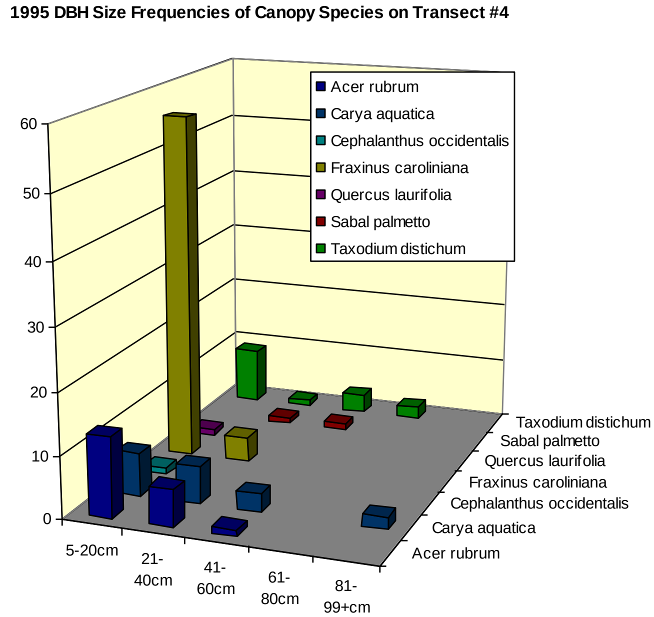
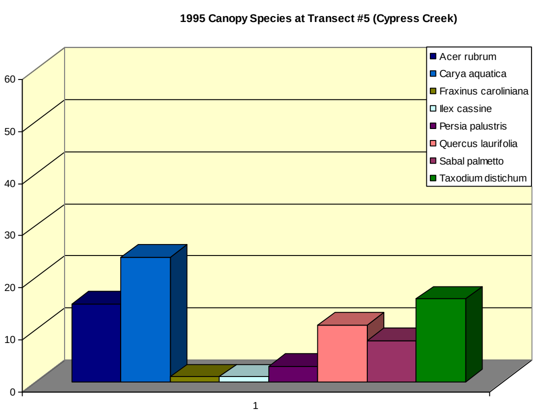


Figure H-6. Abundance and dbh at Transect #5.

Total Number



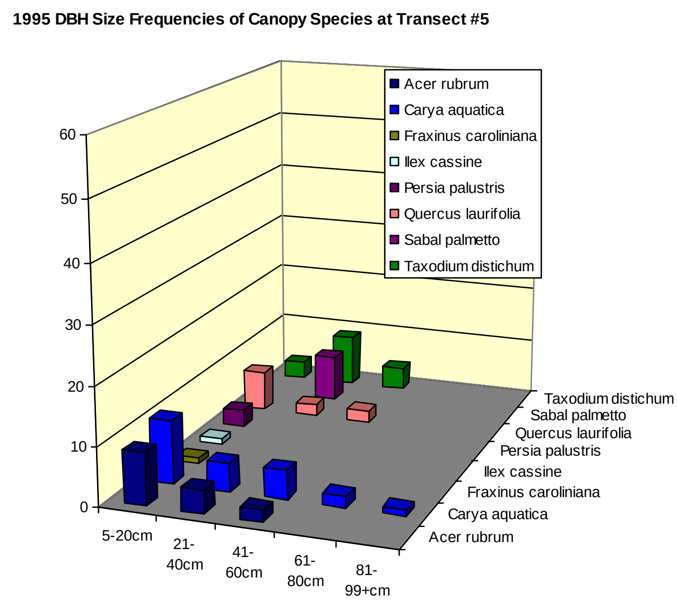
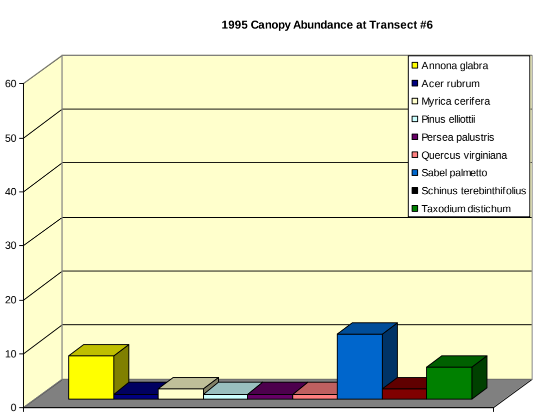


Figure H-7. Abundance and dbh at Transect #6.



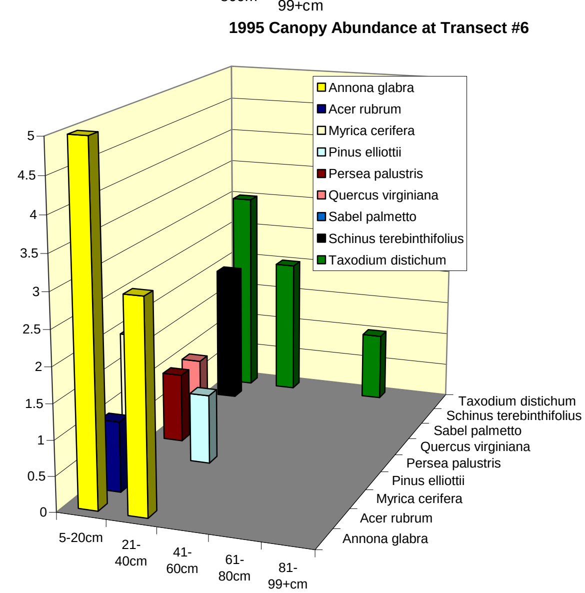


Table H-6: Percent Cover:Shrubs		**Transect**						
Species	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**Overall**
Acer rubrum	Red maple	1.2					0.9	0.4
Annona glabra	Pond apple			2.6			15.7	2.8
Ardisia escallonioides	Marlberry	0.2	0.8		0.9	0.1		0.3
Aster carolinianus	Climbing aster						1	0.2
Baccharis glomeruliflora	Groundsel tree			0.5				0.1
Callicarpa americana	American beautyberry		0.6					0.1
Carya aquatica	Water hickory				0.3			0
Cephalanthus occidentalis	Buttonbush		0.3	0.6	1.2		1.9	0.6
Fraxinus caroliniana	Pop ash		0.1		0.5		1	0.2
Ilex cassine	Dahoon holly					0.2		0
Ipomoea alba	Moonflowers		2.1					0.3
Itea virginica	Virginia willow		3	2	16	0.2		3.3
Myrica cerifera	Wax myrtle						3.2	0.5
Laguncularia racemosa	White mangrove						10.9	1.7
Ludwigia octovalvis	Primrose willow						3.4	0.5
Persea palustris	Swamp bay	1.6				0.6		0.4
Psidium cattleianum	Strawberry guava						6.6	1
Rapanea punctata	Myrsine			1		0.2		0.2
Rhabdadenia biflora	Rubber vine						0.5	0.1
Rhizophora mangle	Red mangrove						25.2	3.8
Sabal palmetto	Cabbage palm	3	0.7		0.3	2.5		1.2
Sarcostemma clausum	White-vine						0.9	0.1
Schinus terebinthifolius	Brazilian pepper				0.2		11.4	1.7
Serenoa repens	Saw palmetto		1.7			6	6.4	2.3
Taxodium distichum	Bald cypress				0.4			0.1
Toxicodendron radicans	Poison ivy						0.3	0.1
Vitis munsoniana	Muscadine grape	1.3	0.5		0.2	0.2	0.3	0.4
Total Shrub Cover		**7.3**	**9.8**	**6.7**	**20**	**10**	**89.6**	**22.4**

Table H-7 Groundcover Percent Cover		Transect						
Species	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**Overall**
Acer rubrum	Red maple		0.1			0.1		0
Acrostichum danaeifolium	Giant leather fern	1.4	3.5	8.3	4.6		39.9	9
Alternanthera philoxeroides	Alligator weed	5.8	0.1					1.1
Alternanthera sessilis	Joyweed			0.1	0.1	0.2		0.1
Apios americana	Groundnut			0.6				0.1
Apteria aphylla	Nodding nixie						0.1	0
Ardisia escallonioides	Marlberry		1.3		0.2	0.4		0.3
Baccharis glomeruliflora	Groundsel tree						0.1	0
Bacopa monnieri	Herb of Grace						1.7	0.3
Befaria racemosa	Tarflower						0.4	0.1
Blechnum serrulatum	Swamp fern	13.5	15.9	7.8	10.5	18.7	10.5	13
Boehmeria cylindrica	False nettle			0.1	1.4			0.2
Callicarpa americana	American beautyberry		0.1			0.1		0
Canna flacida	Golden canna					0.4		0.1
Carya aquatica	Water hickory				0.1	0.7		0.1
Cassia chamaecrista	Partridge pea			0.4			0.1	0.1
Chrysobalanus icaco	Cocoplum	0.1						0
Commelina sp.	Dayflower	2.1	0.8	0.2	0.1	1.3		0.8
Crinum americanum	String-lily	3.1	0.8	2.2	1.3	0.1	3.3	1.8
Dichanthelium commutatum	Witchgrass	0.1	2.7	0.9	3.8	3.3		1.8
Diodia virginiana	Buttonweed					0.1		0
Eulophia alta	Wild coco			0.4				0.1
Galactia elliottii	Milkpea			0.1				0
Hydrocotyle verticillata	Whorled pennywort	0.3	1.5	0.5	0.6			0.5
Hygrophila polysperma	East Indian hygrophila		2.7	0.4	0.1			0.5
Hypericum hypericoides	St. Andrew's cross				0.5		0.1	0.1

Table H-7 Groundcover conti. Species	Common Name	1	2	3	4	5	6	Overall
Hyptis alata	Musky mint			0.4	0.1			0.1
Ipomoea alba	Moonflowers	0.7	1.4	5.6				1.3
Itea virginica	Virginia willow		1	0.4	4.4	0.1		0.9
Laguncularia racemosa	White mangrove						1.1	0.2
Leersia hexandra	Southern cutgrass			0.1				0
Limnophila sessiliflora	Asian marshweed	0.1		8.3	8.8			2.7
Ludwigia erecta	Primrose willow			0.1		0.3		0.1
Ludwigia repens	Creeping Primrose Willow			0.1	5.9		0.1	0.9
Lygodium microphyllum	Old world climbing fern			11.3	8.5	1.9	3	3.9
Lyonia ferruginea	Rusty lyonia						0.4	0.1
Mikania scandens	Hemp vine				4.7	0.1	1.3	0.9
Mitreola petiolata	Miterwort		0.1	0.1	0.1			0
Nephrolepis exaltata	Boston Fern			0.4				0.1
Osmunda cinnamomea	Cinnamon fern						0.4	0.1
Osmunda regalis	Royal fern		1	0.1	0.4	0.4	2.3	0.7
Panicum rigidulum	Redtop panicum		0.5	0.4	0.6	2.7		0.7
Parthenocissus quinquefolia	Woodbine	0.1						0
Paspalum conjugatum	Sour paspalum		0.1			0.7		0.1
Panicum sp.	Panicgrass					1.8		0.3
Pistia stratiotes	Water-lettuce	0.5						0.1
Pluchea camphorata	Marsh fleabane					0.1		0
Polygonum punctatum	Dotted smartweed			0.3	1.8	0.4		0.4
Polypodium polypodioides	Resurrection fern			0.1				0
Pontederia cordata	Pickerelweed				0.9		0.4	0.2
Psidium cattleianum	Strawberry guava						0.9	0.1
Psychotria nervosa	Wild coffee	0.2		1.2	1.3	0.5		0.5
Psychotria sulzneri	Wild coffee	0.3	2.1	2.6	1	1.7		1.3
Pteridium aquilinum	Bracken						0.1	0

Table H-7 Groundcover conti. Species	Common Name	1	2	3	4	5	6	Overall
Quercus laurifolia	Laurel oak	0.4	0.1					0.1
Species	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**Overall**
Quercus virginiana	Live oak						1	0.2
Rhabdadenia biflora	Rubber vine						1	0.1
Rhizospora mangle	Red mangrove						0.7	0.1
Rhynchospora inundata	Inundated Beak rush			0.1	1.5	0.6		0.3
Rhynchospora milliacea	Beak rush					1.5		0.3
Rhynchospora sp.	Beak rush			0.4				0.1
Rubus trivialis	Blackberry			0.1				0
Sabal palmetto	Cabbage palm	0.7	0.2		0.4			0.2
Sagittaria lancifolia	Arrowhead					0.4		0.1
Salvinia minima	Water spangles	1.3						0.3
Samolus valerandi	Pineland pimpernel			0.2	0.1			0
Sarcostemma clausum	White-vine			0.8			0.1	0.1
Saururus cernuus	Lizard's-tail	1.5	1.6	3.8	2	0.4	0.4	1.6
Schinus terebinthifolius	Brazilian pepper	0.1						0
Schrankia microphylla	Sensitive briar			0.4			0.1	0.1
Serenoa repens	Saw palmetto	0.3	1	0.4			0.1	0.3
Smilax bona-nox	Greenbrier	0.1	0.1	0.1	0.6	0.2	0.1	0.2
Syngonium podophyllum	Arrowhead vine, Nephthytis	0.9						0.2
Thelypteris dentata	Downy shield fern	0.3		0.4	0.4			0.2
Thelypteris interupta	Maiden fern	10.2	22.1	21.9	17	17.4	3.4	15.4
Thelypteris kunthii					0.4			0.1
Thelypteris palustris	Marsh fern			1.5				0.3
Thelypteris serrata	Meniscium fern		4.7	7		0.4		2
Toxicodendron radicans	Poison ivy	0.1	0.2	0.6	1	1.5	1.7	0.8
Tripsacum dactyloides	Eastern gamagrass					0.1		0
Urena lobata	Ceasar-weed	0.8	4		0.1			0.8

Table H-7 Groundcover conti. Species	Common Name	1	2	3	4	5	6	Overall
Vitis aestivalis	Summer grape	0.1						
Vitis munsoniana	Muscadine grape	0.4	0.1		0.1	0.2		0.1
Total Groundcover:		**45.5**	**69.8**	**90.8**	**85.4**	**59.2**	**74.8**	**69.8**

Canonical Correspondence Analysis

A canonical correspondence analysis of vegetation and environmental data was conducted. **Table H-8** gives eigenvalues, species and environmental correlations and percent variance explained by the first 4 axes. The first canonical axis ($\lambda1=0.513$) explained 24.6 percent of the variance of the species-environmental relation, while the second canonical axis ($\lambda2=0.467$) explained an additional 22.5 percent of the variance of the species-environment relation. According to Ter Braak (1987), the CCA will not account for 100% of the variance because of noise. Results of a Monte Carlo permutation test indicated that both first canonical axis (F-ratio= 6.27) and the overall model (F-ratio= 3.24) were significant ($p<0.05$). Table H-9 shows the correlation of the environmental variables sampled to the first four canonical axes. Soil magnesium levels followed by soil potassium were most highly correlated to the first axis. All environmental variables except soil zinc and copper were significantly related ($p<0.05$) to the first canonical axis. Relative elevation exhibited the strongest correlation to the second canonical axis. Canopy cover, pH, calcium, zinc, copper, and manganese were also significantly related ($p<0.05$) to the second axis. Elevation above sea level was most highly correlated to the third axis. Elevation and soil copper were most highly correlated to the fourth canonical axis.

Table H-8. Eigenvalues and species-environment correlations for the first 4 axes of the CCA.

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
Eigenvalue	0.513	0.467	0.313	0.227
Species-environment correlation	0.912	0.900	0.864	0.792
of species data:	8.6%	16.3%	21.6%	25.3%
of species-environment relation:	24.6%	47.1%	62.1%	73.0%

Table H-9. Pearson Product moment correlation coefficients relating the CCA axis to the environmental variables.

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
Elevation (ft. MSL)	.516***	.134	.570***	.372***
Canopy Cover	.440***	.292**	.274*	.275*
Rel. Elev. (ft.)	.597***	.741***	.126	.001
pH	.369**	.577***	.090	.092
Ca (mg/kg)	.348**	.679***	.263*	.188
Mg (mg/kg)	.816***	.128	.103	.010
K (mg/kg)	.710***	.032	.040	.008
P (mg/kg)	.379***	.140	.036	.150
Zn (mg/kg)	.001	.679***	.271*	.327**
Cu (mg/kg)	.176	.397***	.067	.520***
Mn (mg/kg)	.283*	.519***	.186	.229*

*$p<0.05$, ** $p<0.01$, ***$p<0.001$

Figure H-8 illustrates the relationship of all 79 sampled plots as they relate to the first two canonical axes. Examination of the biplot indicates a pattern in the relation of the plots to the environmental variables. Most of the plots on the left side of the biplot appear to be lined up along the vector representing relative elevation (this vector also appears to be negatively related to manganese, calcium and pH). As would be expected, the sample plots located at the upland end of the transects are shown on the biplots in the area representing higher relative elevation. On the right side of the biplot, sample plots representing lower elevations appear to be arranged along a secondary gradient associated with the vectors representing magnesium and potassium levels (these vectors are also negatively related to percent canopy cover). The sample plots located in the mangrove portion of Transect #6 are shown on the biplot to be related to higher levels of magnesium and potassium and lower canopy cover.

The relationship of individual plant species to the environmental variables is shown in the species-environment biplot (**Figure H-9**). This biplot shows the same general pattern to that found in the sample-environment biplot although there appears to be more scatter among species. Three plant species appear to be distributed along a gradient of relative elevation, soil pH, manganese and calcium on the left side of the biplot and a gradient of percent canopy cover, potassium and magnesium on the right side of the biplot. Species associated with the highest relative elevation include slash pine, laurel oak, and saw palmetto. Plants associated with intermediate relative elevation and canopy cover and lower levels of magnesium and potassium were cabbage palm, swamp fern, and old World climbing fern. Many of the more commonly encountered species in the survey were found in the lower central area of the biplot. This area is associated with lower relative elevation and low levels of zinc, magnesium, and potassium. Dominant species included bald cypress, pop ash, Virginia willow, blue morning glory (*Ipomoea alba*), maiden fern, and witch grass (*Dichanthelium commutatum*). Dominant plants associated with low relative elevation and intermediate levels of magnesium and potassium were leather fern, swamp lily, and white mangrove. Species associated with lower elevation and canopy cover and with high levels of magnesium and potassium included red mangrove and Brazilian pepper.

Discussion and Conclusions

While Ward (1993) examined the relationship between plant communities and environmental variables on the Wekiva River, this study examined similar parameters along six transects on the Loxahatchee River. And, while elevation and soil organic content had the strongest correlation between environmental variables on the Wekiva River, relative elevation and soil calcium showed the strongest correlation (r^2=-0.72) on the Loxahatchee River. Strong correlations were also observed between pH, potassium, zinc, manganese and relative elevation. Levels of copper appeared to be unrelated to any of the other environmental variables. It appears that average values for elements were higher at Transect 6, which is tidal and Transect 3, which is low in elevation and contains several braided streams. Therefore, more frequent inundation (i.e. longer hydroperiods) may account for these observations.

A two-way indicator analysis divided the 79 plots into six different groups from upland to hammock to bottomland hardwood, to freshwater and saltwater tidal swamps. In general, Groups A and B were associated with tidal plots with mangroves and pond apples while Group C was associated more so with riverine swamp species bald cypress and popash. Group D appeared to have a mixture of hammock and bottomland hardwood species such as water hickory, red maple, cabbage palm and Virginia willow. Group E was similar to Group D but was dominated by the hammock species cabbage palm with saw palmetto. And finally, Group F represented the wet pineland community.

The survey of vegetative communities identified a total of 15 canopy species, 27 shrubs, and 83 groundcover species for a total of 96 plant species in the floodplain. Higher basal area was associated with those plots that contained larger species such as bald cypress, water hickory, and red maple. This was also evident in the dbh size frequency charts of each transect. The upper area of the riverine reach had the highest basal area with its large stands of bald cypress that had not been impacted by lumbering activities in the past. While Transect 6 in the upper tidal reach had the lowest basal area due to the significant removal of bald cypress for lumber and loss of bald cypress to saltwater intrusion. Dbh size frequency charts illustrated that most canopy species were producing new recruits in the floodplain in 1995. In addition, the larger canopy tree species like bald cypress, water hickory and red maple were surviving into the larger size classes.

Shrub and groundcover communities reflected both hydrology and light availability within each plot and transect. Percent cover of shrubs was highest at Transect 6 which presumably has more sunlight reaching the floor of the floodplain with its lack of mature trees but more abundant younger trees in the upper tidal reach. Understandably Transect 1 had the lowest percentage of groundcover with its thick canopy of bald cypress, oaks, and cabbage palm. The percent groundcover was highest at Transect 3 because of the abundance of swamp fern, Asian marsh weed, Old World climbing fern, and maiden fern.

In the canonical correspondence analysis of vegetation and environmental variables, Axis 4 was the most definitive model by explaining 73 percent of the variability in factors. Biplots of the 79 sampled plots illustrated that the plots and plant species sorted predominantly by relative elevation and therefore by hydroperiod. Using detrended Correspondence Analysis (DCA), Burke et al (2003) were able to explain 67 percent of the species distribution fit on the floodplains of the Coosawhatchie River in South Carolina. The most important environmental variables there were elevation and soil characteristics.

With regards to species richness, levels were higher at all six transects during the 1995 study than in the 1985 and 2003 studies. Exotics plant species have definitely increased since 1985. Dbh size class frequencies showed some losses of cabbage palm, red maple, pop ash, and bald cypress between 1985 and 2003. Additional ordination analysis of the 2003 data suggest that particularly in the riverine reach, hydroperiods are not adequate in depth and duration on the Loxahatchee River. This may account for observations of intrusion of non-hydric and exotic plant species, and landscape displacement of the true hydric species. The Restoration Plan for the Northwest Fork of the Loxahatchee River (2006) calls for increasing freshwater flow to the river to improve hydroperiods and to reduce the threat of saltwater intrusion along the river corridor.

Figure H-8. CCA Analysis of the 79 plots.

1995 Ward and Roberts CCA Analysis: Vegetation Plots

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                       >1.1.15            |
                                     >6.1.15
                    >1.1.05          >3.2.05
                                   >2.1.65 |
                                    >5.2.85|
                                       >5.1.15
                                  >3.1.05  |                >6.1.35
                                    >LIST0003                                   >6.1.25
                                   >LIST0004
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                     5.2.25  < .  .  .>1.2.15
               5.1.45  < .  >5.1.35      . ...>1.2.45
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                         4.1.A5  <     . . |.. >1.2.05
                         2.1.25  <   ..    .. .  >5.2.75
                               3.1.A5  < . .>LIST0006   >3.1.75
                                2.1.45  < .|  >LIST0005
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Figure H-9. CCA Analysis of individual plant species.

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         S Calame<>Sererepe                |
                >T Pinell  >S Serrep       |
       LIST0020<    .>Querlaur             |
                      >Chryicac >Schrmicr |
                          Casscham<.>Osmucinn
                            LIST0018<    >S Psicat
              Urenloba<    .     >S VitMun |                         >Baccglom>S Ludoct
                     T Quelau<.     >LIST0014                  S Astcar  S Sarcla
                                 >LIST0012 |          S Myrcer< ^ .  .    ^. .   >Rhizmang
                          LIST0013<       >Lygomicr S Rhabif< >LIST0016  .  >S Schter
                     S SabPal<   ...>LIST0017      T Myrcer<       >T Anngla
                                   >S Perpal    >Toxiradi  Acrodana<   >S Fracar
                     Tripdact<  >T Perpal  |                          >T Schter
 ------------------Paspconj<---.-------.-->Hypehype-------->S-Cepocc---------------------------------------
------------
                    Caryaqua<  . ..  >LIST0015   Crinamer< >Osmurega
                         >LIST0021 .   ... |.   .       >Pontcord
                        Acerrubr<.    . .. . .>Sarcclau
                         Altesess<       . |.  >Vitiaest
                               Thelserr< ..... >Samovale
                               LIST0019<   | >LIST0010
                                         >Hygrpoly
                                           | >S Ipoalb
         +                                 |
+
```

79 Plots
125 Species
903 Occurrences
T=Tree +Species/Genus
S=Shrub +Species/Genus
4Letter Sp/Genus= Herbs

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Appendix I

Comparison of Vegetation Studies

Table I-1. Comparison of Loxahatchee River Transect-based Vegetation Studies: Dewey Worth Study (Z) 1984-1985; Ward & Roberts Study (X) 1993-1994; 2003 Loxahatchee Vegetation Study (O).

Species	Common Name	Wetland Status	Transect #																																
			1			T2-1			T2-2			3			4			5			6			7			8			9			10		
			Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O
*Abrus precatorius	Rosary Pea	--			O																											O			
Acer rubrum	Red Maple	W	Z	X	O	Z	X	O	Z	X		Z	X	O	Z	X	O	Z	X	O	Z	X	O			O			O						O
Acrostichum danaeifolium	Giant Leather Fern	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O		X			X	O			O			O			O			O
*Alternanthera philoxeroides	Alligator Weed	O		X	O		X		X																										
*Alternanthera sessilis	Sessile Joyweed	U			O											X			X																
Amorpha fruticosa	Bastard Indigo	W																				X	O			O						O			
Annona glabra	Pond Apple	O			O	Z		O	Z	X		Z	X	O	Z		O	Z			Z	X	O			O			O			O			O
Apios americana	Groundnut	W											X	O																					
Apteria aphylla	Nodding Nixie	W																				X													
Ardisia escallonioides	Marlberry	F			O		X	O		X	O					X			X	O									O						
Avicennia geminans	Black Mangrove	O																														O			
Baccharis glomeruliflora	Groundsel Tree	W											X							O		X				O			O						O
Baccharis halimifolia	Salt Bush	F																								O			O						
Bacopa monnieri	Herb-of-Grace	O																					O			O			O			O			O
Bejaria racemosa	Tar Flower	F																				X	O												
Bidens alba	Beggar Ticks	W																		O															
*Bischofia javanica	Bishop Wood	--																		O															
Blechnum serrulatum	Swamp Fern	W	Z	X	O	Z	X	O	Z	X	O	Z	X	O		X	O	Z	X	O		X	O			O			O			O			O
Boehmeria cylindrica	False Nettle	W	Z		O	Z					O	Z	X	O	Z	X	O	Z		O						O			O						
Callicarpa americana	American Beautyberry	U			O			O		X	O								X																
Canna flaccida	Golden Canna	O												O					X																
Carex lupuliformis	Hop Sedge	O	Z		O							Z			Z			Z		O															
Carya aquatica	Water Hickory	O				Z	X	O	Z			Z			Z	X	O	Z	X	O															
Centella asiatica	Spadeleaf	W																Z																	
Cephalanthus occidentalis	Buttonbush	O		X	O	Z		O	Z			Z	X	O	Z	X	O	Z			Z	X	O			O			O						
Chamaecrista fasciculata	Partridge Pea	F												O								X													
Chrysobalanus icaco	Coco Plum	W	Z	X		Z			Z		O				Z														O			O			
*Citrus sp.	Citrus group	U			O							Z																							
Cladium jamaicense	Saw Grass	O																																	O
*Colocasia esculenta	Wild Taro	W			O																														
*Commelina diffusa	Dayflower	W	Z	X	O		X	O	Z	X	O	Z		O		X		Z	X	O															
Conoclinium coelestinum	Blue Mistflower	F				Z																													
Crinum americanum	Swamp Lily	O		X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X			X	O			O			O						O
*Crotalaria pallida	Smooth Rattlebox	--																														O			
Cyperus haspan	Haspan Flat Sedge	O																Z																	O
Cyperus ligularis	Swamp Flat Sedge	W																														O			
Cyperus odoratus	Fragrant Flat Sedge	W										O																							
Cyperus retrorsus	Flat Sedge	U									O																								
Dalbergia ecastaphyllum	Coin Vine	W																											O			O			

Table I-1. Comparison of Loxahatchee River Transect-based Vegetation Studies: Dewey Worth Study (Z) 1984-1985; Ward & Roberts Study (X) 1993-1994; 2003 Loxahatchee Vegetation Study (O).

Species	Common Name	Wetland Status	Transect #																																
			1			T2-1			T2-2			3			4			5			6			7			8			9			10		
			Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O
**Desmodium triflorum*	Beggar Weed	U																											O			O			
Dicanthelium commutatum	Variable Witch Grass	F			O		X			X			X			X			X	O															
Dicanthelium spp.	Witch grass	--									O			O			O			O			O			O									
Diodia virginiana	Buttonweed	W																Z																	
Eleocharis baldwinii	Road Grass	W																					O												
Erechtites hieraciifolius	Fire Weed	F												O																					
Eulophia alta	Wild Coco	W											X																						
Eupatorium capillifolium	Dog Fennel	U																Z																	
Fern seedling		--			O						O																								
Ficus aurea	Strangler Fig	W	Z			Z			Z	X		Z	X	O			O															O			
**Ficus microcarpa*	Indian Laurel Ficus	--																														O			
Fraxinus caroliniana	Pop Ash	O				Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z		O	Z		O			O			O						
Galactia spp.	Milkpea	--											X	O																					
Galium tinctorium	Bedstraw	W																Z																	
**Gomphrena serrata*	Globe Amaranth	--																														O			
Grass seedling		--															O																		
Hydrocotyle umbellata	Pennywort	O	Z		O			O	Z		O	Z		O	Z		O	Z		O			O			O			O						O
Hydrocotyle verticillata	Whorled Pennywort	O								X			X			X																			
**Hygrophila polysperma*	Indian Swamp Weed	O					X			X			X			X				O															
Hypericum hyperiocoides	St. Andrew's Cross	F														X			X			X													
Hypericum spp.	St. John's Wort	--												O	Z																				
Hypoxis juncea	Yellow-star Grass	W																Z																	
Hyptis alata	Musky Mint	O											X	O		X										O									
Ilex cassine	Dahoon Holly	W										Z		O					X	O			O												O
Ilex glabra	Inkberry, Gallberry	W																								O									
Ipomoea alba	Moonflowers	F	Z	X			X			X		Z	X																						
Ipomoea indica	Morning-glory	F			O			O						O			O			O			O												
Itea virginica	Virginia Willow	W	Z			Z		O	Z	X	O	Z	X	O	Z	X	O	Z	X	O						O			O						
Laguncularia racemosa	White Mangrove	W																			Z	X	O			O			O			O			O
Licania michauxii	Gopher Apple	--																														O			
**Limnophila sessiliflora*	Asian Marsh Weed	O		X									X			X	O																		
Ludwigia alata	Winged Primrosewillow	O																Z																	
Ludwigia octovalvis	Mexican Primrosewillow	O																				X							O						
Ludwigia repens	Creeping Primrosewillow	O										Z		O	Z	X	O	Z				X				O			O						O
Ludwigia seedling		--			O									O						O						O			O						
**Lygodium microphyllum*	Old World Climbing Fern	--										Z	X	O	Z	X	O	Z	X			X	O						O			O			O
Lyonia fruiticosa	Stagger Bush	F																								O									
Lyonia lucida	Fetterbush	W																					O			O						O			
Melothria pendula	Creeping Cucumber	W																	X																
Micranthemum glomeratum	Baby's Tears	O												O																					

Table I-1. Comparison of Loxahatchee River Transect-based Vegetation Studies: Dewey Worth Study (Z) 1984-1985; Ward & Roberts Study (X) 1993-1994; 2003 Loxahatchee Vegetation Study (O).

Species	Common Name	Wetland Status	Transect #																																
			1			T2-1			T2-2			3			4			5			6			7			8			9			10		
			Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O
Mikania scandens	Climbing Hemp Vine	W	Z					O				Z		O	Z	X		Z	X			X				O			O						O
Mimosa quadrivalvis	Sensitive Briar	--												O																		O			
Mitreola petiolata	Stalked Miterwort	W								X						X																			
Morus rubra	Red Mulberry	F			O																								O						
Myrica cerifera	Wax Myrtle	F											X		Z		O	Z		O	Z	X	O			O			O						O
Nephrolepis exaltata	Boston Fern	U						O					X													O			O			O			
Osmunda cinnamomea	Cinnamon Fern	W										Z ?	X						X			X				O			O						
Osmunda regalis	Royal Fern	O			O	Z	X	O	Z			Z	X	O	Z	X		Z	X			X	O			O			O						
Panicum rigidulum	Redtop Panicum	W								X			X	O	Z	X	O	Z	X										O						
Panicum virgatum	Switchgrass	F																																	O
Parietaria floridana	Pellitory	F																Z																	
Parthenocissus quinquefolia	Virginia Creeper	F		X	O			O							Z		O																		
Paspalum conjugatum	Sour Paspalum	F																	X																
Persea borbonia	Red Bay	W																Z		O									O						O
Persea palustris	Swamp bay	O																	X																
Phlebodium aureum	Golden Polypody	--																				X										O			
Pinus elliottii	Slash Pine	W	Z	X	O					X	O			O								X	O									O			O
Pityopsis graminifolia	Silk Grass	U																														O			
Pleopeltis polypodioides	Resurrection Fern	--															O																		O
Pluchea camphorate	Camphorweed	W																	X																
Polygonum hydropiperoides	Mild Water-pepper	O										Z						Z																	O
Polygonum punctatum	Dotted Smartweed	W											X			X			X							O			O						
Pontederia cordata	Pickerelweed	O													Z	X		Z				X													
**Psidium cattleianum*	Strawberry Guava	F																				X	O						O			O			O
Psilotum nudum	Whisk fern	F																					O												O
Psychotria nervosa	Wild Coffee	W	Z	X	O	Z		O	Z			Z	X	O	Z	X	O	Z	X	O						O									
Psychotria sulzneri	Wild Coffee	F			O		X	O		X		Z	X	O	Z		O	Z	X	O															
Pteridium aquilinum	Bracken Fern	U																	X			X										O			
Quercus geminata	Sand Live Oak	U																														O			
Quercus laurifolia	Laurel Oak	W	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O												O			O
Quercus myrtifolia	Myrtle Oak	--															O															O			
Quercus seedling		--			O									O						O			O			O									
Quercus virginiana	Live Oak	U			O									O			O		X	O		X	O			O									
Rapanea punctata	Myrsine	F				Z			Z				X	O				Z	X	O			O			O			O						O
Rhabdadenia biflora	Rubber Vine	W																				X	O			O						O			O
Rhizophora mangle	Red Mangrove	O																			Z	X	O			O			O			O			O
Rhus copallinum	Winged Sumac	U																														O			
Rhynchospora colorata	White-top sedge	W																Z																	
Rhynchospora inundata	Beak Sedge	O										Z	X	O		X			X										O						
Rhynchospora miliacea	Beak Sedge	O																	X																

Table I-1. Comparison of Loxahatchee River Transect-based Vegetation Studies: Dewey Worth Study (Z) 1984-1985; Ward & Roberts Study (X) 1993-1994; 2003 Loxahatchee Vegetation Study (O).

Species	Common Name	Wetland Status	Transect #																																
			1			T2-1			T2-2			3			4			5			6			7			8			9			10		
			Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O
Rhynchospora rariflora	Beak Sedge	O												O																						
Rhynchospora sp.	Beak Sedge	--											X																							
Roystonea regia	Royal Palm	F																		O			O			O										
Rubus trivialis	Blackberry	F											X	O																						
Sabal palmetto	Cabbage Palm	F	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O			O			O			O			O
Sacciolepis striata	American Cupscale	O							Z			Z			Z			Z																		
Sagittaria lancifolia	Lance Leaf Arrowhead	O																	X																	
Sagittaria latifolia	Duck potato	O												O			O												O							
Salix caroliniana	Carolina Willow	O																								O			O							
**Salvinia minima*	Water Spangles	O		X			X																													
Samolus valerandi	Pineland Pimpernel	O										Z	X		Z	X		Z					O						O							
Sarcostemma clausum	White-vine	W										Z	X	O								X	O			O						O			O
Saururus cernuus	Lizard's Tail	O	Z	X	O	Z	X	O	Z	X	O		X	O	Z	X	O	Z	X	O		X				O			O							
**Schinus terebinthifolius*	Brazilian Pepper	F		X									X	O			O				Z	X	O			O			O			O			O
Sedge seedling		--															O																			
**Senna pendula*	Climbing Cassia	F			O			O																												
Serenoa repens	Saw Palmetto	U		X						X	O						O		X	O		X	O			O			O			O			O
Sida acuta	Wire Weed	--																		O																
Smilax auriculata	Earleaf Greenbrier	U																														O				
Smilax bona-nox	Greenbrier	F		X	O								X	O		X	O		X	O		X	O			O										
Smilax laurifolia	Laurel Greenbrier	W	Z															Z																		
Smilax seedling		--															O																			
Solidago odora	Goldenrod	--																														O				
**Sphagneticola trilobata*	Creeping Oxeye	F			O																															
**Syngonium podophyllum*	Arrowhead Vine, Nephthytis	--		X	O																															
**Syzgium cumini*	Java Plum	F	Z																							O										
Taxodium distichum	Bald Cypress	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O			O			O			O			
**Thelypteris dentata*	Downy Shield Fern	W		X	O			O									O			O																
Thelypteris interrupta	Tri-Veined Fern	F	Z	X	O	Z	X	O	Z	X		Z	X	O	Z	X	O	Z	X	O		X	O			O			O							
Thelypteris kunthii	Maiden Fern	W				Z										X																				
Thelypteris palustris	Marsh Fern	W				Z							X	O	Z								O			O										
Thelypteris reticulata	Lattice Vein Fern	W	Z			Z			Z			Z																								
Thelypteris serrata	Meniscium Fern	W			O		X	O		X	O			O		X	O												O							
Tillandsia fasciculata	Cardinal Air Plant	--			O											X				O																
Tillandsia setacea	Needle Leaf Air Plant	--																		O																
Toxicodendron radicans	Poison Ivy	F	Z	X	O	Z			Z	X		Z	X	O	Z	X	O	Z	X	O		X	O			O			O			O			O
Tripsacum dactyloides	Fakahatchee Grass	F												O					X																	
Typha domingensis	Cattail	O																											O							
Unidentified *Cyperaceae*	Sedge	--												O						O																O
Unidentified *Poaceae*	Grass	--												O			O			O						O			O			O			O

Table I-1. Comparison of Loxahatchee River Transect-based Vegetation Studies: Dewey Worth Study (Z) 1984-1985; Ward & Roberts Study (X) 1993-1994; 2003 Loxahatchee Vegetation Study (O).

Species	Common Name	Wetland Status	Transect #																																
			1			T2-1			T2-2			3			4			5			6			7			8			9			10		
			Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O	Z	X	O
Unidentified seedling		--			O			O			O			O			O			O			O			O			O						
Unidentified species		--			O									O						O						O			O						
Unidentified *Xyris*	Yelloweyed Grass	--															O																		
**Urena lobata*	Caesarweed	F		X	O		X				O			O		X	O		X	O															
Vigna luteola	Yellow Vigna	W																Z																	
Vitis aestivalis	Summer Grape	F		X																															
Vitis rotundifolia	Muscadine Grape	F			O						O			O												O							O			
Vitis shuttleworthii	Calloose Grape	F										Z																								
Vittaria lineata	Shoestring Fern	F																															O			
**Xanthosoma sagittifolium*	Elephant Ear	W			O																															
Zanthoxylum fagara	Wild Lime	U											X																							
Total Species			23	27	48	25	22	29	24	27	24	35	44	58	32	40	44	43	41	44	10	37	40	0	0	51	0	0	50	0	0	43	0	0	34

Vegetation Transect Studies: Z = 1984-1985 DeweyWorth study ; X = 1993-1994 Ward and Roberts study; O = 2003 Loxahatchee Vegetation study

Species notations: * = Exotic species

Wetland Status: O = Obligate; W = Facultative Wet; F = Facultative; U = Facultative Upland; -- = No wetland status

General Notes: Transects 7, 8, 9, and 10 were established after 1994; therefore, only 2003 data are available for these transects.

Table I-2. Comparison of Loxahatchee River Vegetation Based on Field Observations: Ward & Roberts 1995 Study and our 2006 Observations.

Species	Common Name	Wetland Status	T1		T2-1		T2-2		T3		T4		T5		T6		T7		T8		T9		T10	
			1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
**Abrus precatorius*	Rosary Pea	--		Y																		Y		
Acer rubrum	Red Maple	W	X	Y	X	Y	X		X	Y	X	Y	X	Y	X	Y		Y		Y				Y
Acrostichum danaeifolium	Giant Leather Fern	O	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
**Alternanthera philoxeroides*	Alligator Weed	O	X	Y																				
**Alternanthera sessilis*	Sessile Joyweed	U											X											
Ambrosia artemisiifolia	Common Ragweed	U								Y														
Ammannia latifolia	Toothcup	O		Y																				
Amorpha fruticosa	Bastard Indigo	W													X	Y		Y		Y				
Ampelopsis arborea	Pepper Vine	F								Y														
Annona glabra	Pond Apple	O		Y		Y	X		X	Y	X	Y			X	Y		Y		Y		Y		Y
Apios americana	Groundnut	W			X				X	Y														
Apteria aphylla	Nodding Nixie	W					X																	
**Ardisia elliptica*	Shoebutton	F																		Y				
Ardisia escallonioides	Marlberry	--	X	Y	X	Y	X	Y	X		X		X	Y		Y								
Azolla caroliniana	Mosquito Fern	O	X																					
Baccharis glomeruliflora	Groundsel Tree	W							X		X				X	Y		Y		Y				Y
Bacopa monnieri	Herb-of-Grace	O													X	Y		Y		Y		Y		Y
Bejaria racemosa	Tar Flower	F														Y		Y						
Bidens alba	Beggar Ticks	W		Y																				
Blechnum serrulatum	Swamp Fern	W	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
Boehmeria cylindrica	False Nettle	W	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y				
Callicarpa americana	American Beautyberry	U	X	Y	X		X	Y	X		X		X	Y				Y				Y		
Campyloneurum phyllitidis	Strap Fern	---							X	Y	X													
Canna flaccida	Golden Canna	O							X				X	Y										
Carex lupuliformis	Hop Sedge	O								Y		Y		Y						Y				
Carya aquatica	Water Hickory	O		Y	X		X		X	Y	X	Y	X	Y		Y								
Cassytha filiformis	Love Vine	F																		Y				
Cephalanthus occidentalis	Buttonbush	O	X	Y	X	Y			X	Y	X	Y		Y	X			Y		Y				Y
Chamaecrista fasciculata	Partridge Pea	U							X	Y										Y				
Chromolaena odorata	Jack-in-the-Bush	--	X	Y										Y										
Chrysobalanus icaco	Coco Plum	W	X	Y		Y	X	Y												Y		Y		
Chrysophyllum oliviforme	Satinleaf	--					X																	
**Citrus* sp.	Citrus group	U		Y																				
Cladium jamaicense	Saw Grass	O																		Y				Y
**Colocasia esculenta*	Wild Taro	W		Y																				
**Commelina diffusa*	Dayflower	W	X	Y	X		X	Y	X	Y	X		X	Y										
Crinum americanum	Swamp Lily	O	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
Cyperus distinctus	Swamp Flat Sedge	W																		Y				
Cyperus haspan	Haspan Flat Sedge	O											X											
Cyperus ligularis	Swamp Flat Sedge	W							X			Y	X	Y		Y				Y		Y		
Cyperus odoratus	Fragrant Flat Sedge	W		Y										Y						Y				Y
Cyperus retrorsus	Flat Sedge	U																				Y		
Cyperus surinamensis	Tropical Flat Sedge	W											X											
Cyperus tetragonus	Four Angle Flat Sedge	F					X																	
Cyperus virens	Green Flat Sedge	W										Y												
Dalbergia ecastaphyllum	Coin Vine	W														Y		Y		Y		Y		Y
**Desmodium incanum*	Zarzabacoa	F	X																					
Dicanthelium aciculare	Needle Leaf Witch Grass	U	X												X									
Dicanthelium acuminatum	Tapered Witch Grass	F										Y												
Dicanthelium commutatum	Variable Witch Grass	F	X	Y	X		X	Y	X	Y	X		X	Y	X			Y		Y				
Dicanthelium laxiflorum	Open Flower Witch Grass	F					X					Y				Y						Y		
Diodia virginiana	Buttonweed	W											X	Y		Y				Y				Y
Diospyros virginiana	Persimmon	F																		Y				
Echinochloa muricata	Barn Yard Grass	F											X											Y
Echinochloa walteri	Coast Cockspur	O											X	Y										
Eclipta prostrata	False Daisy	W	X	Y		Y		Y		Y		Y	X	Y										
**Eichhornia crassipes*	Water hyacinth	O	X	Y																				
Encyclia tampensis	Butterfly Orchid	--												Y				Y						

Table I-2. Comparison of Loxahatchee River Vegetation Based on Field Observations: Ward & Roberts 1995 Study and our 2006 Observations.

Species	Common Name	Wetland Status	T1		T2-1		T2-2		T3		T4		T5		T6		T7		T8		T9		T10	
			1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
Erechtites hieraciifolius	Fire Weed	F		Y		Y		Y		Y		Y		Y		Y		Y		Y				
Erythrina herbacea	Coralbean	--			X								X	Y										
Eulophia alta	Wild Coco	W							X					Y										
Eupatorium capillifolium	Dog Fennel	U		Y				Y		Y		Y								Y		Y		Y
Eupatorium rotundifolium	False Hoarhound	F	X																					
Fern seedling		--																Y						
Ficus aurea	Strangler Fig	W	X		X		X	Y	X	Y	X				X									
Fraxinus caroliniana	Pop Ash	O		Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y				
Galactia spp.	Milkpea	--		Y					X	Y				Y										
Galium tinctorium	Bedstraw	W		Y																				
**Gomphrena serrata*	Globe Amaranth	--																				Y		
Grass seedling		--														Y		Y				Y		
Gratiola ramosa	Creeping Hedge Hyssop	W	X		X		X		X		X		X											
Hydrocotyle umbellata	Pennywort	O	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y				Y
**Hygrophila polysperma*	Indian Swamp Weed	O		Y		Y		Y						Y										
Hypericum hyperiocoides	St. Andrew's Cross	F								Y	X	Y								Y				
Hypericum spp.	St. John's Wort	--										Y												
Hypoxis juncea	Yellow-star Grass	W											X											
Hyptis alata	Musky Mint	O							X	Y	X		X					Y		Y				
Ilex cassine	Dahoon Holly	W							X	Y			X	Y	X	Y		Y		Y				Y
Ilex glabra	Inkberry, Gallberry	W											X		X	Y		Y						
Ipomoea alba	Moonflowers	F		Y	X	Y	X	Y	X					Y										
Ipomoea cordatotriloba	Tie Vine	U																		Y				
Ipomoea indica	Morning-glory	F	X							Y			X	Y						Y				
Itea virginica	Virginia Willow	W	X		X	Y	X	Y	X	Y	X	Y	X					Y		Y				
Juncus marginatus	Grass Leaf Rush	F												Y										
Laguncularia racemosa	White Mangrove	W													X	Y		Y		Y		Y		Y
**Limnophila sessiliflora*	Asian Marsh Weed	O	X						X	Y	X	Y		Y										
Ludwigia alata	Winged primrosewillow	O																		Y				
Ludwigia erecta	Yerba-De-Jicotea	O	X																					
Ludwigia lanceolata	Lance Leaf Primrose Willow	O													X									
Ludwigia octovalvis	Mexican Primrose Willow	O											X	Y	X	Y		Y		Y				
**Ludwigia peruviana*	Peruvian Primrose Willow	O	X	Y																Y				
Ludwigia repens	Creeping Primrose Willow	O		Y		Y		Y	X		X	Y	X		X			Y		Y				
Ludwigia seedling		--																Y		Y				
**Lygodium microphyllum*	Old World Climbing Fern	--		Y	X	Y			X	Y	X	Y	X	Y	X	Y		Y		Y				Y
Lyonia fruiticosa	Stagger Bush	F														Y		Y				Y		
Lyonia lucida	Fetterbush	W														Y		Y				Y		
Lythrum alatum	Winged Loose Strife	W												Y										
Melothria pendula	Creeping Cucumber	W				Y		Y					X	Y										
Mikania cordifolia	Keys Hemp Vine	--					X		X			Y						Y		Y				
Mikania scandens	Climbing Hemp Vine	W				Y		Y	X	Y	X	Y	X	Y	X	Y		Y		Y				Y
Mimosa quadrivalvis	Sensitive Briar	--							X	Y		Y			X	Y						Y		
Mitreola petiolata	Miterwort	W					X											Y		Y				
**Momordica charantia*	Wild Balsam Apple	U											X											
Morus rubra	Red Mulberry	F					X	Y																
Myrica cerifera	Wax Myrtle	F								Y		Y	X		X	Y		Y		Y				Y
Nephrolepis biserrata	Boston Fern	W													X					Y				
**Nephrolepis cordifolia*	Boston Fern	F								Y														
Nephrolepis exaltata	Boston Fern	U	X		X				X		X				X			Y		Y		Y		
**Nephrolepis multiflora*	Boston Fern	F					X	Y				Y												
Oplismenus hirtellus	Woods Grass	U	X	Y			X	Y																
Osmunda cinnamomea	Cinnamon Fern	W							X		X	Y	X		X	Y		Y		Y				
Osmunda regalis	Royal Fern	O			X	Y			X		X	Y	X		X	Y		Y		Y				
Panicum hians	Gaping Panicum	F											X											
**Panicum maximum*	Guinea Grass	F												Y										
Panicum rigidulum	Redtop Panicum	W	X				X		X	Y	X	Y	X	Y						Y				
Panicum virgatum	Switchgrass	F					X																	Y

Table I-2. Comparison of Loxahatchee River Vegetation Based on Field Observations: Ward & Roberts 1995 Study and our 2006 Observations.

Species	Common Name	Wetland Status	T1		T2-1		T2-2		T3		T4		T5		T6		T7		T8		T9		T10	
			1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
Parietaria floridana	Pellitory	F		Y				Y																
Parthenocissus quinquefolia	Virginia Creeper	F	X			Y					X	Y												
Paspalum conjugatum	Sour Paspalum	F											X											
Paspalum setaceum	Thin Paspalum	F							X	Y														
Passiflora incarnata	Purple Passion Flower	--																				Y		
Persea borbonia	Red Bay	W						Y						Y		Y		Y		Y				
Phlebodium aureum	Golden Polypody	--	X	Y	X		X	Y	X		X		X	Y	X	Y				Y				Y
Phragmites australis	Common Reed	W											X											
Phyla nodiflora	Frog-fruit, Carpetweed	W											X											
Phytolacca americana	Pokeweed	U						Y						Y										
Pinus elliottii	Slash Pine	W	X	Y			X		X	Y					X	Y						Y		Y
Pistia stratiotes	Water Lettuce	O	X			Y		Y																
Pityopsis graminifolia	Silk Grass	U																				Y		
Pleopeltis polypodioides	Resurrection Fern	--		Y		Y	X	Y	X	Y	X	Y	X	Y		Y				Y				Y
Pluchea odorata	Sweetscent	W	X						X	Y		Y	X	Y		Y		Y		Y				Y
Polygonella polygama	October Flower	--																				Y		
Polygonum hydropiperoides	Mild Water-pepper	O	X				X			Y		Y		Y		Y		Y		Y				Y
Polygonum punctatum	Dotted Smartweed	W	X	Y	X			Y	X		X		X	Y										
Pontederia cordata	Pickerelweed	O							X	Y	X	Y	X	Y	X	Y		Y		Y				
Portulaca oleracea	Little Hogweed	U																				Y		
**Pouzolzia zeylanica*	Pouzoulz's Bush	--		Y					X	Y		Y		Y										
**Psidium cattleianum*	Strawberry Guava	F	X		X										X	Y		Y		Y		Y		Y
**Psidium guajava*	Guava	U							X											Y				
Psilotum nudum	Whisk fern	W							X						X	Y		Y						Y
Psychotria nervosa	Wild Coffee	W	X	Y		Y	X	Y	X	Y	X	Y	X	Y				Y						
Psychotria sulzneri	Wild Coffee	F	X	Y	X	Y	X	Y	X	Y		Y	X	Y										
Pteridium aquilinum	Bracken Fern	U	X							Y		Y	X	Y	X	Y		Y				Y		
Ptilimnium capillaceum	Mock Bishop Weed	O		Y		Y		Y		Y		Y		Y		Y								
**Ptychosperma macarthurii*	MacArthur's Palm	--																				Y		
Quercus geminata	Sand Live Oak	U														Y								
Quercus laurifolia	Laurel Oak	W	X	Y	X	Y	X		X	Y	X		X	Y								Y		Y
Quercus myrtifolia	Myrtle Oak	--														Y						Y		
Quercus seedling		--												Y										
Quercus virginiana	Live Oak	U	X	Y								Y	X	Y	X	Y		Y						
Rapanea punctata	Myrsine	F							X	Y		Y	X	Y		Y		Y		Y				Y
Rhabdadenia biflora	Rubber Vine	W													X	Y		Y		Y		Y		Y
Rhizophora mangle	Red Mangrove	O													X	Y		Y		Y		Y		Y
Rhus copallinum	Winged Sumac	U														Y		Y		Y		Y		
Rhynchospora colorata	White-top sedge	W								Y				Y										
Rhynchospora decurrens	Swamp-forest Beakrush	O																		Y				
Rhynchospora fascicularis	Fascicled Beakrush	W								Y														
Rhynchospora grayi	Gray's beakrush	U								Y														
Rhynchospora inundata	Beak Sedge	O							X		X		X							Y				
Rhynchospora miliacea	Beak Sedge	O											X							Y				
Rhynchospora spp.	Beak Sedge	--														Y								
Roystonea regia	Royal Palm	F												Y		Y		Y						
Rubus trivialis	Blackberry	F							X	Y														
Rumex verticillatus	Swamp Dock	W											X											
Sabal palmetto	Cabbage Palm	F	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
Sabatia calycina	Rose Gentian	O																Y		Y				Y
Saccharum giganteum	Sugarcane Plumegrass	W							X															
Sagittaria lancifolia	Lance Leaf Arrowhead	O							X				X		X									
Sagittaria latifolia	Duck potato	O																		Y				
Salix caroliniana	Carolina Willow	O																Y		Y				
**Salvinia minima*	Water Spangles	O	X																					
Samolus valerandi	Pineland Pimpernel	O				Y		Y	X	Y	X	Y	X					Y		Y				Y
Sarcostemma clausum	White-vine	W			X				X	Y					X	Y		Y		Y		Y		Y
Saururus cernuus	Lizard's Tail	O	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X			Y		Y				

Table I-2. Comparison of Loxahatchee River Vegetation Based on Field Observations: Ward & Roberts 1995 Study and our 2006 Observations.

Species	Common Name	Wetland Status	T1		T2-1		T2-2		T3		T4		T5		T6		T7		T8		T9		T10	
			1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995	2006
**Schinus terebinthifolius*	Brazilian Pepper	F	X		X		X		X	Y		Y			X	Y		Y		Y		Y		Y
Scleria triglomerata	Tall Nutgrass	W								Y			X											
Sedge seedling		--														Y								
**Senna pendula*	Climbing Cassia	F		Y																				
Serenoa repens	Saw Palmetto	U	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
Sida acuta	Wire Weed	--												Y										
Smilax auriculata	Earleaf Greenbrier	U		Y				Y		Y						Y		Y		Y		Y		
Smilax bona-nox	Greenbrier	F	X	Y				Y	X	Y	X	Y	X		X									
Smilax seedling		--										Y												
Solanum americanum	Common Nightshade	U	X	Y				Y						Y										
Solidago odora	Goldenrod	--							X			Y										Y		
Spermacoce remota	False Button Weed	--											X											
**Sphagneticola trilobata*	Creeping Oxeye, Wedelia	F		Y																				
Symphyotrichum carolinianum	Climbing Aster	O													X	Y		Y		Y				
Symphyotrichum dumosum	Rice Button Aster	F											X											
Symphyotrichum subulatum	Salt Marsh Aster	O	X																					
**Syngonium podophyllum*	Arrowhead Vine, Nephthytis	--	X	Y			X																	
**Syzgium cumini*	Java Plum	F												Y		Y		Y						
**Syzgium jambos*	Rose Apple	F	X																					
Taxodium distichum	Bald Cypress	O	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y		Y		Y				
Teucrium canadense	Wood Sage	W							X				X											
**Thelypteris dentata*	Downy Shield Fern	W	X	Y	X			Y	X		X			Y				Y						
Thelypteris interrupta	Tri-Veined Fern	F	X	Y	X	Y	X		X	Y	X	Y	X	Y	X	Y		Y		Y				
Thelypteris kunthii	Maiden Fern	W	X	Y			X		X		X	Y												
Thelypteris palustris	Marsh Fern	W							X															
Thelypteris serrata	Meniscium Fern	W	X	Y	X	Y	X	Y	X	Y	X	Y												
Tillandsia balbisiana	Reflexed Air Plant	--	X	Y									X		X	Y		Y						
Tillandsia fasciculata	Cardinal Air Plant	--	X	Y	X	Y	X	Y	X	Y	X		X	Y	X	Y		Y		Y		Y		Y
Tillandsia recurvata	Ball Moss	--	X	Y	X				X				X											Y
Tillandsia setacea	Needle Leaf Air Plant	--		Y				Y	X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
Tillandsia usneoides	Spanish Moss	--	X	Y	X		X	Y	X		X	Y	X		X	Y		Y		Y		Y		Y
Tillandsia utriculata	Giant Air Plant	--	X	Y	X		X		X						X									
Toxicodendron radicans	Poison Ivy	F	X	Y	X	Y	X		X	Y	X	Y	X	Y	X	Y		Y		Y		Y		Y
Triglochin striata	Arrow Grass	O														Y				Y				Y
Tripsacum dactyloides	Fakahatchee Grass	F		Y					X	Y		Y	X	Y								Y		
Typha domingensis	Southern Cattail	O																Y		Y				
Unidentified *Cyperaceae*	Sedge	--																						Y
Unidentified *Poaceae*	Grass	--												Y										Y
Unidentified seedling		--																						Y
**Urena lobata*	Caesarweed	F	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y										
**Urochloa mutica*	Paragrass	W	X											Y										
Vaccinium myrsinites	Shiny Blueberry	U														Y		Y						
Verbesina virginica	Frostweed	U	X																					
Vigna luteola	Yellow Vigna	W		Y									X	Y				Y		Y		Y		
Vitis aestivalis	Summer Grape	F	X			Y				Y			X	Y										
Vitis rotundifolia	Muscadine Grape	F	X	Y	X		X	Y		Y	X	Y	X	Y	X	Y		Y		Y		Y		
Vittaria lineata	Shoestring Fern	F	X	Y	X		X	Y	X				X					Y				Y		Y
Woodwardia virginica	Virginia Chain Fern	O							X	Y														
**Xanthosoma sagittifolium*	Elephant Ear	W		Y																				
Ximenia americana	Tallow Wood	U																Y				Y		
Zanthoxylum fagara	Wild Lime	U							X															
Total Species			70	72	44	39	52	50	82	72	53	62	81	77	52	70	0	76	0	85	0	48	0	48

Vegetation Observations: X = 1995 Ward and Roberts study; Y = 2006 Loxahatchee Vegetation study

Species notations: * = Exotic species

Wetland Status: O = Obligate; W = Facultative Wet; F = Facultative; U = Facultative Upland; -- = No wetland status

General Notes: Transects 7, 8, 9, and 10 were established after 1994; therefore, only 2006 observation data are available for these transects. The first plot in Transect 10 was within a prescribed burn area (burn date January 13, 2006).

APPENDIX J

THREE DIMENSIONAL FLOODPLAIN INUNDATION ANALYSIS AT TRANSECT #3

APPENDIX J

Three Dimensional Floodplain Inundation Analysis at Transect #3

Jeff R. Fisher

INTRODUCTION

Following the study of flow and stage relationships along the 2003 Loxahatchee Vegetation Transects 1 through 4 (Appendix E and SFWMD, 2006, Chapter 5), a more in-depth study of the flow, stage, and inundation relationship was conducted in an area around Transect 3. The purpose of the inundation analysis was to determine the relationship between flow, stage, and inundation over a three-dimensional area as opposed to the two dimensional relationship explored in Appendix E and Chapter 5 of the Restoration Plan for the Northwest Fork of the Loxahatchee River where the focus was on dry season flows during the months of December through May.

STUDY LOCATION

The analysis was conducted in an area roughly 150 x 150 meters extending south from Transect 3 on the eastern floodplain at approximately Rivermile 12.1 (19.4 kilometers). This area was chosen primarily for the presence of a braided channel that begins roughly 100 meters south of Transect 3 and flows through the floodplain, crossing the transect line and then reconnecting with the main channel of the Loxahatchee roughly 50 meters north of Transect 3 near the area known as Governor's Dock.

METHODS

Using a Trimble GPS receiver, grid points were established throughout the study area. At each of these points, elevations were determined using a laser level. Using each grid point as the known location and elevation, the distance, bearing, and elevation for locations around the grid point were determined using a tape measure, compass, and laser level. The distance and bearing information when converted into decimal degrees were input into an ArcGIS project. Once the elevation point collection was completed, a raster layer was created using a spline interpolation in ArcGIS Spatial Analyst **(Figure J1)**.

The elevation raster layer when input into ArcGIS 3D Analyst **(Figure J2)** and overlaid with a water layer representing various stage and flow conditions allowed for a qualitative analysis of floodplain inundation over a three dimensional surface. Four flows were evaluated for inundation in 3D analyst: 65, 90, 110, and 200 cfs. The stage corresponding to each flow was determined using the flow and stage relationship established in Chapter 5 of the Restoration document.

A more in depth quantitative analysis was undertaken using ArcGIS Spatial Analyst. The dry and wet seasons of December 2000 through November 2001 provided a base condition and restoration scenario. This particular season was chosen to show the effects of low dry season flows versus the proposed restoration flows. The flows during December 2000 – May 2001 ranged from a high of 222.4 cfs on 3/21/2001 to a low of 1.33 cfs on 5/21/2001. The average daily flow during this same period was 21.2 cfs. The restoration scenario was created by raising the average daily dry season flow from 21.2 cfs to 70 cfs. Increasing the daily flows by a value of 48.8 cfs. This increase was extended through the month of June as the flows continued to be well below normal, averaging 17 cfs during the first 27 days of the wet season. The dry season restoration flow range was between 50.1 and 271.2 cfs (**Figure J3**).

The stage, flow and floodplain inundation relationship was determined by reclassifying the elevation raster for each day of dry and wet season for both the base condition and the restoration condition. The wet portions of the raster image with an elevation below the stage for a given day received a value of one, and the dry portions of the raster image with an elevation above the stage for the same day were give a value of zero (**Figure J4**). When added together using the raster calculator function in spatial analyst a complete 365 day inundation surface was created. To determine the location and extent of change in inundation between the base condition and the restoration condition the base condition was subtracted from the restoration condition using the raster calculator function.

RESULTS

Figures 5 through 8 depict four different flow regimes of the Loxahatchee River and their resultant inundation of the floodplain in a three-dimensional view. At 65 cfs and stage of 3.27 ft. (**Figure J5**) some of the high areas of the braided channel remain un-inundated while the braided channel appears to be flowing at 90 cfs and a stage of 3.77 ft. (**Figure J6**). At a flow of 110 cfs and stage of 4.12 ft. the braided channel and adjacent low areas are inundated (**Figure J7**). Finally, at a flow of 200 cfs and stage of 5.35 ft., all most 100 percent of the floodplain area is inundated.

Figure J9 illustrates the extent of daily inundation during both the dry and wet season from December of 2000 through November of 2001 under the base condition. The wettest areas, those inundated for 365 days, are blue and the driest areas are red. The restoration condition (**Figure J10)** uses the same criteria as the base condition with the wettest areas in blue and the driest areas in red. The restorative conditions result in an approximately one-third increase in inundation, which amounts to increases in hydroperiod for the river channel and lower floodplain vegetation and aquatic organisms.

The difference between the restoration condition and the base condition in terms of days of inundation over the course of the dry and wet season is shown in **Figure J11**. The red areas of the image are those locations that experienced the greatest amount of change from the base condition to the restoration condition. The blue areas of the image are those locations that experienced the least amount of change from the base condition to the restoration condition. The greatest change associated with increased dry season flow was in the main channel of the Loxahatchee and in the braided channel that cuts through the floodplain. There was little to no change in inundation over the higher elevations of the floodplain.

DISCUSSION

One of the components of restoration for the Northwest Fork of the Loxahatchee River is increasing dry season (December – May) flows. Reduced flows in the Loxahatchee River over the last 30+ years has led to an increase in upland / hammock vegetation in the floodplain as well as an increase in the transition area from fresh water to salt water vegetation downstream of Trapper Nelson’s. However, dry season flows must be kept within bank to allow for the regeneration of floodplain vegetation, particularly bald cypress (*Taxodium distichum*). New seedlings and saplings of this species can easily succumb during extended periods of constant flooding.

The inundation analysis at Transect 3 shows that increased flows over the current conditions will have little to no impact outside of the river channel and braided channels of the floodplain. The positive impacts of increased dry season flows on the Loxahatchee River include: (1)increased nutrients for the vegetation; (2)increased stream bottom habitat; (3)increased groundwater levels; and, (4) increased habitat for aquatic organisms within the river channel and braided streams of the floodplain.

Figure J1. Raster layer created using spline interpolation.

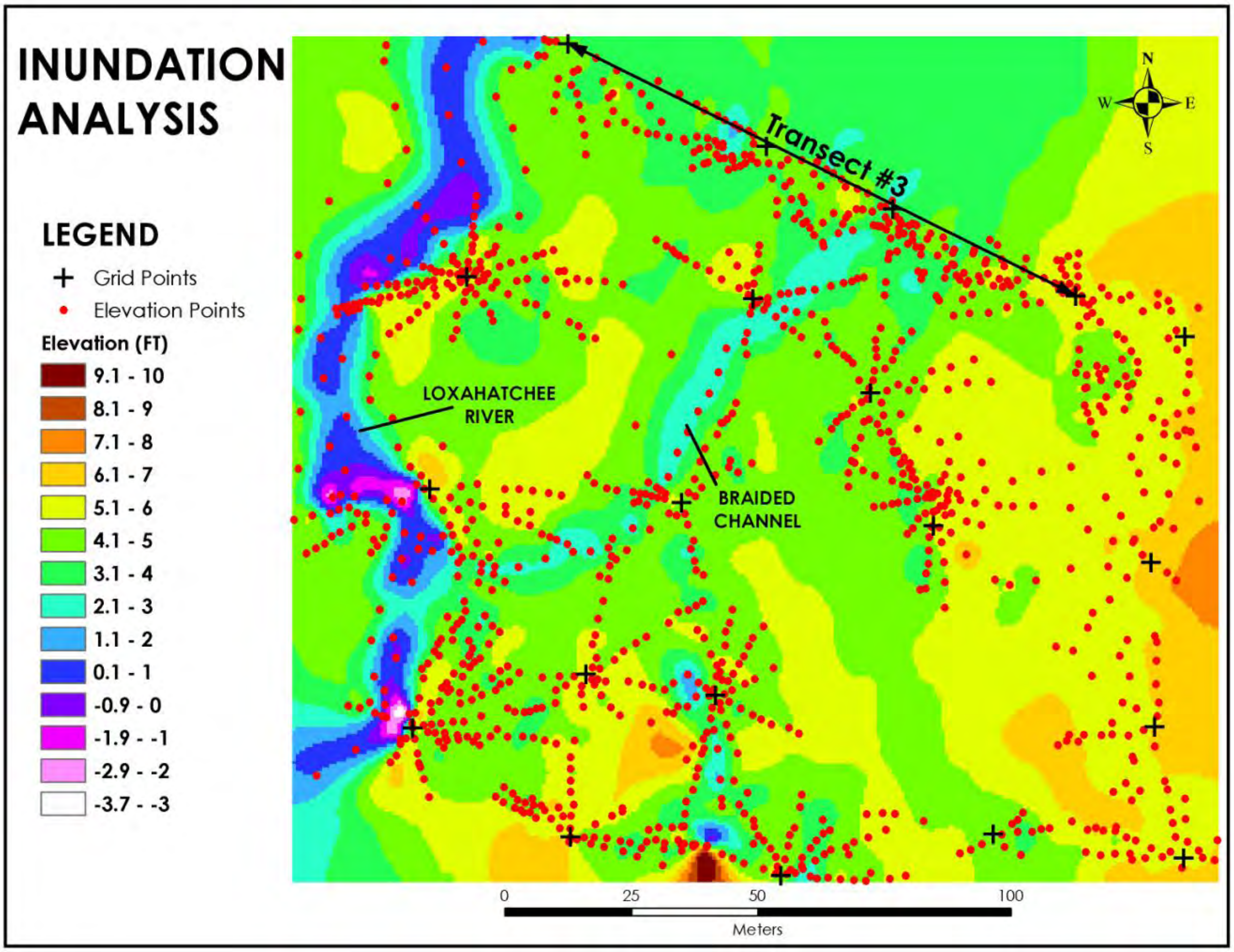


Figure J2. Three-dimensional view of study area in ArcGIS 3D Analyst.

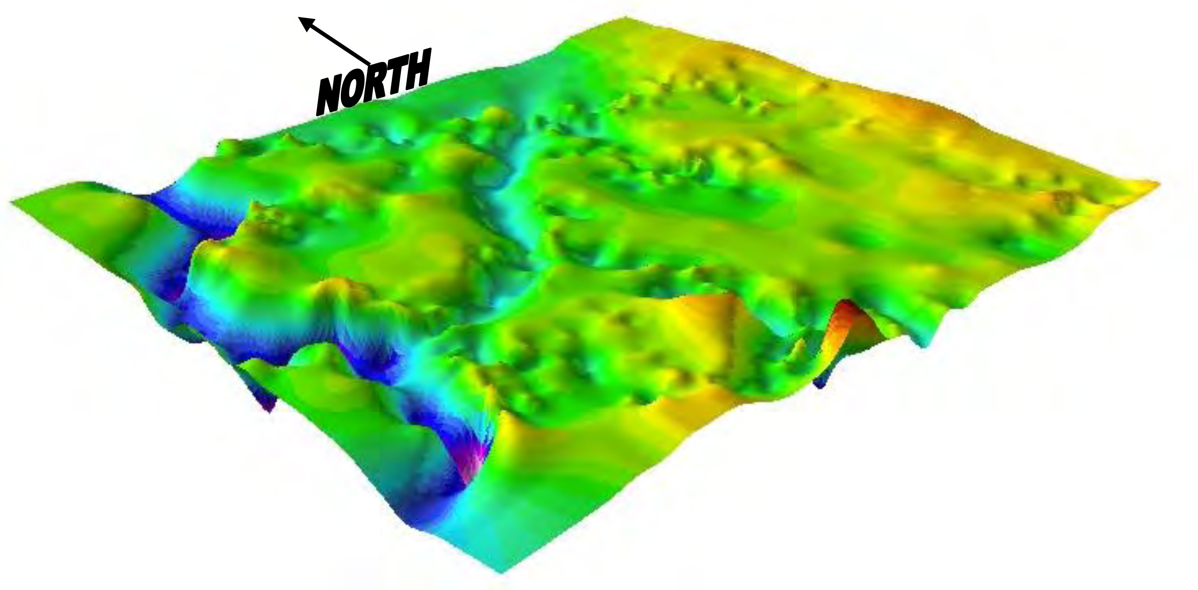


Figure J3. An examination of base and restorative flows.

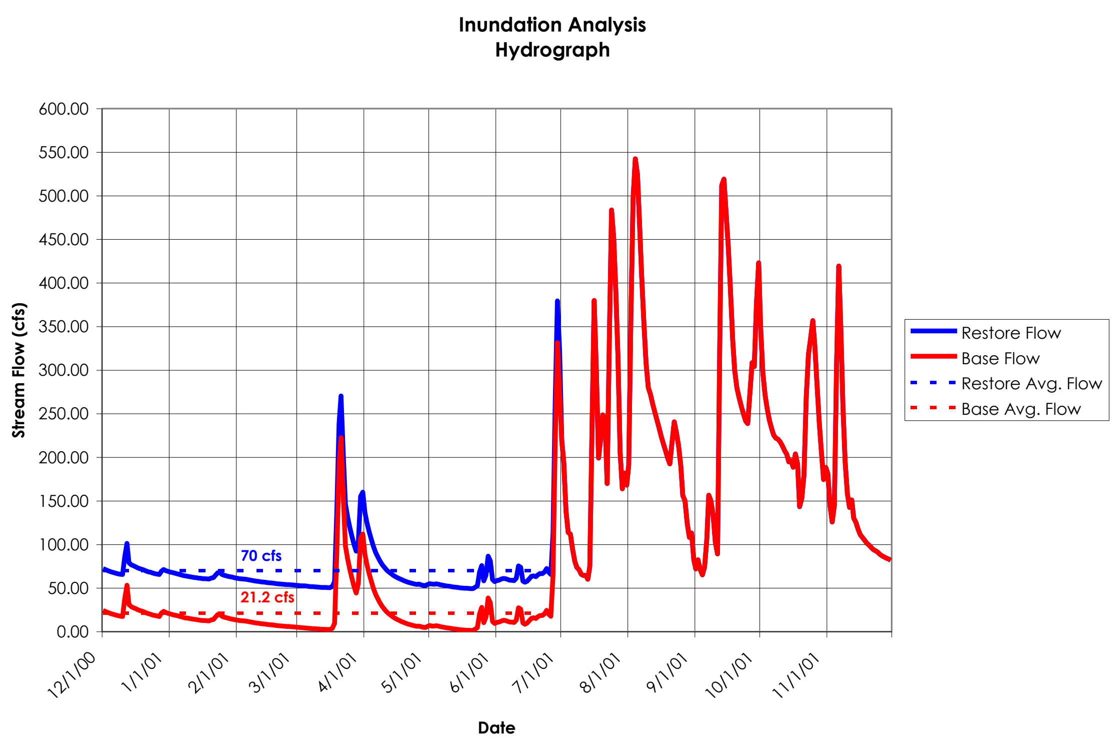


Figure J4. Floodplain inundation on July 6th, 2001. The flow was 94.45 cfs and the stage was 3.85'.

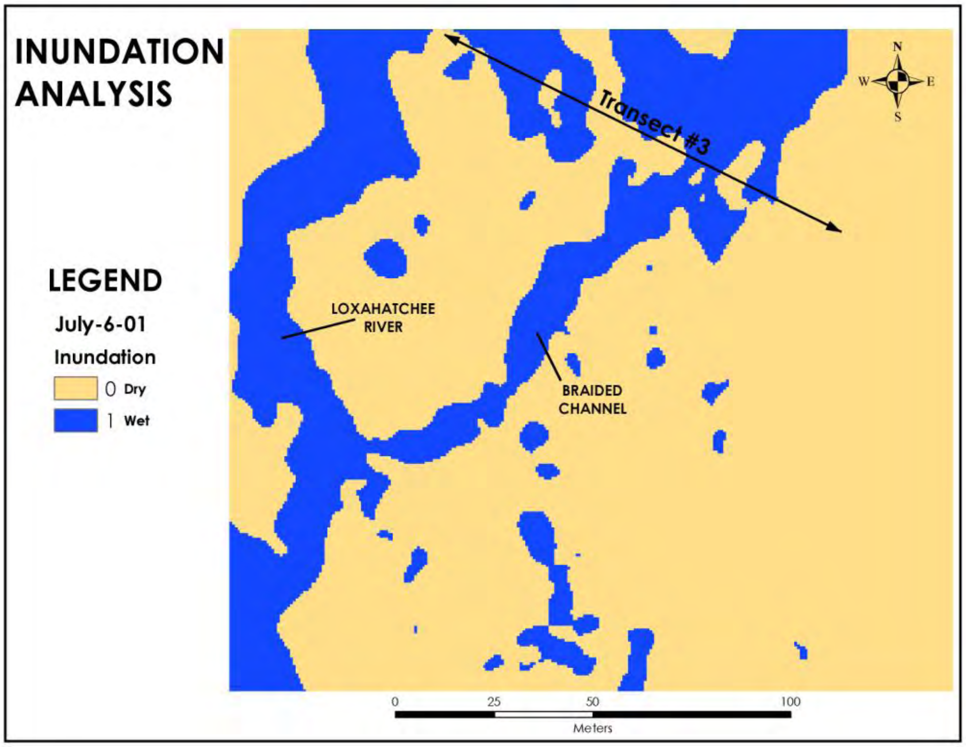


Figure J5. Three-dimensional view of floodplain inundation during a flow of 65 cfs and stage of 3.27'.

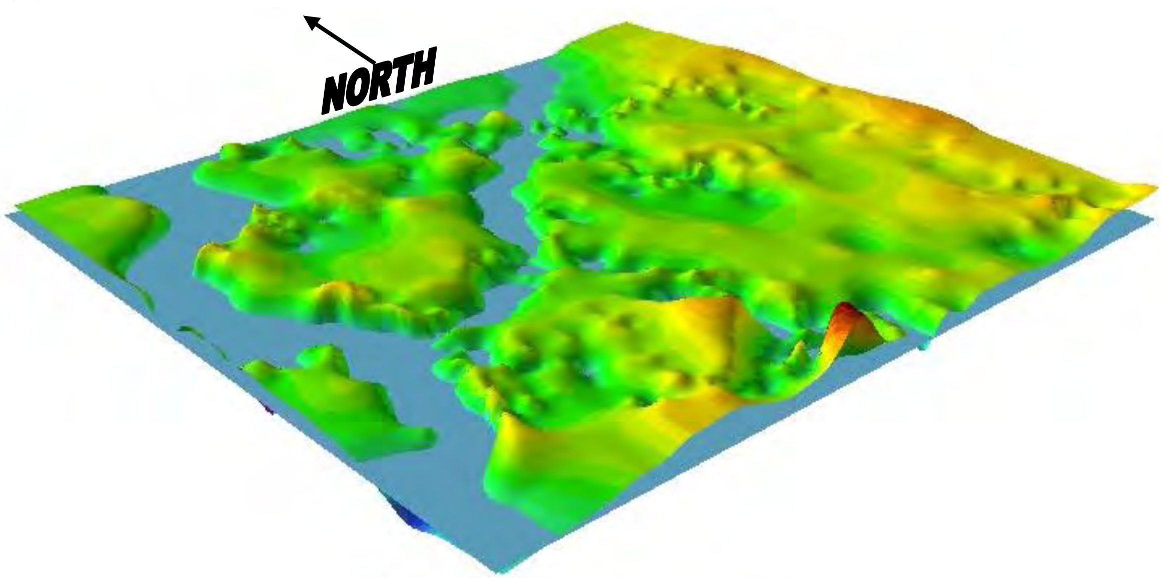


Figure J6. Three-dimensional view of floodplain inundation during a flow of 90 cfs and stage of 3.77'.

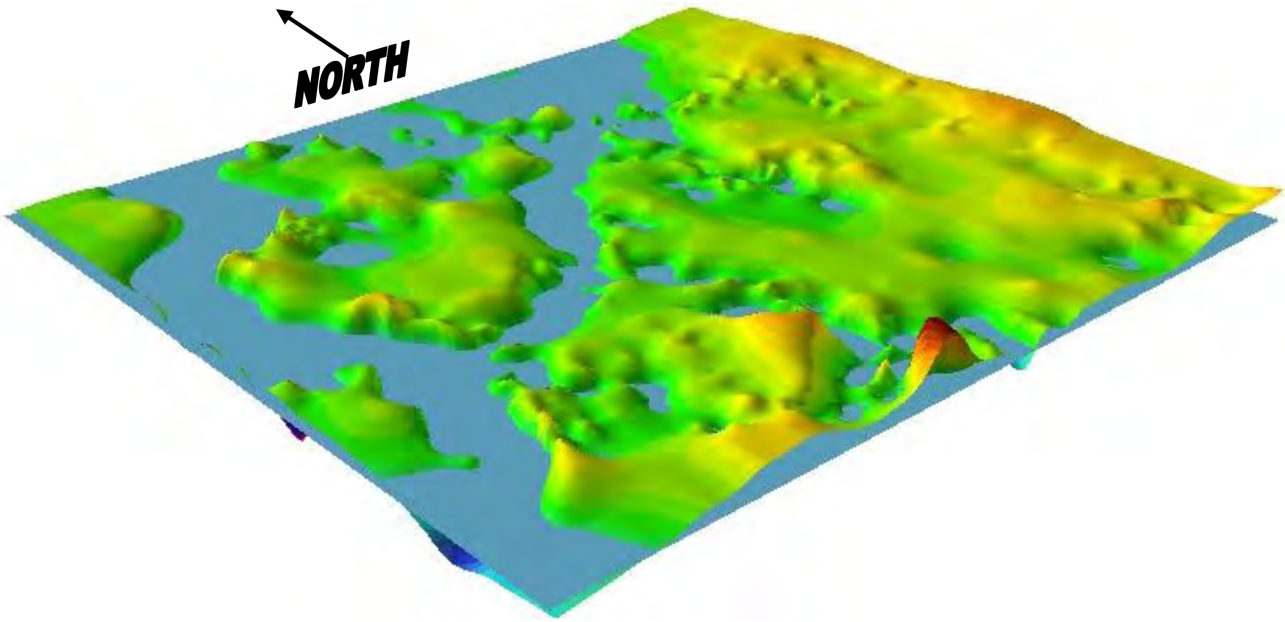


Figure J7. Three-dimensional view of floodplain inundation during a flow of 110 cfs and stage of 4.12'.

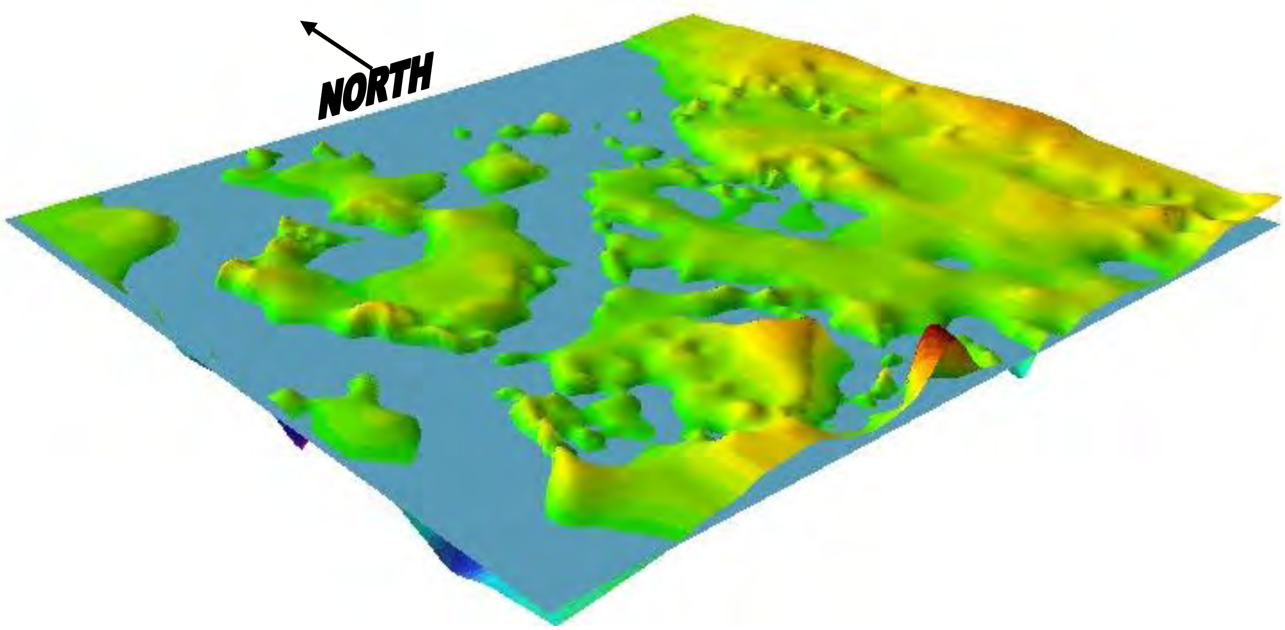


Figure J8. Three-dimensional view of floodplain inundation during a flow of 200 cfs and stage of 5.35'.

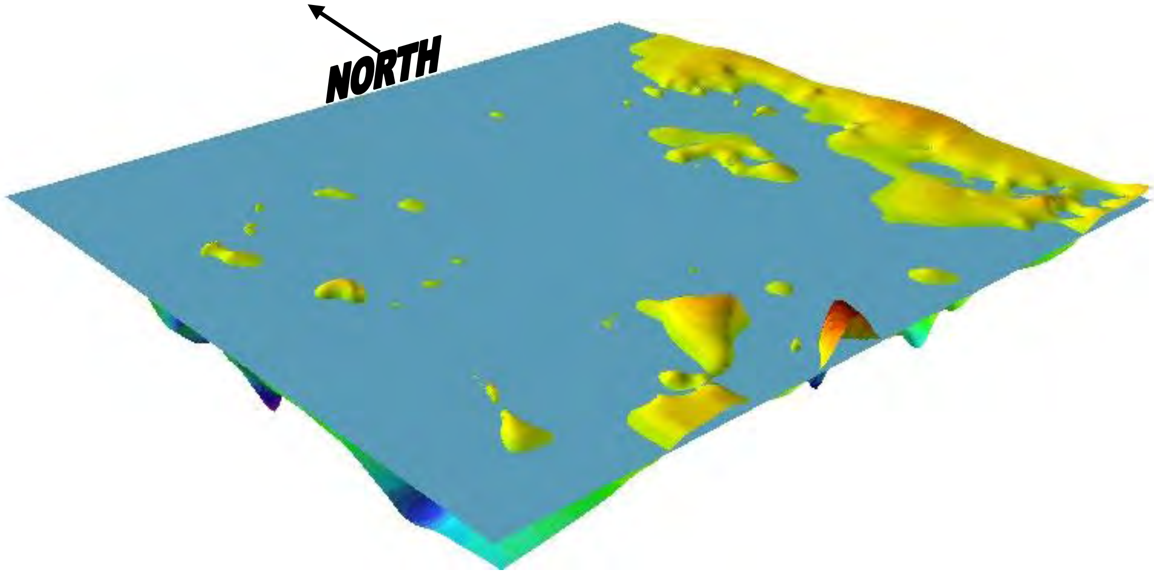


Figure J9. A picture of current inundation conditions along Transect #3.

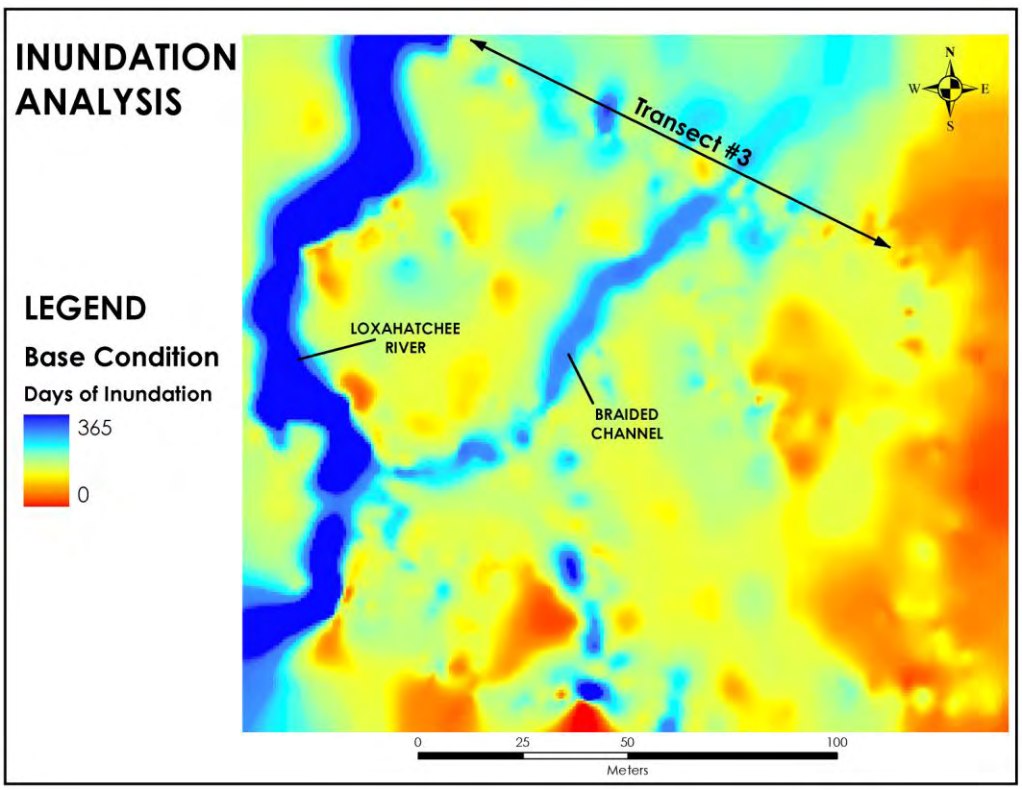


Figure J10. A contrasting picture of restored inundation conditions with increases in freshwater flow.

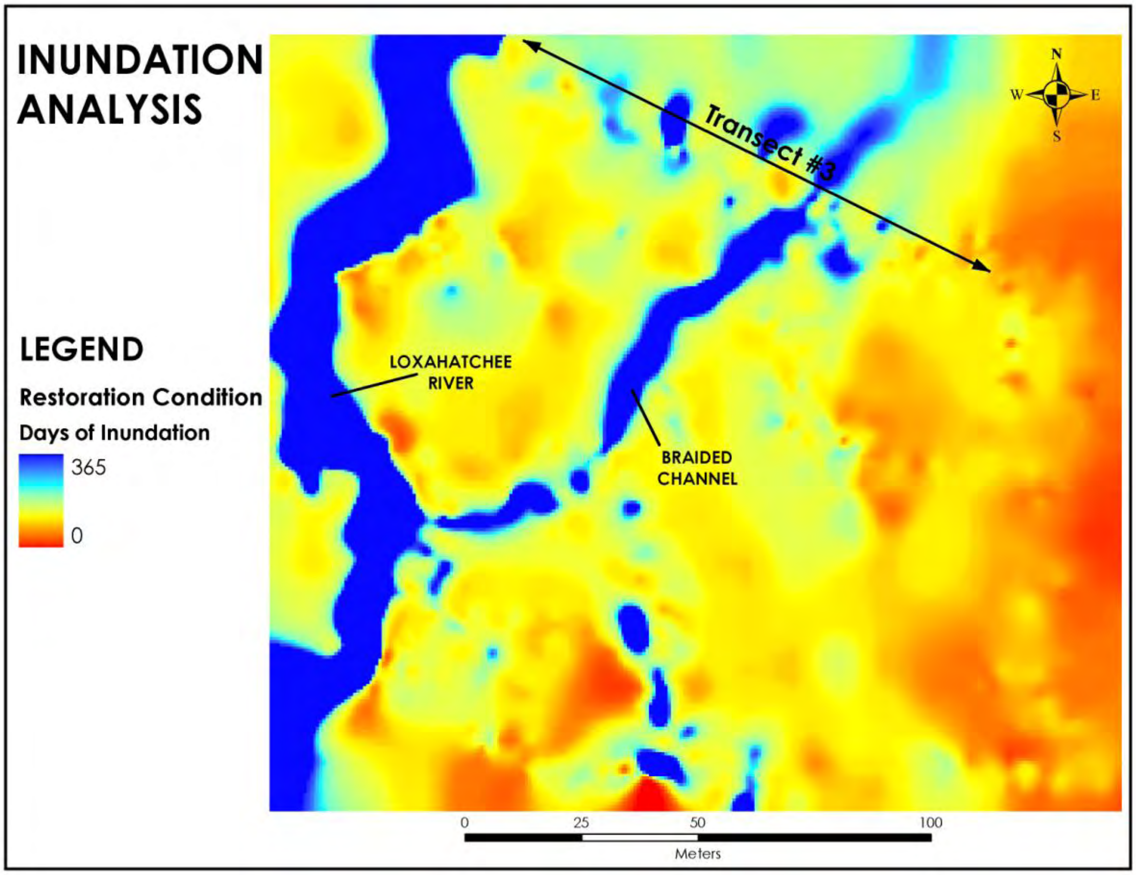
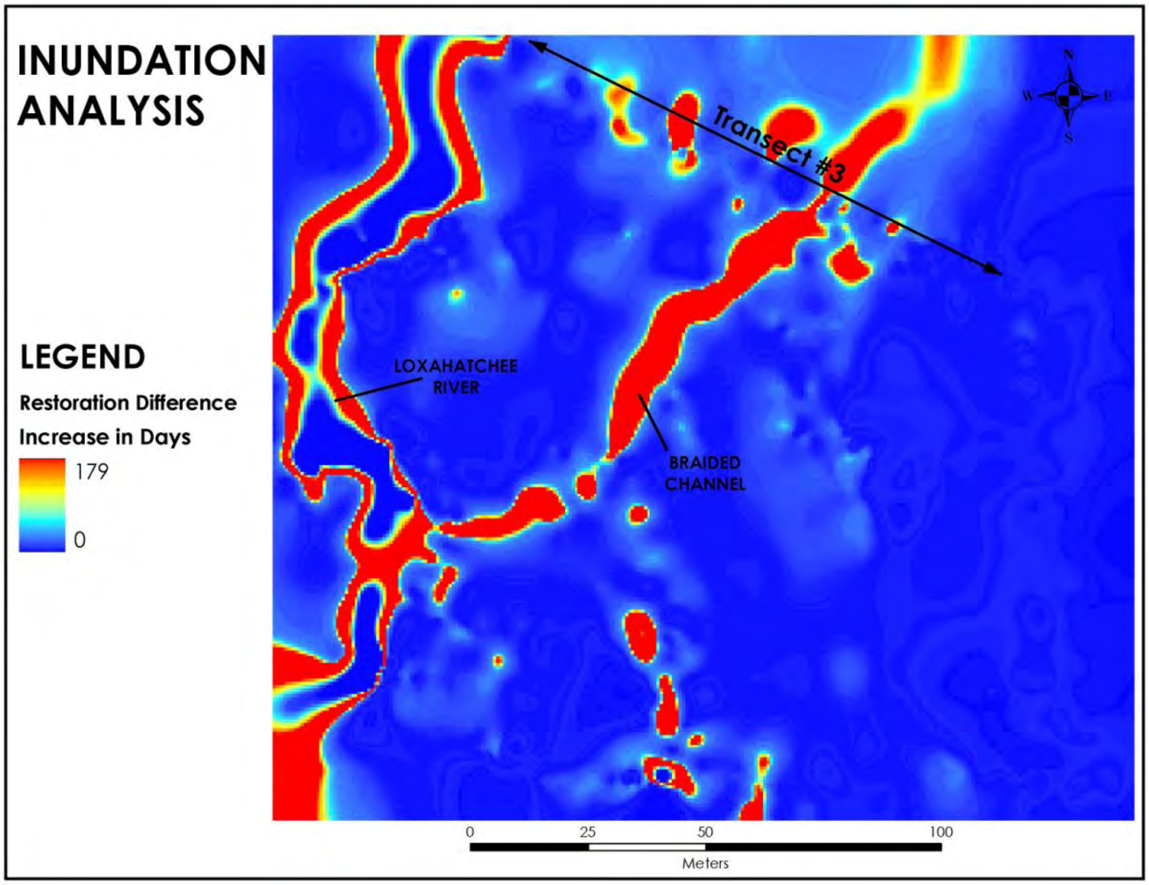


Figure J11. Increase in number of days of inundation.



APPENDIX K:

The Effects of Hurricanes Frances and Jeanne on the Floodplain Forest Communities of the Loxahatchee River, Southeast Florida

The Effects of Hurricanes Frances and Jeanne on the Floodplain Forest Communities of the Loxahatchee River, Southeast Florida

R. E. Roberts, M. Y. Hedgepeth, and Rachel R. Gross

Introduction

Hurricanes play an important ecological role in shaping the structure and dynamics of many natural communities. Spectacular as their physical destruction can be, these storms have been viewed historically as exogenous disturbances (DeAngelis, 1994) that can cause successional setbacks for these communities. They can also alter hydrology, disperse seed materials and change land contours (Alexander and Crook, 1975). Documentation of how these hurricanes interact with other natural processes to produce these varied landscapes is critical to our understanding of how existing ecosystems have come into being and are likely to change in the future (Duever and McCollom, 1993).

Our research has evaluated the effects of Hurricanes Frances and Jeanne on the floodplain forest of the Loxahatchee National Wild & Scenic River in southeastern Florida. The storms both occurred in September 2004. The primary focus is on the mortality and damage of canopy species within the various riverine and tidal floodplain plant communities. The effect of hurricanes on South Florida plant communities has been previously discussed by numerous scientists (Davis, 1943; Craighead and Gilbert, 1962; Craighead, 1964, Alexander, 1967 and Craighead, 1971). While long periods of records are not available for hurricanes, it's probable these storms have significantly affected the ecology of this area since the stabilization of South Florida's shoreline (Gentry, 1974).

In recent times several severe hurricanes have been documented, showing the impressive impacts these events had on the region's vegetation. Both the "Labor Day" hurricane in 1935 and Hurricane Donna in 1960 completely altered the mangrove forest of Florida's southern tip (Craighead, 1971). The 1935 storm virtually demolished the mature mangrove forest (local residents called this the "black forest") along Florida Bay's mainland coast around Flamingo and Cape Sable (Craighead, 1971). The peak winds were estimated between 241 and 322 kilometers per hour on some of the Florida Keys (National Oceanic and Atmospheric Administration, 1977). The 1960 storm, Hurricane Donna, moved slower in a westerly direction over this same area for nearly 36 hours, with wind gusts up to 290 kilometers per hour recorded. Between Flamingo and West Lake, there were many sites where nearly all of the trees over 5 centimeters in diameter were sheared off 1.8 to 3 meters above the ground. Right after the storm, observers commented the twisted trunks and limbers made it nearly an impenetrable tangle (Craighead and Gilbert, 1962).

In 1965 Hurricane Betsy impacted the lower southeast Florida coast with winds of 193 kilometers per hour causing extensive flooding of saltwater forced in from the east coast. The damage in the form of total kill of sawgrass was noted in the area around Canal 111 (near the northeast boundary of Everglades National Park) and U.S. Highway 1. The post-storm vegetational and soil data collected supported the conclusion that death of the plants by this storm was due primarily to the sudden overland influx of salty water, with U. S. Highway 1 impounding the storm driven saltwater.

Hurricane Andrew swept across south Florida in late August 1992. The eye wall winds were about 244 kilometers per hour. Over 28,329 ha of mangrove forest were destroyed, mostly due to wind stress on the taller trees (Wanless et al., 1994). Much like the aftermath of Hurricane Donna many of these flattened mangrove forests did not re-colonize as mangrove swamps because of deeper water, i.e., intertidal to subtidal environments did not allow mangrove seedlings to become established.

The effects of Hurricane Andrew on freshwater riverine forests was less severe, with only 1 to 2% of cypress trees suffering major damage within the vicinity of the hurricane's eye (Loope et al., 1994). However, when Hurricane Hugo passed over the National Audubon Society's Francis Beidler Forest in South Carolina with mean hourly wind speed at 116 kilometers per hour, 43% of the cypress trees sustained major damage (Duever and McCollom, 1993). The authors attributed the more heavily damaged forest in South Carolina to the fact that the large trees in this area were more vulnerable to storm damage than the smaller size cypress in south Florida. Confirmation of this observation is derived from damage caused by Hurricane Donna to an estimated 30% of the large cypress trees at Corkscrew Swamp Sanctuary in southwest Florida (Loope et al., 1994).

The Loxahatchee River area that we studied has a rather unique onsite hurricane log that was recorded from 1947 to 1964 by Trapper Nelson, a landowner who lived beside the river. After his death the land was eventually purchased, becoming part of Jonathan Dickinson State Park. The log kept by Trapper Nelson related to how intense he felt a hurricane was with regard to his river home. The only hurricane given his highest rating of 3 stars was "The Great Hurricane of '49". The storm came ashore at Palm Beach in 1949 and moved westward to the Lake Okeechobee area. Wind gusts were recorded at 246 kilometers per hour in Jupiter, Florida before the anemometer failed (Gentry, 1974). Major hurricanes and tropical storms that were recorded in the vicinity of the Loxahatchee River were in: 1893, 1903, 1924, 1926, 1928, 1933, 1948, 1949, 1964 and 1979. The 1979 storm (Hurricane David) had wind gusts of 137 kilometers per hour (Barnes, 1988).

During the 2004 hurricane season, Florida was hit by an unprecedented four major hurricanes (Charley, Frances, Ivan and Jeanne). The Loxahatchee River's floodplain forest was impacted by both Hurricanes Frances and Jeanne. Hurricane Frances made landfall on September 5 near Sewall's Point with maximum sustained winds recorded at 169 kilometers per hour, a Category 2 storm. Approximately 3 weeks later, on September 26, Hurricane Jeanne came ashore near the southern end of Hutchinson Island as a Category 3 storm with sustained winds of 193 kilometers per hour (Tuckwood, 2004). Both the tidal and riverine floodplain plant communities experienced damage from these storms.

Study Location

The Northwest Fork of the Loxahatchee River is primarily located within Jonathan Dickinson State Park in southeastern Florida's Martin and Palm Beach Counties (27 degrees 00'N; 80 degrees 06' W). This fork of the river flows from its headwaters in the Loxahatchee and Hungryland Sloughs downstream to merge with the North and Southwest Forks and then empties out into the Atlantic Ocean at Jupiter Inlet. Although some lumbering activities were noted at the turn of the century and lastly in 1940, the trees have been protected from lumbering activities since the State of Florida acquired the property for a state park in 1947 (Roberts et al., in press). The Loxahatchee River was Florida's first National Wild and Scenic River, receiving this designation in 1985.

Methods

For the analysis of canopy data from the 2003 Vegetation study, plant communities of the floodplains of the Northwest Fork of the Loxahatchee River were divided into three distinct groups or reaches [riverine (R), upper tidal (UT) and lower tidal (LT) (**Figure K-1**)]. These groups were distinguished based on hydrological conditions, vegetation, and soils (modified from USGS, 2002). The riverine reach is that part of the floodplain forest having primarily freshwater canopy forest that is generally unaffected by salinity. On the Northwest Fork of the Loxahatchee River, this area ranges from just north of the G-92 Structure at 27 km (River mile, RM 16.9) downstream to 15.3 km (RM 9.5). Vegetative communities in this reach are dominated by bald cypress (*Taxodium distichum*) with pop ash (*Fraxinus caroliniana*), red maple (*Acer rubrum*), pond apple (*Annona glabra*), water hickory (*Carya aquatica*), and other trees present with less frequency.

The upper tidal reach is that part of the floodplain forest having a mixed freshwater/brackish canopy forest that has experienced some salt water intrusion due to tidal influences and lack of freshwater flow in the dry season. On the Northwest Fork of the Loxahatchee River this area occurs between 15.3 km (RM 9.5) and 13.1 km (RM 8.13, the mouth of Kitching Creek)**.** Upper tidal reach communities are dominated by pond apple, red and white mangrove (*Rhizophora mangle* and *Laguncularia racemosa)* and cabbage palm (*Sabel palmetto)* with some communities of bald cypress present in the inner floodplain areas away from the river channel.

The lower tidal reach is that part of the Northwest Fork having primarily salt tolerant species and is highly influenced by tides and salinity in the water and soils. This area extends from approximately 13.1 km (RM 8.13) to 8.8 km (RM 5.5) although several smaller areas can be found around 7.2 km (RM 4.5) and in the embayment area (3.2 km, RM 2). The lower tidal reach is dominated by red and white mangrove. A total of ten vegetative belt transects (138 10 m^2 plots) were resurveyed during this study.

Six transects were established in 1983 at designated locations along the upper and middle segments of the Northwest Fork of the river and along Cypress Creek, a tributary to the Northwest Fork. The additional four transects were created in 2003 at two more downstream locations of Northwest Fork and two additional tributary locations (Kitching Creek and North Fork). Transects 1 through 6 were studied by Dewey Worth (1983-1986) and by Ward and Roberts (1993-1994), with transect 5 positioned on Cypress Creek (Ward and Roberts, unpublished report). Transect 7 was established within the upper tidal reach of the river. Transect 9 was a resurvey of the areas previously studied by Taylor Alexander in 1967. Both Transects 8 and 10 were on the tributaries, with the former on Kitching Creek and the latter on the North Fork.

All vegetative belt transects were positioned perpendicular to the river or its tributaries and to the existing elevational gradients. The transects begin at the upland edge of the floodplain and continue to the river's or tributary's edge. Each one is 10 meters wide and partitioned off into 10 m^2 plots. All trees greater than 5 cm diameter at breast height (dbh) were measured. The identification of floodplain forest community type was based on the canopy tree species that generally grow together in recognizable communities (modified from USGS, 2002) among the three reaches of the river system (**Figure K-1**). Tree canopy data from both the 1995 Ward and Roberts study and the 2003 transect study (a total of 138 10m^2 plots) were collected; the Relative Basal Area (RBA) of each tree species within a plot was determined using diameter at breast height (dbh) measurements. RBA is calculated by dividing the total basal area of a species (in m^2) by the total basal area of all species within a 10m^2 plot. Multi-trunk trees were considered separate trees for this analysis. The most common multi-trunk trees observed were pond apple (*Annona glabra*), red mangrove (*Rhizophora mangle*) and bald cypress (*Taxodium distichum*).

Guidelines were developed to identify the 15 forest community types and assess damage by reach. For each reach, the major vegetative community categories were identified as swamp (Riverine swamp, Rsw1; Upper Tidal swamp, UTsw1; and Lower Tidal swamp, LTsw1, etc.), bottomland hardwood (Riverine bottomland hardwood, Rblh), hydric or mesic hammock (HH and MH), or uplands (U) with the lower the associated number in a community the lower the reported elevation. For example, Rsw1 plots occurred at lower elevations than Rsw2.

According to a method defined by Duever and McCollum (1993) the trees affected by hurricanes were classified into four damage types, listed from the most to the least severe: main broken trunk or bole, uprooted, major branch damage and bent trunk. Trees that sustained several types of damage were assigned to the most severe damage category. Non-hurricane related deaths (i.e. saltwater, lighting, etc.) since 2003 were also noted.

Rainfall and flow prior, during and after the storms were examined to further describe the magnitudes and impacts of the storm events. Rainfall was examined from a weather station within the watershed while freshwater flow was obtained from Lainhart Dam (a long term flow/stage monitoring station located at 24 km (RM 14.8) on the Northwest Fork of the Loxahatchee River.

Results

Hurricane Frances made landfall as a Category 2 storm near Stuart, Florida on September 5, 2004. It impacted the floodplain forest of the Loxahatchee River, which is further south with top sustained wind speed of 169 km/hr. Winds in Jupiter, Florida were recorded between 146-156 km/hr. The storm had been slow at coming ashore as it spent several days spinning off the coast of Florida. In August, rainfall had averaged 6.9 millimeters (mm) and flow had averaged 1.96 cubic meters per second (m^3/s, or 69 cfs) (**Figure K-2**). Daily rainfall measured 11.4, 40.9, 147.3 and 32 mm between September 3 and 6, 2004 respectively. Flows measured 4.02, 4.18, 15.56, and 17.08 m^3/s (142, 148, 549 and 603 cfs) for the same time period. As rainfall returned to normal, flows remained above 6.8 m^3/s until September 11, 2004. An average flow of 3.1 m^3/s (110 cfs) takes the stage of the river out of the channel and into the swamp at Transect #1. River stage remained in the swamp at Transect 1 until October 4, 2004. Rainfall averaged 19.6, 2.8, 0.7 mm for the months of September through October while flows averaged 8.78, 4.04, and 2.01 m^3/s respectively (310,143, and 71 cfs).

The remnants of Hurricane Ivan swept through the area on September 21, 2004 and dropped a modest 32 mm of rain, which brought flow up to 11-12 m^3/s for a day or two. There were no noticeable winds with this rainfall event.

Hurricane Jeanne also came ashore in the Stuart area on September 26, 2004 as a Category 3 storm with top sustained winds of 193 km/hr. It too impacted the floodplain forest of the Loxahatchee River. This was a much faster moving storm than Hurricane Frances. There was no rainfall reported on September 25, 2004; however on September 26, 2004, 209 mm of rainfall was reported (**Figure K-2**). Flows had been running between 5 and 6 m^3/s but responded by increasing to levels of 22 and 18 m^3/s on September 26 and 27, 2004. Flows remained above 3.1 m^3/s for 5 more days before leveling off again.

Table K-1 summarizes the results of our hurricane damage assessment by reach and forest type. Of the 427 trees sampled in the riverine reach, 206 or 48.2% were damaged by the storms. Most of the observed damage was loss of branches (64%) while 19.4 % and 13.6% were broken trunks and tip overs. Only 18 deaths were reported in the riverine reach. These were predominantly breaks. Of the 33 Rsw1 and Rsw2 plots, which were dominated by either bald cypress or pop ash, 58.5% of the canopy trees were damaged. Sixty-four percent of the damage in the swamps was loss of branches followed by 22% trunk breakage and 12% tip overs. Of the 16 bottomland hardwood plots (Rblh) 55% were damaged. Of the bottomland hardwood damage, 58.5% was loss of branches, 20.8% was trunk breakage, and 19% was tip over. In the 12 mesic and hydric hammock plots, only 27.4 % of the canopy trees were damaged. Seventy-three percent of this damage was loss of branches. Only 3 tip overs and 2 breaks were reported in the hammock plots.

Of the 5 riverine transects, the largest amount of damage occurred on Transect 5 (Cypress Creek) (**Figure K-3**). Seventy-five percent of the 71 canopy trees were damaged. Thirty four or 64% were broken branches, 13 (24.5%) were trunk breaks, 3 (4.2%) and 8 were tip overs (15%) were noted. Eleven deaths were reported. Cypress Creek is a tributary of the Northwest Fork that is partly channelized downstream of agriculture and urban land uses. On average Cypress Creek provides about 35% of the total freshwater flow to the Northwest Fork of the Loxahatchee River. An agricultural water control structure on a canal leading to Cypress Creek had been breached by the hurricanes and the banks of the creek eroded away as a result of the rainfall and heavy flows. On September 6, 2004 flows on Cypress Creek peaked at 14 m^3/s (504 cfs.) while flows on September 26, 2004 peaked at 29 m^3/s (1,020 cfs). The winds and high flows produced many tip overs (primarily water hickory and red maples) (Figure 3), and covered the floor of the floodplains with sand and muck downstream of the breached structure.

Of the 797 canopy trees sampled in the upper tidal reach, 42.4% (338) were damaged. Damage was reported in both fresh and brackish water vegetative plots of this reach. Due to the sheer numbers of individuals, mangroves and pondapples in the UTsw1 and UTsw3 plots were sub-sampled. Of the 230 canopy trees reported as damaged in the tidal swamps, 159 or 69% had broken branches, 30 (13%) had trunk breaks, 12 (5%) had bent trunks and 29 (13%) were tip overs. Only 5 deaths were noted in these communities. At the back of the floodplains in the riverine plots, 18 of 31 trees were damaged and the damage was primarily broken branches. Forty eight percent of the canopy trees were damaged in the 3 hydric hammock plots. Of these damaged trees , forty-five percent had breaks in the trunk. Seven deaths (primarily cabbage palms) occurred. Mangroves in both the Upper and Lower Tidal Reaches experienced some degree of defoliation as a result of the storms. Subsequent visits to the transects revealed that recovery from defoliation was rapid after the storms.

Of the 438 canopy trees sampled in the lower tidal reach, 53.7% (235) were damaged. Most of the damaged occurred within the 13 LTsw2 plots, which consisted primarily of white mangroves. Of the 311 trees sampled in this community, 68% or 211 were damaged. Within the LTsw2 plots, 40% of the damage consisted of broken branches, 14.2% of the damage had broken trunks, 3.8% had bent trunks, and 56.4% of the damage were tip overs. In the 4 LTsw1 plots, which consisted primarily of red mangroves, only 12% of the canopy trees were damaged. Only one tip over occurred in these plots. Seven deaths were reported in the Lower Tidal Reach (one in the hydric hammock and 6 in the LTsw2 plots).

The preponderance of white mangrove tip overs on Transect 9 may have been caused additionally by dead bald cypress trees falling onto the mangroves. The majority of the large bald cypress died on this peninsular as a result of saltwater intrusion since the 1960s. Out of 161 bald cypress trees (7 stressed and 151 dead) surveyed in April 2004 only 3 remain healthy on this peninsular. Another conjecture regarding the cause of such large amounts of destruction in this one area may be the possibility of a localized tornado or severe wind gusts during one of the hurricanes. A few other similarly destroyed mangrove areas were noted during helicopter flights and from aerial photography taken after the storms.

Table K-2 summarizes the damage results by canopy species. Major canopy species with the most damaged individuals included white mangrove (72%), bald cypress (71.3%), red maple (68%), water hickory (57.1%), pond apple (41.5%), and red mangrove (40%). Other minor species with notable damage included slash pine (80%) and laurel oak (75%). Bald cypress are the most abundant canopy tree on the Loxahatchee River and its tributaries. This species along with red maple and water hickory are the tallest trees on the floodplain; therefore they would be more highly impacted particularly by the high wind velocities of hurricanes. Similarly in the tidal floodplains, white mangrove grow tall and close together sending out very few branches as they compete for available sunlight at the top of the canopy. Although bald cypress exhibited one of the highest numbers of damaged trees, most of the damage (86.3%) was branch damage. There were only 15 broken trunks, one tip over, and 4 mortalities reported for bald cypress out of 164 individuals sampled (**Table K-2**). White mangrove had the highest number of tip overs (121, 47%) and breaks (24, 9.3%). Cabbage palms followed by wax myrtles had the highest numbers of mortalities (11 and 9 respectively); however, only 7% of the 214 cabbage palms and 37 % of the 107 wax myrtle examined during the study were damaged. Ten additional cabbage palm deaths were probably related to salinity as opposed to being damaged by the storms. Of the 1, 694 total canopy trees sampled, the mortality rate was only 2.5% one year after the 2004 storms.

Discussion

Both Hurricanes Frances and Jeanne appeared to have had stronger winds than Hurricane David in 1979 but not perhaps the “The Great Hurricane of 49”. And, since our investigation, the floodplain forest of the Loxahatchee River was hit again in October 2005 by Hurricane Wilma (Category 2) with the highest recorded wind gust in Jupiter, Florida at 183 km/hr . In comparison with the winds and impacts of Hurricane Hugo in South Carolina, the winds of the 2004 storms were higher; however, damage was somewhat comparable between the two studies except the measured trees were larger in South Carolina (15 cm versus 5 cm). With Hurricane Hugo 60% of the 1,233 trees sampled were damaged (Duever and McCollom, 1993) while 45.3% of the 1,694 trees sampled in our study were damaged. While most of the damage in South Carolina was breaks, the majority of our damage was broken branches (58.3%). Only 17.1% were breaks and 23.8% were tip overs in our study. Both studies recorded broken branches as the major damage to bald cypress while bottomland hardwood species were commonly uprooted or experienced broken trunks (i.e. boles) in riverine areas. Damages in the South Carolina study may have been more severe because the “old growth” forested wetlands within the Francis Beidler Forest are taller and older than the communities along the Loxahatchee River and it tributaries.

There were also differences in geographical distance and differences in tree species between the two studies. Only four species could be compared. Pop ash, laurel oak, red maple and bald cypress were studied in both geographical areas. In our south Florida study, pop ash was the least affected (34%) while laurel oak was one of the most affected species (75%). Bald cypress and red maple were affected about the same (71% and 68%, respectively). In the South Carolina study (Deuver and McCollum, 1993), pop ash, laurel oak, and red maple were affected similar to the south Florida study (33%, 66%, and 77%, respectively). Only 46% of the bald cypress were affected after Hurricane Hugo.

The results of our damage analysis on the Loxahatchee River clearly indicated a non- random pattern in the effects of Hurricane Frances and Jeanne. Severe damage and mortality was most apparent in areas of the tallest canopy species (bald cypress, red maple, and water hickory) as compared to those species of lower stature (i.e. mangrove). Non-forested wetland and upland pine communities did not appear to be greatly affected by the hurricanes. The freshwater plant communities of the riverine reach and the mangrove communities of the tidal floodplain reaches exhibited the most severe effects. The

Riverine Reach experienced a 48.2% damage rate versus a 39.1% rate in the Upper Tidal Reach and a 53.6% rate in the Lower Tidal Reach. The higher damage rate of the Lower Tidal Reach is a factor of the abundance of white mangroves that were impacted at Transect 9. These trees grew at very thick densities with primarily one major trunk and branches primarily at the canopy surface only. Tip overs immediately began sending out new branches all along the base of the trunk.

The high winds of both storms apparently affected seed production of the bald cypress community for the fall of 2004 and winter of 2005. Cones, which generally release their seeds by the end of the year were absent on the trees after the storms. Subsequently, the observed number of seedlings was small over the course of the remaining year.

On a short and long term basis both Hurricane Frances and Jeanne decreased canopy cover and increased light penetration within the floodplain forest of the Loxahatchee River. Defoliation was only a short term factor; however, loss of major branches will be a long term factor. The winter of 2005 was mild in terms of South Florida temperatures and rainfall in 2005 has been above normal. We noted particularly that bald cypress did not go dormant for this period but continued to sprout new branches in their effort to recover. Shrub and ground cover species have reacted positively to the increase in light levels and nutrients from the flooding. Also, exotic species such as Old world climbing fern (*Lygodium microphyllum*); Brazilian pepper (Schinus terebinthifolius); java plum (*Syzygium cumini*); and strawberry guava (*Pisidium cattleianum*) appeared to be on the rise in the floodplains and are a concern.

Additional concerns of the storm impacts were the abundance of downed branches and leaves within the floodplains. Fifty-eight percent of the tree damage was branches while another 18% was broken trunks. This increased the organic loadings in the river and dramatically reduced dissolved oxygen levels. After Hurricane Frances, the dissolved oxygen levels dropped to zero for a week. This probably had a short term impact on the river's biological productivity, but this will require further assessment. Also, some of the tip overs were attributed to the flows from these storm events that undermined the bases of trees near the river and braided channels.

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Figure K-1. Location of the three floodplain reaches (Riverine, Upper Tidal and Lower Tidal) of the Loxahatchee River System.

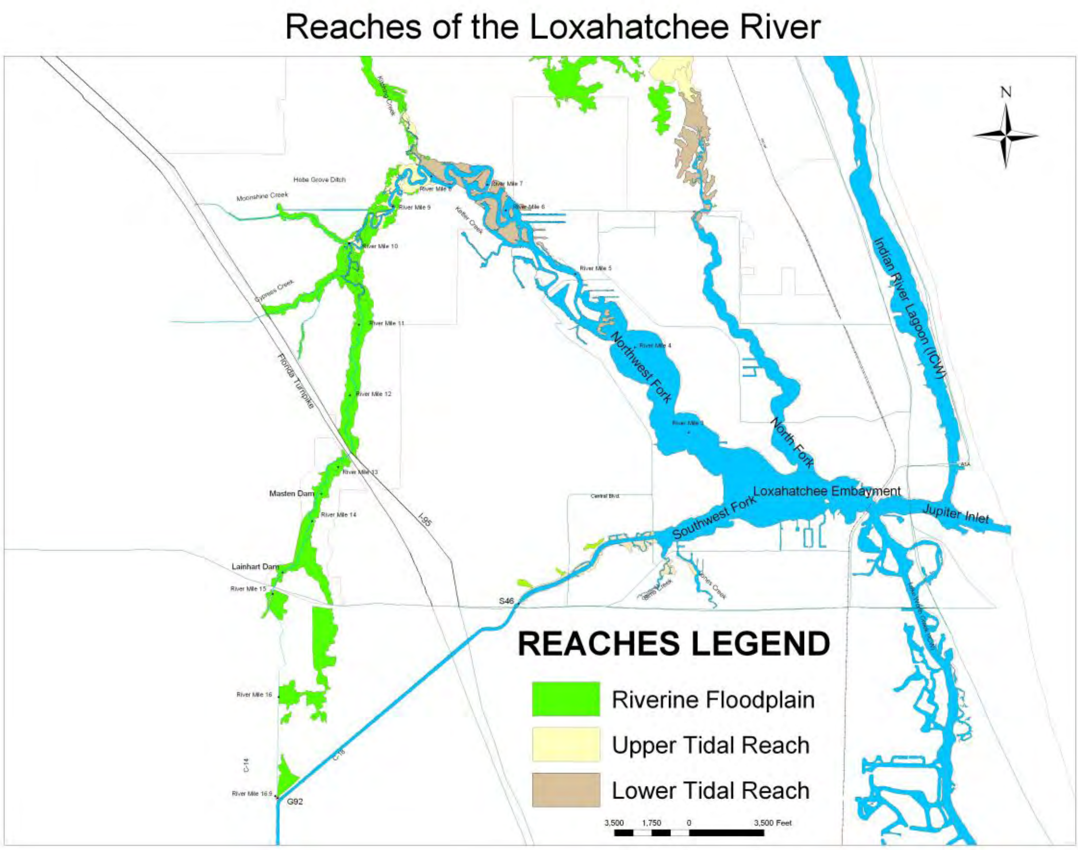

Figure K- 2. Local Rainfall and Lainhart Dam Flow between August 1, 2004 and November 30, 2004.

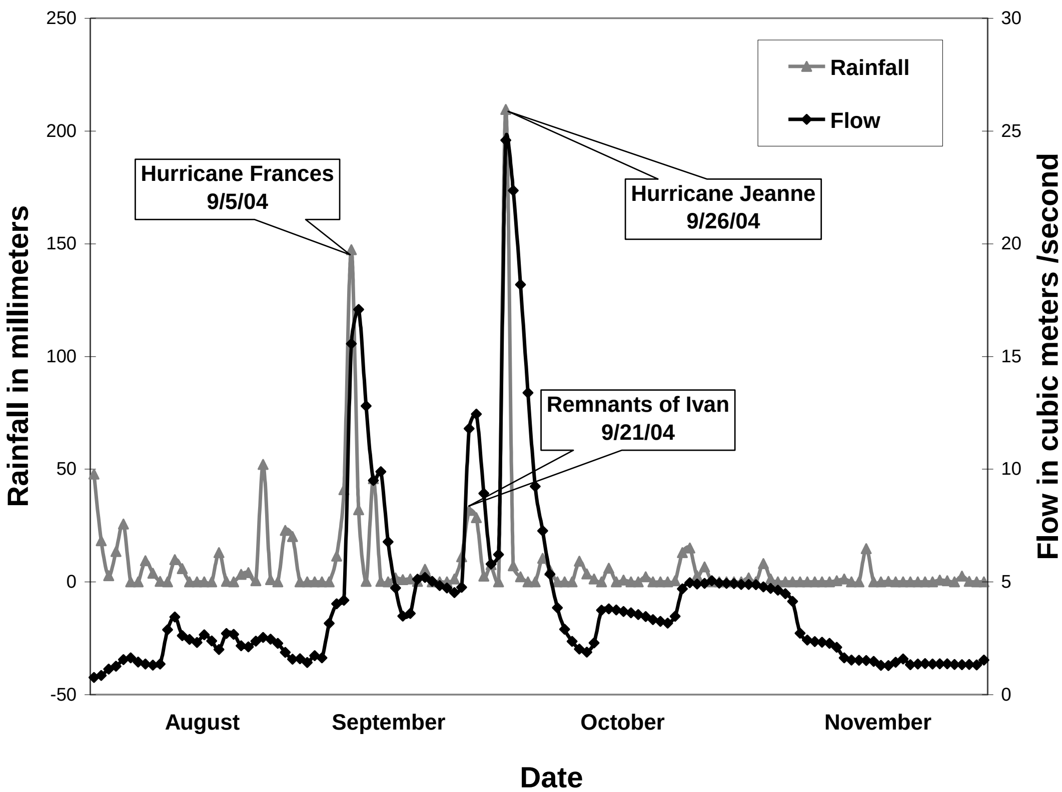

Figure K-3. An example of a windthrown water hickory on Transect #5 (Cypress Creek).

Table K-1. A Summary of Hurricane Damage by Transect and Forest Type

Reach	Forest type	# Plots	Total sampled	Total damaged	Type of damage: Branches	Break	Bent	Tip over	Mortality	Mortality (non-storm)
Riverine	MH	8	54	20	15	1	1	2	2	
Transects	HH	4	41	6	4	1		1		
#	HH/U	2	9	4	3			1		
1,2,3,4,	HH/Rsw1	2	9	1	1					
& 5	HH/Rsw2	1	7							
	Rsw1	25	139	90	67	12		11	7	
	Rsw2	8	66	30	10	14	3	3	2	
	Rsw1/Rblh2	1	5	2	1	1			2	
	Rblh1	3	15	11	7	4				
	Rblh2	10	67	33	17	5	1	10	5	
	Rblh3	3	15	9	7	2				
Upper Tidal	Marsh	1	4	2		1		1		
Transects	HH/Marsh	1	2							
#	HH	3	46	22	6	10	2	4	7	
6,7,8, &	U	2	5	2	1		1			
10	MH/Rsw1	1	11	2	1			1		
	Rsw1	3	31	18	13	3		2	1	
	UTsw1	15	279*	126	93	16	5	12	2	1
	UTsw2	6	155	35	28	3		4	1	
	UTsw3	6	162*	69	38	11	7	13	2	
	UTmix	6	75	39	26	9	2	2	1	1
	Rmix	7	94	23	11	9		2	4	
Lower	U	1	2	2	2					
Tidal	HH	1	10	3		1		2	1	

Transect #9	LTsw2	13	311	211	84	30	8	119	6	5
	LTsw1	4	99	12	8	1	2	1		
	LTmix	1	16	7	5	1		1		3

Table K-2. A Summary of Hurricane Damage by Selected Species

* subsample of 221 RM, 358 LR

Species	Total sampled	Total damaged	Type of damage: Branches	Break	Bent	Tip over	Mortality	Mortality (non-storm)
Acer rubrum, Red maple	50	34	17	10		8	4	
Annona glabra, Pond apple	193	80	59	17	4	1	3	
Carya aquatica, Water hickory	35	20	15	1		5	5	
Cephalanthus occidentalis, Button bush	2	1	1					
Citrus sp.	3	1				1		
Ficus aurea, Ficus	5	1	1					
Fraxinus caroliniana, Pop ash	125	43	17	18	3	5	3	
Grapevine	1							
Illex cassine, Dahoon holly	5	3	1		2			
Laguncularia racemosa, White Mangrove	408*	258	127	24	9	121	2	
Myrica cerifera, Wax myrtle	107	40	7	22		11	9	
Persea borbonia, Red bay	6	2		1		1		
Pinus elliottii, Slash pine	10	8	8					
Psidium cattleianum, Strawberry guava	4	2	1			1		
Quercus laurifolia, Laurel oak	16	12	10	2			1	
Quercus myrtifolia, Myrtle oak	1							
Quercus virginiana, Live oak	22	12	8	2	1			
Rhizophora mangle, Red mangrove	251*	88	64	12	6	5	1	
Roystonea regia, Royal palm	4	1	1					
Sabal palmetto, Cabbage palm	214	15	2	4		11	11	10
Salix caroliniana, Carolina willow	18	4		1		3		
Schinus terebinthifolius, Brazilian pepper	44	29	8	3	7	16		
Serenoa repens, Saw palmetto	3							
Syzgium cumini, Java plum	3							
Taxodium distichum, Bald cypress	164	117	101	15		1	4	