# Vegetation Sampling at
# Picayune Strand State Forest
# Task 2c

PSRA Vegetation Monitoring 2005-2006
PC P502173

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## Table of Contents



*Cover Photo: Monitoring Plot/Transect at Picayune Strand State Forest taken by Josh Mahoney, October 2005.*

**Background (excerpt from the Scope of Work for this project provided by SFWMD)**
The Picayune Strand Restoration Area (PSRA), formerly known as Southern Golden Gate Estates, is a large development located east of Naples in southern Collier County. It is located within the southeastern portion of Picayune Strand, and is part of a larger development, Golden Gate Estates (GGE), the northern portion of which is a developing residential community. The whole GGE area has undergone hydrologic and environmental alteration due to construction of a network of canals, levees, and roads built in the 1960s.

Prior to development, the PSRA was characterized by seasonal flooding and slow-moving overland sheet flow that supported a variety of plant and animal communities in uplands and freshwater wetlands and in its downstream brackish wetlands and estuaries. Channelization of water flows has resulted in elimination of sheetflow across the PSRA and into the estuaries, lowered water tables within the PSRA, and created a fluctuating freshwater point discharge to the estuarine ecosystem. Upland, wetland, and estuarine plant communities have been degraded, the abundance of native fish, wildlife, and estuarine shellfish populations has declined, recharge of the surficial aquifer has been reduced, and non-native species have increased in abundance. The drained conditions have resulted widespread and more intense wildfires than occurred under pre-drainage conditions. These fires are accelerating the change in vegetation from wetlands to upland communities dominated by fire tolerant species such as cabbage palm (*Sabal palmetto*) and exotics such as Brazilian-pepper (*Schinus terebinthifolius*). In addition, similar impacts are occurring over distances of a mile or more from the canals into adjacent public lands

The PSRA currently has a network of east-west roads every quarter mile that are connected by north-south roads approximately every mile. The most significant environmental impact of the road network is that it impedes natural sheetflow. However, it also provides access to all parts of the project area where there are impacts from off-road vehicles, poaching of animals and plants, vandalism, and the illegal dumping of solid waste. It has resulted in the fragmentation of an extensive block of contiguous natural lands that compromises the value of the area for a variety of wide-ranging wildlife such as the Florida panther as well as other threatened and endangered species.

**Introduction**

The South Florida Water Management District (SFWMD) plans on restoring the hydrology at the Picayune Strand Restoration Area (PSRA) within and around PSSF. Task 1 was to establish permanent VMTs in coordination with other ongoing projects to assess the effects of restored hydrology (Woodmansee and Barry 2005). The second task was to gauge the impact of this restoration by installing permanent sampling plots with Vegetation Monitoring Transects (VMTs) and monitor specific points within PSSF coordinated with monitoring well locations. A draft report was sent upon completion of sampling of VMTs (Woodmansee and Barry 2006). This report is a final summary of the vegetation sampling with emphasis on relationships between plant species composition, dominance, and hydrology. Discussion of preliminary analysis using the as yet incomplete Floristic Quality Index (FQI) is in preparation by USFWS. More detailed discussion on the effects of fire and coverage by exotics through comparisons with FPNWR data can be found in the report for FPNWR (Barry 2006).

**Methods**

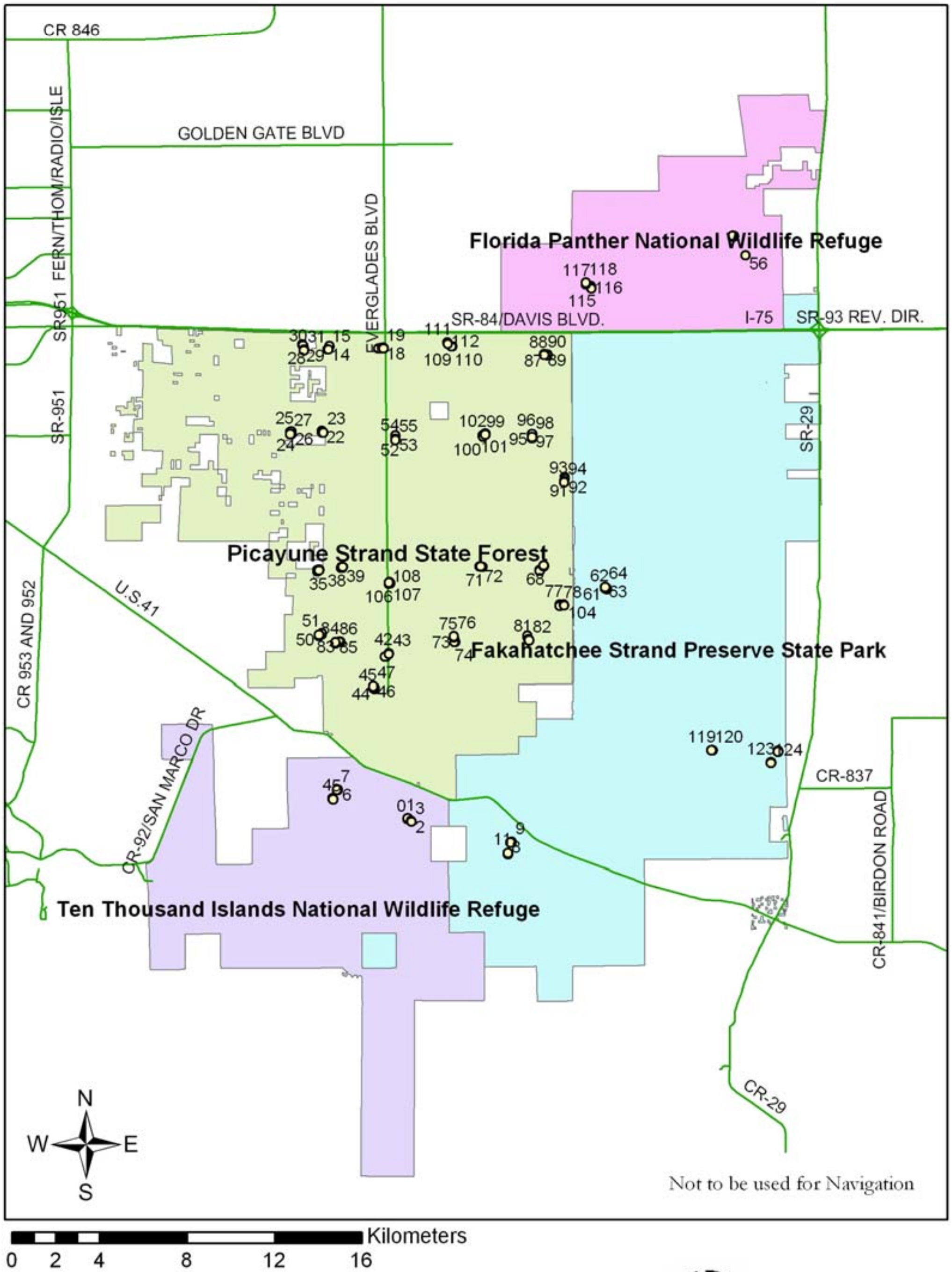
Overview
After receiving approval for the position of VMT locations (completion of Task 1), field work was conducted during September through November 2005 by staff and volunteers from The Institute for Regional Conservation (IRC) (Woodmansee and Barry, 2005). VMTs were located at PSRA (including Florida Panther National Wildlife Refuge (FPNWR), Fakahatchee Strand Preserve State Park (FSPSP), and Ten Thousand Islands National Wildlife Refuge (TTINWR)). Installation of the VMTs and data collection took place in the vicinity of the 27 SFWMD monitoring wells and at selected control sites within PSRA (Figure 1).

Field Study
Two permanently marked 50 m VMTs were established at each of the 27 new well sites: 23 within PSRA, two within TTINWR, and two in relatively undisturbed areas of FSPSP (Figure 1). An additional nine relatively undisturbed reference (control) sites at FSPSP and FPNWR were marked with VMTs (Figure 1). A total of 50 VMTs were placed in areas to be hydrologically influenced upon restoration, while a total of 13 VMTs were placed as control plots. Each vegetation line was located within a different plant community at least 25 m from where there was likely to be any direct influence of road removal or any other disturbance during restoration. They were located in relatively uniform stands of vegetation, both in terms of the existing community and the likely restored community. Where feasible, the suite of sites along each east-west band of the new monitoring wells provided at least three examples of each of the existing major plant community types and the major plant communities likely to be present following restoration. Major plant community type descriptions followed a modified version of The United States Department of Agriculture Natural Resources Conservation Service (NRCS) codes (Burch et al. 1998). It should be noted that authors coordinated with other researchers to prevent overlap of VMTs and yet match habitats being monitored by other concurrent studies (*i.e.* faunal studies).

For each VMT, fire interval was recorded. Fire Intervals were measured in three categories: 1 = <1 yr, 2 = 1-7 yrs, and 3 = > 7 yrs. Intervals were determined by field observations cross referenced with burn history provided by staff at PSSF.

Each VMT was marked with rebar at each end and then each rebar position coordinates were recorded in UTMs (NAD83 17N) using a sub-meter accuracy Global Positioning System (GPS) device throughout the study. Rebar markers were jacketed with PVC pipe, flagged, and tagged with a numbered aluminum tag. In addition, trees near each rebar were flagged using either orange tape with black polka dots or white tape with blue polka dots; distinguishing VMTs from other ongoing research at PSRA. A fifty-meter transect tape was then strung between the two rebar at a taught/straight position. In all cases transects were positioned North/South and East/West, with the origins occurring at the East or North. Although not required, at least one photo was taken at each rebar position in the direction of the other rebar stake for each transect.

Figure 1: Picayune Strand State Forest Vegetation Monitoring Study area (with Transect Points)




Data and map by Steven W. Woodmansee & Mike Barry
The Institute for Regional Conservation, Miami, FL
June 30, 2006

The 50 m VMTs were sampled using methods similar to those utilized at FPNWR, with some modification to include the canopy stratum (Main et al. 2000). Restoration targets for the PSRA monitoring sites will be a function of their new hydrologic regime, and should be comparable to the composition and structure of hydrologically similar reference sites.

The vegetation along the VMTs was divided into four strata based on guidelines (DEP 62-340.200) outlined in Gilbert et al. (1996).

Canopy trees were defined as those woody plants with a diameter at breast height (dbh) greater than 10 cm (approx. 4 in). The subcanopy consisted of tree species (excluding common shrubs such as wax-myrtle (*Myrica cerifera*), willow (*Salix caroliniana*), Brazilian-pepper, and saltbush (*Baccharis* spp.)) with a dbh between 2.5 and 10 cm (1-4 in). The shrub layer consisted of trees with a dbh less than 2.5 cm (1 in) and any-sized individuals of the four common shrub species mentioned above. Ground cover consisted of all vascular plants and *Chara* sp. not found in the other strata and was made up of primarily herbaceous species.

Special attention was paid toward cabbage palms (*Sabal palmetto*), which due to the alteration of the natural habitats had become a dominant species in many former wetland habitats. Cabbage palms (*Sabal palmetto*) were separated into the following strata: 1) canopy palms with apical meristems above 2.4 m (8 ft), 2) subcanopy palms with apical meristems greater than a breast height of 1.4 m (4.5 ft) but less than 2.4 m (8 ft), 3) shrub layer palms with apical meristem just above ground level to a breast height of 1.4 m (4.5 ft), 4) ground cover palms with palmate leaves but apical meristem still at ground level (i.e. no trunk) or with at least four (or evidence of having produced four) non-palmate leaves. By McPherson and Williams (1996) this stratum would include pre-trunk plants with palmate leaves down to plants with pinnate leaves but leaf width >8mm. 5) Palm seedlings were defined by individuals without palmate leaves and only two - three leaves (including remnant petioles at the base if present). McPherson and Williams (1996) defined new recruits to be the smallest plants with leaves of three segments (a segment is the characteristic plication with "V" shape) further distinguished by leaf width < or = 8mm. This stratum is intended to represent only the newest recruits. For cabbage palms with trunks within strata 1-3, the presence or absence of adventitious roots was recorded.

Additionally, presumed "old growth", or pre-disturbance overstory slash pine and cabbage palm were separated into strata 1.5 for analysis. This determination was made based on morphological characters such as slash pine crown form and whether a cabbage palm was completely bootless with adventitious roots. Detailed explanation of this strata designation can be found in the FPNWR report (Barry 2006).

Canopy and subcanopy trees (and cabbage palms in all strata) were sampled along 5 m wide belt vegetation lines within the VMT (Mueller-Dombois and Ellenberg 1974). Diameters of all canopy trees were measured and tagged to facilitate re-sampling and to document mortality and recruitment. Subcanopy trees were counted by stems of each species to estimate density, and were not tagged nor were their measurements recorded. Cabbage palms, but not other tree species, were counted in the shrub, groundcover, and seedling strata.

The composition and cover of shrub species, as defined above, was quantified using the line-intercept method (Mueller-Dombois and Ellenberg 1974, Lindsey 1955, Canfield 1941) along each of the VMTs. Intercept lengths included overhanging or underlying shrub canopy. Saw palmetto (*Serenoa repens*) was always considered a shrub. From these data, percent coverage was estimated.

Species composition and cover of herbaceous ground cover species and shrubs were quantified using 0.5 $m^2$ rectangular quadrats (40.5" x 20.75") placed at 10 m intervals along the vegetation line using Daubenmire (1959) cover classes. When comparing with previous data from FPNWR, there were some inconsistencies with actual placement of the quadrats, but such differences are encompassed within the study design goals of nested quadrats. For more detailed discussion of these methods see the FPNWR report (Barry 2006). There are seven cover classes including: .5) <1%, 1) 0-5%, 2) 5-25%, 3) 25-50%, 4) 50-75%, 5) 75-95%, and 6) 95-100%.

All herbaceous species whose stems originated from within the quadrat were assigned cover class values. Shrub and vine species were assigned cover class values if any part of the plant overhung the quadrat regardless of where the stems originated. Only photosynthetic portions of the plant species were recorded (*i.e.* trunks of trees or shrubs were not counted as coverage). Within each quadrat, cabbage palm coverage was recorded separately for seedling strata. Although not required, plant reproductive phenology and whether it was browsed by deer were also recorded.

An attempt was made to identify all vascular plant species to the infraspecific taxon level. Therefore monitoring was conducted during the fall when most of the species which cannot be identified using vegetative parts were reproductive. Plant taxonomy predominantly followed Wunderlin (1998). Codes were used for each taxon and are translated in an accompanying electronic database.

<u>Data Entry</u>
Data was entered into an Access database. A single table was used for each study type: belt transect data, line intercept data, and quadrat data. In addition a table marked "transect" was created for descriptions of each VMT, including well number, location, rebar number, transect number, fire interval, habitat, former habitat, photo ID, and any notes. Comment fields were provided for all these tables. Additional tables were provided including a GPS table linking geographic coordinates of each rebar belonging to VMTs, an Accepted Names table (linking taxon code with genus species, higher taxonomic data, plant authority code, nativity, rare plant status, and Florida Exotic Pest Plant Council status), an Authority table (linking authority code with the appropriate literature reference), and lookup tables for each of the data tables. After initial data entry, data was cross-checked for errors and corrected accordingly.

Previous data collection events possessing the same Field Study methods were incorporated into the Access database and were included in some of the analyses of this report. This was done in order to discuss preliminary findings, as well as to summarize habitats better, before restoration took place. A summary of all data set events is in Table 1. For a complete discussion of these events refer to Barry (2006).

Five basic tables have been created in the database including: *TRANSECT_PARAMETERS, SAMPLING_EVENT, BELT_TRANSECT_DA, LINE_INTERCEPT_DA*, and *QUAD_DA*. The actual detailed file structures of these tables are listed in a spreadsheet *Structures_PICA_FPNWR.xls* included with the database. All transect location information is kept in the *monitoring_pts* table as a part of the GIS shapefile. Primary common fields for linking the data include the TRAN_ID and EVENT_NU fields, allowing data to be linked by transect location and sampling event. For more detailed discussion of the database structure see the FPNWR report (Barry 2006).

**Table 1: Summary of events.**

| Location | Funding Source | Principal Investigator | Control for PSRP | Sampling Event # | Beginning Date | Ending Date | Number of Transects |
|---|---|---|---|---|---|---|---|
| Florida Panther National Wildlife Refuge | SFWMD | S. Woodmansee | Yes | 4 | 10/19/2005 | 12/5/2005 | 6 |
| | USFWS | Dr. M. Main | No | 0 | 4/29/1996 | 1/7/1998 | 216 |
| | USFWS | Dr. M. Main | No | 1 | 8/12/1996 | 6/2/1998 | 205 |
| | USFWS | Dr. M. Main | No | 2 | 11/14/1996 | 12/10/1997 | 153 |
| | USFWS | Dr. M. Main | No | 3 | 4/23/1997 | 9/20/1998 | 135 |
| | Everglades Reprogram | M. Barry | No | 4 | 5/13/2005 | 9/20/2006 | 72 |
| Fakahatchee Strand Preserve State Park | SFWMD | S. Woodmansee | Yes | 4 | 9/30/2005 | 11/10/2005 | 7 |
| | SFWMD | M. Barry | No | 0 | 3/11/2004 | 5/3/2004 | 15 |
| Picayune Strand State Forest | SFWMD | M. Barry | No | 0 | 12/9/2003 | 5/11/2004 | 23 |
| | SFWMD | S. Woodmansee | No | 4 | 9/6/2005 | 10/6/2005 | 46 |
| Ten Thousand Islands National Wildlife Refuge | SFWMD | S. Woodmansee | No | 4 | 8/10/2005 | 10/14/2005 | 4 |
| | | | | | | **Total:** | 882 |

<u>Data Analyses</u>

Basic statistics were calculated and presented for each of the field methods including standard forestry parameters such as density, basal area, and stand basal area for belt transect data, percent cover for line intercept data, and percent cover, percent frequency of occurrence in quadrats, and percent dominance using quadrat data. Additional analysis using wetland indicator values (Reed 1988) to calculate Wetland Affinity Index (WAI) was utilized to assist with evaluating the effects of hydrological conditions on the plant communities. In order to analyze the dominance by ruderal species often associated with ground disturbance, either by previous development activities or current fire management or restoration efforts, the draft version of the newly created Floristic Quality Index (FQI) was utilized for comparison between sites with varying disturbance histories.

## Results and Discussion

<u>Vegetation Monitoring Overview</u>
*Habitats*

A total of twelve distinct habitats (including altered habitat types) were studied under this project (Table 2). Habitat designations followed Jim Burch's definitions, with some modifications (Burch et al. 1998) Dominant habitats studied in non-control plots included prairie (8 VMTs), hydric pine flatwoods (8 VMTs), and mesic flatwoods (6 VMTs). However, when all varieties of cypress habitat types are combined, cypress is the dominant habitat type (12 VMTs). Control plots focused on these dominant habitats with the exception of mesic flatwoods which is not abundant at FSPSP and it was difficult to coordinate with complementary research studies. However, data for this habitat exists from the FPNWR sampling and is discussed in the FPNWR report (Barry 2006). These data, collected at FPNWR from 1996-2006, are included in comparisons throughout this report.

**Table 2: Transects by habitat (study type included).**

| Habitat | Habitat Code | Vegetation Monitoring Transect (VMT) | Control |
|---|---|---|---|
| Prairie | G | 8 | No |
| Hydric Pine Flatwoods | Ph | 8 | No |
| Mesic Flatwoods | Pm | 6 | No |
| Cypress Slough | C | 5 | No |
| Cabbage palm Hammock | Hp | 5 | No |
| Hydric Hammock | Hh | 4 | No |
| Saltwater Marsh | Ms | 4 | No |
| Cypress w/graminoid understory | Cg | 3 | No |
| Disturbed Cypress Slough | Cx | 3 | No |
| Freshwater Marsh | Mf | 2 | No |
| Cypress/hardwood slough | Ch | 1 | No |
| Disturbed Prairie | Gx | 1 | No |
| Hydric Pine Flatwoods | Ph | 4 | Yes |
| Cypress Slough | C | 3 | Yes |
| Prairie | G | 3 | Yes |
| Saltwater Marsh | Ms | 2 | Yes |
| Cypress w/graminoid understory | Cg | 1 | Yes |
| | Total VMTs = | 63 | |

*Fire Intervals*

Within the study area, two transects possessed a fire interval 1 (of less than one year) in mesic flatwoods and prairie habitats (Table 3). Seventeen transects possessed a fire interval 2 (1-7 years) in various habitats. Thirty-one transects possessed a fire interval 3 (greater than

7 years), four of which were hydric hammock and eight of which were deep water cypress habitats which rarely burn. Additional data from FPNWR (sampling funded by USFWS from 1996 to 2006) is included in this report and is summarized in the FPNWR report (Barry 2006).

**Table 3: Transects by habitat and fire interval (study type included).**

| Habitat | Habitat Code | Fire Interval | Vegetation Monitoring Transect (VMT) | Control |
|---|---|---|---|---|
| Cypress Slough | C | 3 | 5 | No |
| Cypress w/graminoid understory | Cg | 3 | 1 | No |
| Cypress w/graminoid understory | Cg | 2 | 2 | No |
| Cypress/hardwood slough | Ch | 3 | 1 | No |
| Disturbed Cypress Slough | Cx | 3 | 2 | No |
| Disturbed Cypress Slough | Cx | 2 | 1 | No |
| Disturbed Prairie | Gx | 3 | 1 | No |
| Freshwater Marsh | Mf | 3 | 2 | No |
| Hydric Hammock | Hh | 3 | 4 | No |
| Hydric Pine Flatwoods | Ph | 3 | 4 | No |
| Hydric Pine Flatwoods | Ph | 2 | 4 | No |
| Mesic Flatwoods | Pm | 3 | 4 | No |
| Mesic Flatwoods | Pm | 2 | 1 | No |
| Mesic Flatwoods | Pm | 1 | 1 | No |
| Prairie | G | 3 | 1 | No |
| Prairie | G | 2 | 6 | No |
| Prairie | G | 1 | 1 | No |
| Cabbage palm Hammock | Hp | 3 | 2 | No |
| Cabbage palm Hammock | Hp | 2 | 3 | No |
| Saltwater Marsh | Ms | 3 | 4 | No |
| Cypress Slough | C | 3 | 3 | Yes |
| Cypress w/graminoid understory | Cg | 2 | 1 | Yes |
| Hydric Pine Flatwoods | Ph | 3 | 1 | Yes |
| Hydric Pine Flatwoods | Ph | 2 | 3 | Yes |
| Prairie | G | 3 | 1 | Yes |
| Prairie | G | 2 | 2 | Yes |
| Saltwater Marsh | Ms | 3 | 2 | Yes |
| | Study VMTs= | | 50 | |
| | Control VMTs= | | 13 | |
| | Total VMTs = | | 63 | |

*Soils*

Soil types were determined utilizing data from the Collier County Soil Survey (Liudahl et al. 1998). The number of VMTs by soil type is presented in Table 4. Hallandale fine sand was the most heavily sampled soil type at FPNWR (86 VMTs – including sampling since 1996) while Hallandale and Boca fine sands were the most sampled soil types at PSSF (22 VMTs). Soil type designations at FPNWR, except for the two cypress control transects, were verified in the field by soil scientist Dr. Tom Obreza in 1998 (Barry 2006). However, only those transects associated with the peizometers installed by NRCS in 1997 were reviewed by Howard Yamataki at that time. Because soil mapping units are broad in scale and often include other soil types within them, before extensive analysis of vegetation data by soil types is conducted, it would be good to verify the soil types at the transects in the field.

**Table 4: Number of transects by soil type, location.**

| Soil Type | Soil Name | Location | Control | # Transects |
|---|---|---|---|---|
| | undetermined | PSSF | | 1 |
| 2 | HOLOPAW FINE SAND, LIMESTONE SUBSTRATUM | PSSF | | 2 |
| 6 | RIVERIA, LIMESTONE SUBSTRATUM-COPELAND FINE SANDS | PSSF | | 1 |
| 10 | OLDSMAR FINE SAND, LIMESTONE SUBSTRATUM | PSSF | | 1 |
| 11 | HALLANDALE FINE SAND | FPNWR | Yes | 1 |
| 11 | HALLANDALE FINE SAND | FPNWR | | 86 |
| 11 | HALLANDALE FINE SAND | PSSF | | 9 |
| 18 | RIVIERA FINE SAND, LIMESTONE SUBSTRATUM | PSSF | | 3 |
| 21 | BOCA FINE SAND | FPNWR | | 6 |
| 22 | CHOBEE, WINDER, AND GATOR SOILS, DEPRESSIONAL | PSSF | | 1 |
| 23 | HOLOPAW AND OKEELANTA SOILS, DEPRESSIONAL | PSSF | | 1 |
| 25 | BOCA, RIVIERA, LIMESTONE SUBSTRATUM, COPELAND FINE SANDS, DEPRESS | FPNWR | Yes | 2 |
| 25 | BOCA, RIVIERA, LIMESTONE SUBSTRATUM, COPELAND FINE SANDS, DEPRESS | FPNWR | | 38 |
| 25 | BOCA, RIVIERA, LIMESTONE SUBSTRATUM, COPELAND FINE SANDS, DEPRESS | FSPSP | Yes | 2 |
| 25 | BOCA, RIVIERA, LIMESTONE SUBSTRATUM, COPELAND FINE SANDS, DEPRESS | FSPSP | | 3 |
| 25 | BOCA, RIVIERA, LIMESTONE SUBSTRATUM, COPELAND FINE SANDS, DEPRESS | PSSF | | 10 |
| 48 | PENNSUCO SILT LOAM | PSSF | | 3 |
| 49 | HALLANDALE AND BOCA FINE SANDS | FPNWR | Yes | 1 |
| 49 | HALLANDALE AND BOCA FINE SANDS | FPNWR | | 14 |
| 49 | HALLANDALE AND BOCA FINE SANDS | FSPSP | | 2 |
| 49 | HALLANDALE AND BOCA FINE SANDS | PSSF | | 22 |
| 50 | OCHOPEE FINE SANDY LOAM, LOW | FPNWR | Yes | 1 |
| 50 | OCHOPEE FINE SANDY LOAM, LOW | FPNWR | | 47 |

| Soil Type | Soil Name | Location | Control | # Transects |
|---|---|---|---|---|
| 50 | OCHOPEE FINE SANDY LOAM, LOW | FSPSP | Yes | 2 |
| 50 | OCHOPEE FINE SANDY LOAM, LOW | FSPSP | | 2 |
| 50 | OCHOPEE FINE SANDY LOAM, LOW | PSSF | | 7 |
| 50.1 | OCHOPEE FINE SANDY LOAM, separate | FPNWR | | 12 |
| 51 | OCHOPEE FINE SANDY LOAM | FPNWR | Yes | 1 |
| 51 | OCHOPEE FINE SANDY LOAM | FPNWR | | 9 |
| 51 | OCHOPEE FINE SANDY LOAM | FSPSP | Yes | 1 |
| 51 | OCHOPEE FINE SANDY LOAM | FSPSP | | 8 |
| 51 | OCHOPEE FINE SANDY LOAM | PSSF | | 3 |
| 52 | KESSON MUCK, FREQUENTLY FLOODED | FSPSP | Yes | 2 |
| 52 | KESSON MUCK, FREQUENTLY FLOODED | TTINWR | | 4 |

*Plant Identification*

Plants within the belt and line intercept area of all VMTs were identified to the infraspecific taxon level (if it existed). Over 98% of the ground cover species were identified to the infraspecific taxon level. For those exceptions, plants were labeled either unknown (0.26%), or were identified to the plant family (0.26%), or genus (1.2%) levels.

Belt Transect Evaluation

Data (including stem counts, DBH, density, basal area, etc.), for overstory, understory, cabbage palm, and all strata, were summarized for all sites by transect in the database. Data for slash pine and cabbage palm densities is presented below for pinelands, including the data collected at FPNWR outside the SFWMD contract (Table 5). In general, the highest slash pine densities in the overstory were found in the fire-excluded hydric pine flatwoods of PSSF, which is consistent with expectations. For more detailed discussion of pineland comparisons with respect to fire see the FPNWR report (Barry 2006). Overstory density data for dominant tree species for all other habitats sampled is presented in (Table 5).

Surprisingly, some of the highest densities of cabbage palm were found in the pineland groundcover stratum on FPNWR (Table 6). Densities ranged from 1100 to 3400 trees/acre on FPNWR, while on PSSF and FSPSP, densities generally ranged from 300 to 1000 trees/acre. To be conservative, these numbers could be combined with seedling counts to minimize error in determination of strata (ground cover vs. seedling) caused by multiple data collectors, as the definition of this stratum did cause some problems.

Cabbage palm densities in pinelands at FPNWR, especially in the lower strata, do seem exceedingly high, however, currently we have no reference or control sites with similar soil types without altered hydrology or fire regimes for comparison. Natural sites like these may in fact exhibit somewhat higher densities of cabbage palms in the pre-trunk stage (*i.e.* groundcover and seedling strata) relative to upper strata as cabbage palms. This is because they likely spend 20 or more years in this early stage, while trunk formation after this stage may be rapid with growth rates as fast as 15 cm/year under optimal conditions (McPherson and Williams 1996). Our data supports the literature as both the seedling strata and the sub canopy strata (early trunk formation) exhibit the lowest densities, while the groundcover strata is higher than all other strata combined. It would be interesting to look for sites in the interior of adjacent Big Cypress National Preserve for reference sites with similar edaphic characteristics as at least the hydrological patterns have been less impacted.

Densities greater than 1000 trees/acre were also observed in other habitats on PSSF, especially including cabbage palm hammock (Hp) which was formerly (pre-drainage) cypress with graminoid. These high densities were also observed in other cypress dominated communities including cypress with graminoid (Cg), cypress with hardwoods (Ch), and disturbed cypress (Cx). The absolute highest densities in the lower strata were observed in PSSF in cypress with graminoid (Cg) with cabbage palm density greater than 7,000 trees/acre, found in one transect adjacent to the Prairie Canal. Hydroperiods in these drained cypress communities may actually be similar to the hydric pinelands on FPNWR. These data may suggest an optimal hydroperiod for establishment of cabbage palm and drainage may actually have lowered the suitability of pinelands for cabbage palm establishment at PSSF relative to FPNWR. More analysis with actual hydroperiods should be done to examine this hypothesis, however, at the current time no hydrological data is available from FPNWR (despite years of well monitoring).

**Table 5: Slash pine and cabbage palm densities by location, fire interval, for pineland habitats.**

| | | | | | FPNWR (all data) | | PSSF (Prairie Canal ) | | PSSF (event 4) | | FSPSP | | FSPSP (control) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Habitat** | **Fire** | **Event #** | **Strata** | **Species** | **Density (trees/acre)** | **n** | **Density (trees/acre)** | **n** | **Density (trees/acre)** | **n** | **Density (trees/acre)** | **n** | **Density (trees/acre)** | **n** |
| Ph | 1 | 4 | 1 | *Pinus elliottii* | 77.3 | 9 | 64.7 | 1 | | | | | | |
| Ph | 1 | 4 | 1 | *Sabal palmetto* | 89.9 | 9 | | 1 | | | | | | |
| Ph | 1 | 4 | 1.5 | *Sabal palmetto* | 10.8 | 9 | | 1 | | | | | | |
| Ph | 1 | 4 | 2 | *Pinus elliottii* | 3.6 | 9 | | 1 | | | | | | |
| Ph | 1 | 4 | 2 | *Sabal palmetto* | 39.6 | 9 | | 1 | | | | | | |
| Ph | 1 | 4 | 3 | *Sabal palmetto* | 503.4 | 9 | 48.5 | 1 | | | | | | |
| Ph | 1 | 4 | 4 | *Sabal palmetto* | 3356.7 | 9 | 16.2 | 1 | | | | | | |
| Ph | 1 | 4 | 5 | *Sabal palmetto* | 50.3 | 9 | | 1 | | | | | | |
| Ph | 2 | 4 | 1 | *Pinus elliottii* | 59.3 | 3 | 56.6 | 6 | 76.9 | 4 | 55.0 | 5 | | |
| Ph | 2 | 4 | 1 | *Sabal palmetto* | 21.6 | 3 | 94.4 | 6 | 44.5 | 4 | 38.8 | 5 | | |
| Ph | 2 | 4 | 1.5 | *Pinus elliottii* | | 3 | 8.1 | 6 | | 4 | | 5 | | |
| Ph | 2 | 4 | 1.5 | *Sabal palmetto* | 10.8 | 3 | 5.4 | 6 | | 4 | 29.1 | 5 | | |
| Ph | 2 | 4 | 2 | *Pinus elliottii* | | 3 | 18.9 | 6 | 8.1 | 4 | | 5 | | |
| Ph | 2 | 4 | 2 | *Sabal palmetto* | 5.4 | 3 | 27.0 | 6 | 28.3 | 4 | 32.4 | 5 | | |
| Ph | 2 | 4 | 3 | *Sabal palmetto* | 183.4 | 3 | 210.4 | 6 | 105.2 | 4 | 268.6 | 5 | | |
| Ph | 2 | 4 | 4 | *Sabal palmetto* | 1132.7 | 3 | 480.0 | 6 | 279.1 | 4 | 857.6 | 5 | | |
| Ph | 2 | 4 | 5 | *Sabal palmetto* | 75.5 | 3 | 62.0 | 6 | 129.4 | 4 | 90.6 | 5 | | |
| Ph | 3 | 4 | 1 | *Pinus elliottii* | 32.4 | 3 | | | 109.2 | 4 | | | 80.9 | 1 |
| Ph | 3 | 4 | 1 | *Sabal palmetto* | 48.5 | 3 | | | 40.5 | 4 | | | 32.4 | 1 |
| Ph | 3 | 4 | 1.5 | *Sabal palmetto* | 5.4 | 3 | | | | 4 | | | 32.4 | 1 |
| Ph | 3 | 4 | 2 | *Pinus elliottii* | | 3 | | | 190.1 | 4 | | | | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ph | 3 | 4 | 2 | *Sabal palmetto* | 43.1 | 3 | | | 4.0 | 4 | | | | 1 |
| Ph | 3 | 4 | 3 | *Sabal palmetto* | 550.2 | 3 | | | 161.8 | 4 | | | 307.4 | 1 |
| Ph | 3 | 4 | 4 | *Sabal palmetto* | 1769.1 | 3 | | | 687.7 | 4 | | | 970.9 | 1 |
| Ph | 3 | 4 | 5 | *Sabal palmetto* | 75.5 | 3 | | | 307.4 | 4 | | | | 1 |
| Pm | 1 | 4 | 1 | *Pinus elliottii* | | | | | 48.5 | 1 | | | | |
| Pm | 1 | 4 | 1 | *Sabal palmetto* | | | | | 16.2 | 1 | | | | |
| Pm | 1 | 4 | 1.5 | *Sabal palmetto* | | | | | 16.2 | 1 | | | | |
| Pm | 1 | 4 | 2 | *Sabal palmetto* | | | | | 48.5 | 1 | | | | |
| Pm | 1 | 4 | 3 | *Sabal palmetto* | | | | | 226.5 | 1 | | | | |
| Pm | 1 | 4 | 4 | *Sabal palmetto* | | | | | 291.3 | 1 | | | | |
| Pm | 1 | 4 | 5 | *Sabal palmetto* | | | | | 258.9 | 1 | | | | |
| Pm | 2 | 4 | 1 | *Pinus elliottii* | 52.9 | 15 | | | 80.9 | 1 | | | | |
| Pm | 2 | 4 | 1 | *Sabal palmetto* | 115.4 | 15 | | | 16.2 | 1 | | | | |
| Pm | 2 | 4 | 1.5 | *Pinus elliottii* | 3.2 | 15 | | | | 1 | | | | |
| Pm | 2 | 4 | 1.5 | *Sabal palmetto* | 7.6 | 15 | | | | 1 | | | | |
| Pm | 2 | 4 | 2 | *Pinus elliottii* | 4.3 | 15 | | | 48.5 | 1 | | | | |
| Pm | 2 | 4 | 2 | *Sabal palmetto* | 35.6 | 15 | | | | 1 | | | | |
| Pm | 2 | 4 | 3 | *Sabal palmetto* | 343.0 | 15 | | | 32.4 | 1 | | | | |
| Pm | 2 | 4 | 4 | *Sabal palmetto* | 1181.2 | 15 | | | 129.4 | 1 | | | | |
| Pm | 2 | 4 | 5 | *Sabal palmetto* | 34.5 | 15 | | | 404.5 | 1 | | | | |
| Pm | 3 | 0 | 1 | *Pinus elliottii* | | | 64.7 | 2 | 64.7 | 4 | | | | |
| Pm | 3 | 0 | 1 | *Sabal palmetto* | | | 97.1 | 2 | 56.6 | 4 | | | | |
| Pm | 3 | 0 | 1.5 | *Pinus elliottii* | | | | 2 | 4.0 | 4 | | | | |
| Pm | 3 | 0 | 2 | *Pinus elliottii* | | | 80.9 | 2 | 8.1 | 4 | | | | |
| Pm | 3 | 0 | 2 | *Sabal palmetto* | | | 80.9 | 2 | 12.1 | 4 | | | | |
| Pm | 3 | 0 | 3 | *Sabal palmetto* | | | 404.5 | 2 | 169.9 | 4 | | | | |
| Pm | 3 | 0 | 4 | *Sabal palmetto* | | | 784.8 | 2 | 614.9 | 4 | | | | |
| Pm | 3 | 0 | 5 | *Sabal palmetto* | | | 242.7 | 2 | 113.3 | 4 | | | | |
| Pp | 1 | 4 | 1 | *Pinus elliottii* | 83.6 | 6 | | | | | | | | |
| Pp | 1 | 4 | 1 | *Sabal palmetto* | 75.5 | 6 | | | | | | | | |
| Pp | 1 | 4 | 1.5 | *Pinus elliottii* | 2.7 | 6 | | | | | | | | |
| Pp | 1 | 4 | 1.5 | *Sabal palmetto* | 32.4 | 6 | | | | | | | | |
| Pp | 1 | 4 | 2 | *Pinus elliottii* | 10.8 | 6 | | | | | | | | |
| Pp | 1 | 4 | 2 | *Sabal palmetto* | 70.1 | 6 | | | | | | | | |
| Pp | 1 | 4 | 3 | *Sabal palmetto* | 501.6 | 6 | | | | | | | | |
| Pp | 1 | 4 | 4 | *Sabal palmetto* | 2527.0 | 6 | | | | | | | | |
| Pp | 1 | 4 | 5 | *Sabal palmetto* | 16.2 | 6 | | | | | | | | |
| Pp | 2 | 4 | 1 | *Pinus elliottii* | 86.3 | 3 | | | | | | | | |
| Pp | 2 | 4 | 1 | *Sabal palmetto* | 86.3 | 3 | | | | | | | | |
| Pp | 2 | 4 | 1.5 | *Sabal palmetto* | 21.6 | 3 | | | | | | | | |
| Pp | 2 | 4 | 2 | *Sabal palmetto* | 53.9 | 3 | | | | | | | | |
| Pp | 2 | 4 | 3 | *Sabal palmetto* | 329.0 | 3 | | | | | | | | |
| Pp | 2 | 4 | 4 | *Sabal palmetto* | 2518.9 | 3 | | | | | | | | |
| Pp | 2 | 4 | 5 | *Sabal palmetto* | 145.6 | 3 | | | | | | | | |

**Table 6: Density of dominant tree species by location, habitat, and time since last fire.**

| NRCS Habitat | Fire | Strata | Scientific Name | FPNWR Density (trees/acre) | n | FPNWR (Control) Density (trees/acre) | n | PSSF (Event 0 - 2004) Density (trees/acre) | n | PSSF (Event 4 – 2005) Density (trees/acre) | n | FSPSP Density (trees/acre) | n | FSPSP (Control) Density (trees/acre) | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 2 | 1 | *Sabal palmetto* | | | | | | | | | 16.2 | 1 | | |
| C | 2 | 1.5 | *Sabal palmetto* | | | | | | | | | 48.5 | 1 | | |
| C | 2 | 3 | *Sabal palmetto* | | | | | | | | | 404.5 | 1 | | |
| C | 2 | 4 | *Sabal palmetto* | | | | | | | | | 48.5 | 1 | | |
| C | 3 | 1 | *Taxodium ascendens* | | | 97.1 | 1 | 275.1 | 2 | 265.4 | 5 | 124.1 | 3 | 307.4 | 2 |
| C | 3 | 2 | *Taxodium ascendens* | | | 161.8 | 1 | 24.3 | 2 | 556.6 | 5 | 318.2 | 3 | 186.1 | 2 |
| C | 3 | 1 | *Sabal palmetto* | | | | | 40.5 | 2 | 3.2 | 5 | 48.5 | 3 | 8.1 | 2 |
| C | 3 | 1.5 | *Sabal palmetto* | | | | | | | | | 37.8 | 3 | 16.2 | 2 |
| C | 3 | 2 | *Sabal palmetto* | | | | | | | 3.2 | 5 | 5.4 | 3 | | |
| C | 3 | 3 | *Sabal palmetto* | | | | | 40.5 | 2 | 68.0 | 5 | 124.1 | 3 | 40.5 | 2 |
| C | 3 | 4 | *Sabal palmetto* | | | 64.7 | 1 | 210.4 | 2 | 391.6 | 5 | 345.2 | 3 | 121.4 | 2 |
| C | 3 | 5 | *Sabal palmetto* | | | 16.2 | 2 | 8.1 | 2 | 29.1 | 5 | 679.6 | 3 | | |
| C | 3 | 1 | *Quercus laurifolia* | | | | | 8.1 | 2 | 19.4 | 5 | 5.4 | 3 | | |
| C | 3 | 2 | *Quercus laurifolia* | | | | | | | 3.2 | 5 | 21.6 | 3 | | |
| Cg | 1 | 1 | *Taxodium ascendens* | 70.1 | 3 | | | | | | | | | | |
| Cg | 1 | 2 | *Taxodium ascendens* | 10.8 | 3 | | | | | | | | | | |
| Cg | 1 | 1 | *Sabal palmetto* | 27.0 | 3 | | | | | | | | | | |
| Cg | 1 | 2 | *Sabal palmetto* | 5.4 | 3 | | | | | | | | | | |
| Cg | 1 | 3 | *Sabal palmetto* | 53.9 | 3 | | | | | | | | | | |
| Cg | 1 | 4 | *Sabal palmetto* | 307.4 | 3 | | | | | | | | | | |
| Cg | 2 | 1 | *Taxodium ascendens* | 598.7 | 1 | | | | | 24.3 | 2 | | | | |
| Cg | 2 | 2 | *Taxodium ascendens* | 307.4 | 1 | | | | | 48.5 | 2 | 8.1 | 2 | | |
| Cg | 2 | 1 | *Sabal palmetto* | | | | | 129.4 | 1 | 64.7 | 2 | 137.5 | 2 | | |
| Cg | 2 | 1.5 | *Sabal palmetto* | | | | | 32.4 | 1 | | | | | | |

| NRCS Habitat | Fire | Strata | Scientific Name | FPNWR Density (trees/acre) | n | FPNWR (Control) Density (trees/acre) | n | PSSF (Event 0 - 2004) Density (trees/acre) | n | PSSF (Event 4 – 2005) Density (trees/acre) | n | FSPSP Density (trees/acre) | n | FSPSP (Control) Density (trees/acre) | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cg | 2 | 2 | *Sabal palmetto* | | | | | 32.4 | 1 | 16.2 | 2 | 56.6 | 2 | | |
| Cg | 2 | 3 | *Sabal palmetto* | | | | | 32.4 | 1 | 32.4 | 2 | 752.4 | 2 | | |
| Cg | 2 | 4 | *Sabal palmetto* | | | | | 2912.6 | 1 | 396.4 | 2 | 857.6 | 2 | | |
| Cg | 2 | 5 | *Sabal palmetto* | | | | | 7993.5 | 1 | 210.4 | 2 | 178.0 | 2 | | |
| Cg | 2 | 2 | *Quercus virginiana* | | | | | 32.4 | 1 | | | | | | |
| Cg | 2 | 1 | *Quercus laurifolia* | | | | | | | 16.2 | 2 | | | | |
| Cg | 3 | 1 | *Taxodium ascendens* | | | | | 129.4 | 2 | 194.2 | 1 | | | | |
| Cg | 3 | 2 | *Taxodium ascendens* | | | | | 56.6 | 2 | 129.4 | 1 | | | | |
| Cg | 3 | 1 | *Sabal palmetto* | | | | | 153.7 | 2 | | | | | | |
| Cg | 3 | 2 | *Sabal palmetto* | | | | | 32.4 | 2 | | | | | | |
| Cg | 3 | 3 | *Sabal palmetto* | | | | | 186.1 | 2 | 161.8 | 1 | | | | |
| Cg | 3 | 4 | *Sabal palmetto* | | | | | 614.9 | 2 | 307.4 | 1 | | | | |
| Cg | 3 | 5 | *Sabal palmetto* | | | | | 80.9 | 2 | 32.4 | 1 | | | | |
| Ch | 3 | 1 | *Taxodium ascendens* | | | | | 205.0 | 3 | 242.7 | 1 | | | | |
| Ch | 3 | 2 | *Taxodium ascendens* | | | | | 27.0 | 3 | 80.9 | 1 | | | | |
| Ch | 3 | 1 | *Sabal palmetto* | | | | | 64.7 | 3 | 48.5 | 1 | | | | |
| Ch | 3 | 1.5 | *Sabal palmetto* | | | | | 27.0 | 3 | | | | | | |
| Ch | 3 | 2 | *Sabal palmetto* | | | | | 53.9 | 3 | 48.5 | 1 | | | | |
| Ch | 3 | 3 | *Sabal palmetto* | | | | | 528.6 | 3 | 291.3 | 1 | | | | |
| Ch | 3 | 4 | *Sabal palmetto* | | | | | 695.8 | 3 | 550.2 | 1 | | | | |
| Ch | 3 | 5 | *Sabal palmetto* | | | | | 113.3 | 3 | 16.2 | 1 | | | | |
| Ch | 3 | 1 | *Quercus laurifolia* | | | | | | | 80.9 | 1 | | | | |
| Ch | 3 | 2 | *Quercus laurifolia* | | | | | | | 48.5 | 1 | | | | |
| Cx | 2 | 1 | *Taxodium ascendens* | | | | | | | 80.9 | 1 | | | | |
| Cx | 2 | 1 | *Sabal palmetto* | | | | | | | 16.2 | 1 | | | | |
| Cx | 2 | 3 | *Sabal palmetto* | | | | | | | 614.9 | 1 | | | | |

| NRCS Habitat | Fire | Strata | Scientific Name | FPNWR Density (trees/acre) | n | FPNWR (Control) Density (trees/acre) | n | PSSF (Event 0 - 2004) Density (trees/acre) | n | PSSF (Event 4 – 2005) Density (trees/acre) | n | FSPSP Density (trees/acre) | n | FSPSP (Control) Density (trees/acre) | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cx | 2 | 4 | *Sabal palmetto* | | | | | | | 1230.0 | 1 | | | | |
| Cx | 2 | 5 | *Sabal palmetto* | | | | | | | 161.8 | 1 | | | | |
| Cx | 3 | 1 | *Taxodium ascendens* | | | | | | | 8.1 | 2 | | | | |
| Cx | 3 | 1 | *Sabal palmetto* | | | | | | | 24.3 | 2 | | | | |
| Cx | 3 | 1.5 | *Sabal palmetto* | | | | | | | 24.3 | 2 | | | | |
| Cx | 3 | 2 | *Sabal palmetto* | | | | | | | 16.2 | 2 | | | | |
| Cx | 3 | 3 | *Sabal palmetto* | | | | | | | 48.5 | 2 | | | | |
| Cx | 3 | 4 | *Sabal palmetto* | | | | | | | 865.7 | 2 | | | | |
| Cx | 3 | 5 | *Sabal palmetto* | | | | | | | 299.4 | 2 | | | | |
| G | 1 | 1 | *Taxodium ascendens* | 1.3 | 12 | | | | | | | | | | |
| G | 1 | 1 | *Sabal palmetto* | 22.9 | 12 | | | | | | | | | | |
| G | 1 | 2 | *Taxodium ascendens* | 1.3 | 12 | | | | | | | | | | |
| G | 1 | 2 | *Sabal palmetto* | 10.8 | 12 | | | | | | | | | | |
| G | 1 | 3 | *Sabal palmetto* | 111.9 | 12 | | | | | | | | | | |
| G | 1 | 4 | *Sabal palmetto* | 779.4 | 12 | | | | | | | | | | |
| G | 1 | 5 | *Sabal palmetto* | 21.6 | 12 | | | | | | | | | | |
| G | 2 | 1 | *Taxodium ascendens* | | | 16.2 | 1 | 8.1 | 4 | | | | | | |
| G | 2 | 1 | *Sabal palmetto* | 86.3 | 3 | | | 8.1 | 4 | | | 5.4 | 3 | | |
| G | 2 | 2 | *Taxodium ascendens* | | | 16.2 | 1 | | | 2.7 | 6 | | | | |
| G | 2 | 2 | *Sabal palmetto* | 43.1 | 3 | 32.4 | 1 | 4.0 | 4 | | | | | | |
| G | 2 | 3 | *Sabal palmetto* | 134.8 | 3 | | | 24.3 | 4 | 5.4 | 6 | 16.2 | 3 | | |
| G | 2 | 4 | *Sabal palmetto* | 1591.2 | 3 | 323.6 | 1 | 76.9 | 4 | 27.0 | 6 | 70.1 | 3 | | |
| G | 2 | 5 | *Sabal palmetto* | 97.1 | 3 | 16.2 | 1 | 8.1 | 4 | | | 16.2 | 3 | | |
| G | 3 | 1 | *Sabal palmetto* | 5.4 | 3 | | | | | | | | | | |
| G | 3 | 3 | *Sabal palmetto* | 16.2 | 3 | | | | | | | 16.2 | 1 | | |
| G | 3 | 4 | *Sabal palmetto* | 102.5 | 3 | | | 48.5 | 1 | | | 129.4 | 1 | | |

| NRCS Habitat | Fire | Strata | Scientific Name | FPNWR Density (trees/acre) | n | FPNWR (Control) Density (trees/acre) | n | PSSF (Event 0 - 2004) Density (trees/acre) | n | PSSF (Event 4 – 2005) Density (trees/acre) | n | FSPSP Density (trees/acre) | n | FSPSP (Control) Density (trees/acre) | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G | 3 | 2 | *Taxodium ascendens* | | | | | 32.4 | 1 | 16.2 | 1 | | | | |
| G/Mf | 2 | 1 | *Sabal palmetto* | 2.7 | 6 | | | | | | | | | | |
| G/Mf | 2 | 2 | *Sabal palmetto* | 8.1 | 6 | | | | | | | | | | |
| G/Mf | 2 | 3 | *Sabal palmetto* | 27.0 | 6 | | | | | | | | | | |
| G/Mf | 2 | 4 | *Sabal palmetto* | 377.6 | 6 | | | | | | | | | | |
| G/Mf | 2 | 5 | *Sabal palmetto* | 5.4 | 6 | | | | | | | | | | |
| Gx | 1 | 1 | *Sabal palmetto* | 32.4 | 2 | | | | | 16.2 | 1 | | | | |
| Gx | 1 | 2 | *Sabal palmetto* | 16.2 | 2 | | | | | | | | | | |
| Gx | 1 | 3 | *Sabal palmetto* | 72.8 | 2 | | | | | 32.4 | 1 | | | | |
| Gx | 1 | 4 | *Sabal palmetto* | 396.4 | 2 | | | | | 420.7 | 1 | | | | |
| Gx | 1 | 5 | *Sabal palmetto* | 8.1 | 2 | | | | | | | | | | |
| Hh | 2 | 1 | *Taxodium ascendens* | | | | | 32.4 | 1 | 32.4 | 4 | | | | |
| Hh | 2 | 1 | *Sabal palmetto* | | | | | 97.1 | 1 | 113.3 | 4 | | | | |
| Hh | 2 | 1 | *Quercus laurifolia* | | | | | 32.4 | 1 | 60.7 | 4 | | | | |
| Hh | 2 | 2 | *Sabal palmetto* | | | | | 48.5 | 1 | 28.3 | 4 | | | | |
| Hh | 2 | 3 | *Sabal palmetto* | | | | | 48.5 | 1 | 169.9 | 4 | | | | |
| Hh | 2 | 4 | *Sabal palmetto* | | | | | 275.1 | 1 | 1165.1 | 4 | | | | |
| Hh | 2 | 5 | *Sabal palmetto* | | | | | 647.2 | 1 | 327.7 | 4 | | | | |
| Hh | 3 | 1 | *Quercus virginiana* | | | | | | | 4.0 | 4 | | | | |
| Hh | 3 | 2 | *Taxodium ascendens* | | | | | | | 4.0 | 4 | | | | |
| Hh | 3 | 2 | *Quercus laurifolia* | | | | | | | 28.3 | 4 | | | | |
| Hp | 2 | 1 | *Sabal palmetto* | | | | | | | 280.5 | 3 | | | | |
| Hp | 2 | 1.5 | *Sabal palmetto* | | | | | | | 32.4 | 3 | | | | |
| Hp | 2 | 2 | *Sabal palmetto* | | | | | | | 43.1 | 3 | | | | |
| Hp | 2 | 3 | *Sabal palmetto* | | | | | | | 253.5 | 3 | | | | |
| Hp | 2 | 4 | *Sabal palmetto* | | | | | | | 496.2 | 3 | | | | |

| NRCS Habitat | Fire | Strata | Scientific Name | FPNWR Density (trees/acre) | n | FPNWR (Control) Density (trees/acre) | n | PSSF (Event 0 - 2004) Density (trees/acre) | n | PSSF (Event 4 – 2005) Density (trees/acre) | n | FSPSP Density (trees/acre) | n | FSPSP (Control) Density (trees/acre) | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hp | 2 | 5 | *Sabal palmetto* | | | | | | | 1289.1 | 3 | | | | |
| Hp | 3 | 1 | *Sabal palmetto* | | | | | | | 97.1 | 2 | | | | |
| Hp | 3 | 1 | *Quercus laurifolia* | | | | | | | 40.5 | 2 | | | | |
| Hp | 3 | 1.5 | *Sabal palmetto* | | | | | | | 48.5 | 2 | | | | |
| Hp | 3 | 3 | *Sabal palmetto* | | | | | | | 145.6 | 2 | | | | |
| Hp | 3 | 4 | *Sabal palmetto* | | | | | | | 760.5 | 2 | | | | |
| Hp | 3 | 5 | *Sabal palmetto* | | | | | | | 590.6 | 2 | | | | |
| Mf | 3 | 1.5 | *Sabal palmetto* | 3.2 | 5 | | | | | | | | | | |
| Mf | 3 | 2 | *Sabal palmetto* | 6.5 | 5 | | | | | | | | | | |
| Mf | 3 | 3 | *Sabal palmetto* | 29.1 | 5 | | | | | | | | | | |
| Mf | 3 | 4 | *Sabal palmetto* | 74.4 | 5 | | | | | | | | | | |

Effects of Hurricane Wilma on Belt Transects

The eye of hurricane Wilma passed directly over the study area with 120 mph sustained winds on October 24, 2005. This natural event took place during on-going sampling at FPNWR for the Everglades reprogramming funded sampling at the FPNWR, but after all sampling on PSSF and FSPSP had been completed. At least on pinelands of FPNWR, this provided an excellent opportunity to document the effects of the storm while continuing sampling. All downed trees were counted and notes were made as to the type of damage and the direction of the fall. The data was then analyzed as though there were two sampling events, before and after the storm (n=27 transects). These data are presented and discussed in the FPNWR report (Barry 2006).

The greatest change in density in the pinelands occurred with slash pine overstory which dropped from 73 to 66 trees/acre (a 9% decrease). Additional slash pine mortality likely occurred following the severe drought (March-June 2006) through pine bark beetle infestations on the storm damaged, drought weakened pines (personal observations). Most trees were uprooted and fell predominantly towards the southeast which is consistent with reports of the strongest winds occurring as the eye passed to the east and interacted with the high pressure from the cold front to the north. Although no mortality was observed in overstory cabbage palms (stratum 1), tall bootless palms with adventitious roots (strata 1.5), presumed to be "old growth", declined from 17.4 to 16.7 trees/acre (a 3% decrease). Many of these palms snapped at weak points in the stem, all of which had char that appeared to have been created by past fires. A few did uproot when on shallow soils over cap rock, and afterward some continued to survive on the ground.

In other habitats, especially hammock areas (unfortunately not sampled at FPNWR), the damage appeared to be more severe (personal observations by authors). For example, at FSPSP, many very large laurel oaks had been completely uprooted thus the resistance of the laurel oaks in the pinelands (no mortality observed at FPNWR pineland transects) may be a factor of their relatively small stature.

It may be advisable to re-sample at least some of the belt transects before the 2007 storm season in at least some of these other habitats at PSSF to be able to separate effects of hydrological restoration from storm damage. In general, a 10% reduction in pine canopy at PSSF could be attributed to Wilma by the extrapolation of FPNWR tree damage; however, we are unable to make predictions in hammocks without additional sampling.

Line Intercept Data

Combined line intercept data summarized by transect is presented in the database Line_intercept_analysis.mdb. These data were also analyzed by location, habitat, and fire, but the table (with all 61 species) is too large to present here. However, data for total shrub cover, separating other species from cabbage palm and saw palmetto, is presented in Table 7. Highest shrub coverage was surprisingly found in the relatively more intensely fire managed pinelands of the FPNWR (>100%). These data may be somewhat misleading as shrub diversity is higher in these areas and there is significant overlap; however these areas are often dense in the shrub layer, even when cabbage palm coverage is not included. There may be soil differences to account for some of this as well as season of controlled burns. Consistent with belt transect data, the pinelands of FPNWR have similar overall shrub cover (including palms) as the degraded cypress, especially cypress with graminoid (Cg) and cabbage palm hammock (Hp) which was formerly cypress with graminoid (Cg), on PSSF.

Coverage by Brazilian-pepper, the most prevalent exotic shrub species, is presented and discussed in the FPNWR report (Barry 2006). The areas with the highest coverage were found throughout PSSF and in the areas of FSPSP along the Prairie Canal as these areas suffered the most disturbance. Only one habitat, pine with palms (Pp), showed significant coverage at FPNWR (n=3), and this is not surprising as these areas represent a transition to hydric hammock with less intense fire allowing Brazilian-pepper to establish. Significant coverage (>30%) was found in drained cypress communities (C, Cg), including transects designated as cabbage palm hammock (Hp) at PSSF which were historically cypress with graminoid understory (Cg) (n=2 transects). Only one control site had significant coverage of Brazilian-pepper with 13% found in the strand swamp at FSPSP (n=1).

**Table 7: Total shrub cover by habitat, location, time since fire, sampling event.**

| NRCS Habitat | Location | Control | FIRE | Event # | n | All other (Cover) | *Sabal palmetto* (Cover) | *Serenoa repens* (Cover) | Total (Cover) |
|---|---|---|---|---|---|---|---|---|---|
| C | FPNWR | TRUE | 3 | 4 | 1 | 20.20 | 0.20 | | 20.40 |
| C | FSPSP | TRUE | 3 | 4 | 2 | 27.30 | 4.30 | | 31.60 |
| C | FSPSP | | 2 | 0 | 1 | 4.20 | 3.00 | | 7.20 |
| C | FSPSP | | 3 | 0 | 3 | 77.73 | 11.53 | | 89.27 |
| C | PSSF | | 3 | 0 | 2 | 58.70 | 4.60 | | 63.30 |
| C | PSSF | | 3 | 4 | 5 | 59.12 | 5.04 | 2.68 | 66.84 |
| Cg | FPNWR | TRUE | 2 | 4 | 1 | 2.90 | | | 2.90 |
| Cg | FPNWR | | 1 | 1 | 13 | 7.20 | 1.18 | 0.03 | 8.42 |
| Cg | FPNWR | | 1 | 2 | 13 | 9.66 | 1.51 | 0.31 | 11.48 |
| Cg | FPNWR | | 1 | 3 | 10 | 11.94 | | 0.36 | 12.30 |
| Cg | FPNWR | | 1 | 4 | 3 | 16.33 | 7.67 | 0.60 | 24.60 |
| Cg | FPNWR | | 2 | 0 | 14 | 18.86 | 1.74 | 0.27 | 20.87 |
| Cg | FPNWR | | 2 | 3 | 3 | 12.87 | 4.53 | 0.73 | 18.13 |
| Cg | FSPSP | | 2 | 0 | 2 | 106.40 | 35.80 | | 142.20 |
| Cg | PSSF | | 2 | 0 | 1 | 97.40 | 9.40 | | 106.80 |
| Cg | PSSF | | 2 | 4 | 2 | 19.10 | 5.00 | | 24.10 |
| Cg | PSSF | | 3 | 0 | 2 | 48.30 | 12.80 | | 61.10 |
| Cg | PSSF | | 3 | 4 | 1 | 27.00 | 5.20 | | 32.20 |
| Ch | PSSF | | 3 | 0 | 3 | 87.27 | 53.87 | | 141.13 |
| Ch | PSSF | | 3 | 4 | 1 | 33.40 | 32.60 | | 66.00 |
| Cx | PSSF | | 2 | 4 | 1 | 56.90 | 26.80 | | 83.70 |
| Cx | PSSF | | 3 | 4 | 2 | 107.25 | 3.15 | | 110.40 |
| G | FPNWR | TRUE | 1 | 1 | 1 | 6.60 | 4.80 | 0.40 | 11.80 |
| G | FPNWR | TRUE | 2 | 0 | 1 | 2.00 | 0.40 | | 2.40 |
| G | FPNWR | TRUE | 2 | 4 | 2 | 4.90 | 0.60 | | 5.50 |
| G | FPNWR | | 1 | 1 | 50 | 5.11 | 1.89 | 0.13 | 7.13 |
| G | FPNWR | | 1 | 2 | 46 | 7.25 | 3.19 | 0.11 | 10.55 |
| G | FPNWR | | 1 | 3 | 15 | 10.85 | 1.91 | | 12.76 |

| NRCS Habitat | Location | Control | FIRE | Event # | n | All other (Cover) | ***Sabal palmetto*** (Cover) | ***Serenoa repens*** (Cover) | Total (Cover) |
|---|---|---|---|---|---|---|---|---|---|
| G | FPNWR | | 1 | 4 | 12 | 8.90 | 5.58 | 0.48 | 14.97 |
| G | FPNWR | | 2 | 0 | 63 | 9.54 | 2.03 | 0.18 | 11.76 |
| G | FPNWR | | 2 | 1 | 1 | 1.20 | 1.20 | | 2.40 |
| G | FPNWR | | 2 | 3 | 23 | 16.05 | 6.74 | 0.87 | 23.66 |
| G | FPNWR | | 2 | 4 | 3 | 4.87 | 2.87 | | 7.73 |
| G | FPNWR | | 3 | 4 | 3 | 5.20 | 0.47 | | 5.67 |
| G | FSPSP | | 2 | 0 | 3 | 4.87 | 2.07 | 2.20 | 9.13 |
| G | FSPSP | | 3 | 0 | 1 | 4.60 | 4.60 | | 9.20 |
| G | PSSF | | 1 | 4 | 1 | 13.60 | | | 13.60 |
| G | PSSF | | 2 | 0 | 3 | 6.40 | 1.27 | | 7.67 |
| G | PSSF | | 2 | 4 | 6 | 4.97 | 0.13 | | 5.10 |
| G | PSSF | | 3 | 0 | 1 | 5.20 | | | 5.20 |
| G | PSSF | | 3 | 4 | 1 | 3.40 | | | 3.40 |
| G/Mf | FPNWR | | 1 | 1 | 5 | 3.68 | 2.56 | | 6.24 |
| G/Mf | FPNWR | | 1 | 2 | 5 | 4.68 | 3.52 | | 8.20 |
| G/Mf | FPNWR | | 2 | 0 | 5 | 4.80 | 2.68 | | 7.48 |
| G/Mf | FPNWR | | 2 | 3 | 6 | 2.97 | 1.80 | | 4.77 |
| G/Mf | FPNWR | | 2 | 4 | 6 | 4.20 | 2.53 | | 6.73 |
| Gx | FPNWR | | 1 | 1 | 3 | 11.67 | 8.67 | | 20.33 |
| Gx | FPNWR | | 1 | 2 | 3 | 16.00 | 12.13 | | 28.13 |
| Gx | FPNWR | | 1 | 4 | 3 | 3.47 | 3.47 | | 6.93 |
| Gx | FPNWR | | 2 | 0 | 3 | 9.73 | 6.13 | | 15.87 |
| Gx | FPNWR | | 2 | 3 | 3 | 12.40 | 7.27 | | 19.67 |
| Gx | PSSF | | 3 | 4 | 1 | 8.40 | 2.40 | | 10.80 |
| Hh | PSSF | | 2 | 0 | 1 | 81.20 | 14.40 | | 95.60 |
| Hh | PSSF | | 3 | 4 | 4 | 69.18 | 14.28 | | 83.45 |
| Hp | PSSF | | 2 | 4 | 3 | 51.33 | 22.33 | 1.53 | 75.20 |
| Hp | PSSF | | 3 | 4 | 2 | 64.50 | 12.00 | | 76.50 |
| Mf | FPNWR | | 2 | 0 | 3 | 2.33 | 2.33 | | 4.67 |
| Mf | FPNWR | | 2 | 1 | 4 | 2.10 | 1.50 | | 3.60 |
| Mf | FPNWR | | 3 | 4 | 3 | 5.93 | 2.07 | | 8.00 |
| Mf | PSSF | | 3 | 4 | 2 | 68.30 | | | 68.30 |
| Ms | TTINWR | | 3 | 4 | 4 | 11.60 | | | 11.60 |
| Ph | FPNWR | TRUE | 1 | 1 | 1 | 30.80 | 5.20 | 19.40 | 55.40 |
| Ph | FPNWR | TRUE | 2 | 0 | 2 | 54.80 | 18.70 | 25.30 | 98.80 |
| Ph | FPNWR | TRUE | 2 | 4 | 2 | 64.20 | 20.10 | 25.90 | 110.20 |
| Ph | FPNWR | | 1 | 1 | 56 | 20.20 | 11.15 | 5.01 | 36.36 |
| Ph | FPNWR | | 1 | 2 | 50 | 39.08 | 23.75 | 9.40 | 72.23 |
| Ph | FPNWR | | 1 | 3 | 23 | 53.92 | 29.90 | 16.37 | 100.18 |
| Ph | FPNWR | | 1 | 4 | 9 | 60.51 | 35.22 | 14.53 | 110.27 |
| Ph | FPNWR | | 2 | 0 | 69 | 56.29 | 29.99 | 15.14 | 101.41 |
| Ph | FPNWR | | 2 | 3 | 17 | 54.47 | 29.42 | 10.38 | 94.27 |
| Ph | FPNWR | | 3 | 4 | 3 | 90.60 | 25.80 | 36.13 | 152.53 |
| Ph | FSPSP | TRUE | 3 | 4 | 1 | 89.40 | 24.40 | 23.60 | 137.40 |
| Ph | FSPSP | | 2 | 0 | 5 | 19.72 | 16.04 | 1.32 | 37.08 |

| NRCS Habitat | Location | Control | FIRE | Event # | n | All other (Cover) | *Sabal palmetto* (Cover) | *Serenoa repens* (Cover) | Total (Cover) |
|---|---|---|---|---|---|---|---|---|---|
| Ph | PSSF | | 1 | 0 | 1 | 55.60 | | | 55.60 |
| Ph | PSSF | | 2 | 0 | 6 | 35.83 | 13.30 | | 49.13 |
| Ph | PSSF | | 2 | 4 | 4 | 44.65 | 5.80 | | 50.45 |
| Ph | PSSF | | 3 | 4 | 4 | 28.55 | 20.35 | 1.95 | 50.85 |
| Pm | FPNWR | | 1 | 1 | 24 | 42.13 | 10.32 | 22.57 | 75.02 |
| Pm | FPNWR | | 1 | 2 | 16 | 67.66 | 15.54 | 36.70 | 119.90 |
| Pm | FPNWR | | 1 | 3 | 7 | 71.09 | 10.60 | 44.63 | 126.31 |
| Pm | FPNWR | | 2 | 0 | 30 | 100.11 | 20.46 | 57.23 | 177.80 |
| Pm | FPNWR | | 2 | 3 | 9 | 110.20 | 29.91 | 48.31 | 188.42 |
| Pm | FPNWR | | 2 | 4 | 15 | 125.77 | 29.49 | 57.55 | 212.81 |
| Pm | PSSF | | 1 | 4 | 1 | 58.80 | 11.20 | 43.60 | 113.60 |
| Pm | PSSF | | 2 | 4 | 1 | 43.60 | 1.60 | 25.20 | 70.40 |
| Pm | PSSF | | 3 | 0 | 2 | 54.60 | 31.20 | 9.60 | 95.40 |
| Pm | PSSF | | 3 | 4 | 4 | 77.00 | 16.70 | 35.75 | 129.45 |
| Pp | FPNWR | | 1 | 1 | 9 | 49.58 | 28.51 | 7.96 | 86.04 |
| Pp | FPNWR | | 1 | 2 | 9 | 64.91 | 39.20 | 11.49 | 115.60 |
| Pp | FPNWR | | 1 | 4 | 6 | 84.80 | 44.70 | 18.50 | 148.00 |
| Pp | FPNWR | | 2 | 0 | 9 | 79.29 | 41.82 | 17.20 | 138.31 |
| Pp | FPNWR | | 2 | 3 | 9 | 96.73 | 52.51 | 18.56 | 167.80 |
| Pp | FPNWR | | 2 | 4 | 3 | 86.47 | 47.93 | 13.80 | 148.20 |

Cabbage palm was the shrub species (when measured using the line intercept method) was the most significant as an indicator of hydrological change. Coverage of cabbage palm when greater than 5% (sorted descending by percent cover) is presented in Table 8. Data collected less than 1 year since fire (FIRE=1) was eliminated from the comparison because it would attribute change in coverage to fire (not hydrology), however one year is sufficient time for shrub species to resprout. Percent cover of cabbage palms in pinelands of FPNWR was potentially significant, nearly all greater than 20% with an average approaching 50% for the hydric flatwoods with significant presence of “old growth” palms (Pp). In pinelands at PSSF the range was lower by up to 30% in transects in fire suppressed (FIRE=3) transects. Coverage in pinelands of FPNWR was similar to cypress with graminoid (Cg), cabbage palm hammock (Hp) (former cypress with graminoid), disturbed cypress (Cx), and hydric hammock (Hh) in PSSF which is consistent with the trend observed in the belt transect analysis. The drier conditions of the pinelands on PSSF may stunt growth and recruitment relative to FPNWR, as mentioned above in the belt transect analysis. Edaphic characteristics of the sites are also different. The high density transects in FPNWR are found on the east side of the Fakahatchee with more marl and soils similar to those in the neighboring Big Cypress National Preserve.

**Table 8: Cabbage palm cover by habitat, location, fire, sorted by cover (>5%).**

| NRCS Habitat | Location | Control | FIRE (>1) | Event # | n | Mean Percent Cover |
|---|---|---|---|---|---|---|
| Ch | PSSF | 0 | 3 | 0 | 3 | 53.9 |
| Pp | FPNWR | 0 | 2 | 3 | 9 | 52.5 |
| Pp | FPNWR | 0 | 2 | 4 | 3 | 47.9 |
| Pp | FPNWR | 0 | 2 | 0 | 9 | 41.8 |
| Cg | FSPSP | 0 | 2 | 0 | 2 | 35.8 |
| Ch | PSSF | 0 | 3 | 4 | 1 | 32.6 |
| Pm | PSSF | 0 | 3 | 0 | 2 | 31.2 |
| Ph | FPNWR | 0 | 2 | 0 | 69 | 30.0 |
| Pm | FPNWR | 0 | 2 | 3 | 9 | 29.9 |
| Pm | FPNWR | 0 | 2 | 4 | 15 | 29.5 |
| Ph | FPNWR | 0 | 2 | 3 | 17 | 29.4 |
| Cx | PSSF | 0 | 2 | 4 | 1 | 26.8 |
| Ph | FPNWR | 0 | 3 | 4 | 3 | 25.8 |
| Ph | FSPSP | -1 | 3 | 4 | 1 | 24.4 |
| Hp | PSSF | 0 | 2 | 4 | 3 | 22.3 |
| Pm | FPNWR | 0 | 2 | 0 | 30 | 20.5 |
| Ph | PSSF | 0 | 3 | 4 | 4 | 20.4 |
| Ph | FPNWR | -1 | 2 | 4 | 2 | 20.1 |
| Ph | FPNWR | -1 | 2 | 0 | 2 | 18.7 |
| Pm | PSSF | 0 | 3 | 4 | 4 | 16.7 |
| Ph | FSPSP | 0 | 2 | 0 | 5 | 16.0 |
| Hh | PSSF | 0 | 2 | 0 | 1 | 14.4 |
| Hh | PSSF | 0 | 3 | 4 | 4 | 14.3 |
| Ph | PSSF | 0 | 2 | 0 | 6 | 13.3 |
| Cg | PSSF | 0 | 3 | 0 | 2 | 12.8 |
| Hp | PSSF | 0 | 3 | 4 | 2 | 12 |
| C | FSPSP | 0 | 3 | 0 | 3 | 11.5 |
| Cg | PSSF | 0 | 2 | 0 | 1 | 9.4 |
| Gx | FPNWR | 0 | 2 | 3 | 3 | 7.3 |
| G | FPNWR | 0 | 2 | 3 | 23 | 6.7 |
| Gx | FPNWR | 0 | 2 | 0 | 3 | 6.1 |
| Ph | PSSF | 0 | 2 | 4 | 4 | 5.8 |
| Cg | PSSF | 0 | 3 | 4 | 1 | 5.2 |
| C | PSSF | 0 | 3 | 4 | 5 | 5.0 |

Quadrat Data Evaluation

For general statistics such as number of species observed, species richness by habitat and fire, species composition and dominance including exotic versus native species by location, and more detailed discussion of the effects of fire management on species richness in pinelands, see the FPNWR report (Barry 2006). Also, the authors further discuss rare plants observed at PSRA in Woodmansee and Barry (2006). In this report, the emphasis in analysis is placed on hydrological relationships with species composition and dominance. Specifically, the Wetland Affinity Index (WAI) was recalculated using updated wetland indicator categories and compared with actual hydroperiod data where available Reed (1988). Preliminary results of analysis with the Floristic Quality Index (FQI) are also presented and discussed in this report.

*Wetland Affinity Index*

Dominance by hydrophytic species can be quantified by summarizing the data using the wetland indicator values (Reed 1988). The WAI, or simply the weighted mean probability of occurrence in wetlands for all species combined in each one meter$^2$ quadrat, is calculated by the following formula:

$$P_{overall} = \frac{\Sigma\, x_i\, w_i}{\Sigma\, w_i}$$

$x_i = P_{USFWS}$ for indicator category i. (based on 1996 classification)

$w_i$ = Weight = Percent Cover by plants in indicator category i

This artificial index of dominance by hydrophytic vegetation allows us to quantify degree of dominance by inundation tolerant species (0.99 = obligate wetland species, 0.5 = facultative wetland species, and <0.5 = upland species). However, one must bear in mind the origin and intent of the indicator categories used to calculate $P_{overall}$. Many plant species found in Florida may behave differently in SW Florida than in other parts of the USFWS's Region 2, which encompasses all of the southeastern states. Moreover, many of the plant species listed by USFWS are poorly understood and may not be accurately categorized.

WAI, calculated at the quadrat level (excluding epiphytes) then averaged first by transect then by site variables, is presented by habitat for FPNWR, PSSF, FSPSP, and TTINWR (Table 9). These data follow the general trend with cypress and marsh communities showing greater dominance by wetland species than hammock and pineland species (Figure 2). However, a clear difference between the less drained FPNWR and the severely drained PSSF is not obvious. The WAI for cypress with graminoid (Cg) and hydric flatwoods (Ph) was the most notable difference observed with a lower WAI at PSSF. Little difference was observed in the wet prairie (G) data, although the absolute lowest values were observed at PSSF as expected. This was also the trend observed when the WAI was calculated with the 1987 indicator values in the FPNWR report (Barry 2006). Sampling in other habitats was low on FPNWR, such as the one transect in Cypress (C), and these data (a very low WAI) should be disregarded as most of the six quadrats had no cover and included plants growing on hummocks (rises at the bases of cypress trees or fallen rotting logs).

WAI was also calculated using the same variables, but excluding woody vegetation and epiphytes, based on the idea that graminoids and herbs may respond more quickly to changes in hydrology (Figure 3). At first glance these data do not appear distinctly different. Most notable differences observed were some of the cypress w/graminoid (Cg) and hydric pine flatwoods (Ph) transects at PSSF which did show a decrease with woody vegetation eliminated as expected. In a few cases, such as the cypress with hardwoods (Ch), where the

WAI actually increased, results were contrary to what we expected. This may be due to dominance of cabbage palm and Brazilian-pepper in these transects while groundcover consists of native perennial wetland species. These mixed results are contrary to the expectations discussed in the FPNWR report (Barry 2006). However, WAI analysis by growth habit should be considered as a useful tool in evaluating success of restoration in future sampling events.

Also, the high variability in WAI in cypress communities may be largely an effect of the plant communities associated with hummocks, or the microtopographic variation associated with fallen logs, stumps, and buttressed trunks of cypress. I would suggest that in future data collection we try to systematically include a field denoting whether or not the plant was rooted at ground elevation or above on a hummock. In some cases, quadrats possessed large tree trunks within them, which at a minimum could lower species cover as a large percentage of the area is occupied by tree species (this is also the case for quadrats in other forest/woodland communities such as pinelands and hammocks). Some notes in the comments field were kept on this, however it was inconsistently collected during these multiple sampling events.

**Table 9: Wetland Affinity Index (WAI) by habitat, location, and time since fire.**

| NRCS Habitat | Location | Control | Event # | FIRE | n | WAI (Poverall) |
|---|---|---|---|---|---|---|
| C | FPNWR | TRUE | 4 | 3 | 1 | 0.193209 |
| Cg | FPNWR | TRUE | 4 | 2 | 1 | 0.884038 |
| Cg | FPNWR | FALSE | 0 | 2 | 14 | 0.590611 |
| Cg | FPNWR | FALSE | 1 | 1 | 14 | 0.775164 |
| Cg | FPNWR | FALSE | 2 | 1 | 14 | 0.774251 |
| Cg | FPNWR | FALSE | 3 | 1 | 10 | 0.703934 |
| Cg | FPNWR | FALSE | 3 | 2 | 3 | 0.756142 |
| Cg | FPNWR | FALSE | 4 | 1 | 3 | 0.892969 |
| G | FPNWR | TRUE | 0 | 2 | 1 | 0.64843 |
| G | FPNWR | TRUE | 1 | 1 | 1 | 0.702048 |
| G | FPNWR | TRUE | 4 | 2 | 1 | 0.708589 |
| G | FPNWR | FALSE | 0 | 2 | 74 | 0.708854 |
| G | FPNWR | FALSE | 1 | 1 | 70 | 0.696519 |
| G | FPNWR | FALSE | 1 | 2 | 3 | 0.773531 |
| G | FPNWR | FALSE | 2 | 1 | 55 | 0.699842 |
| G | FPNWR | FALSE | 3 | 1 | 23 | 0.67267 |
| G | FPNWR | FALSE | 3 | 2 | 24 | 0.75168 |
| G | FPNWR | FALSE | 4 | 1 | 12 | 0.807164 |
| G | FPNWR | FALSE | 4 | 2 | 3 | 0.791503 |
| G | FPNWR | FALSE | 4 | 3 | 3 | 0.81911 |
| G/Mf | FPNWR | FALSE | 0 | 2 | 6 | 0.836833 |
| G/Mf | FPNWR | FALSE | 1 | 1 | 6 | 0.852191 |
| G/Mf | FPNWR | FALSE | 2 | 1 | 6 | 0.852253 |
| G/Mf | FPNWR | FALSE | 3 | 2 | 6 | 0.863035 |
| G/Mf | FPNWR | FALSE | 4 | 2 | 6 | 0.877351 |
| Gx | FPNWR | FALSE | 0 | 2 | 3 | 0.75206 |

| NRCS Habitat | Location | Control | Event # | FIRE | n | WAI (Poverall) |
|---|---|---|---|---|---|---|
| Gx | FPNWR | FALSE | 1 | 1 | 3 | 0.736953 |
| Gx | FPNWR | FALSE | 2 | 1 | 3 | 0.719054 |
| Gx | FPNWR | FALSE | 3 | 2 | 3 | 0.791842 |
| Gx | FPNWR | FALSE | 4 | 1 | 3 | 0.835961 |
| Mf | FPNWR | FALSE | 0 | 2 | 6 | 0.819169 |
| Mf | FPNWR | FALSE | 1 | 2 | 6 | 0.80101 |
| Mf | FPNWR | FALSE | 4 | 3 | 6 | 0.918963 |
| Ph | FPNWR | TRUE | 0 | 2 | 3 | 0.664944 |
| Ph | FPNWR | TRUE | 1 | 1 | 3 | 0.661786 |
| Ph | FPNWR | TRUE | 4 | 2 | 3 | 0.605803 |
| Ph | FPNWR | FALSE | 0 | 2 | 70 | 0.536442 |
| Ph | FPNWR | FALSE | 1 | 1 | 57 | 0.469041 |
| Ph | FPNWR | FALSE | 1 | 2 | 3 | 0.359799 |
| Ph | FPNWR | FALSE | 2 | 1 | 50 | 0.436182 |
| Ph | FPNWR | FALSE | 3 | 1 | 23 | 0.494531 |
| Ph | FPNWR | FALSE | 3 | 2 | 18 | 0.469227 |
| Ph | FPNWR | FALSE | 4 | 1 | 9 | 0.476988 |
| Ph | FPNWR | FALSE | 4 | 3 | 3 | 0.38102 |
| Pm | FPNWR | FALSE | 0 | 2 | 30 | 0.41923 |
| Pm | FPNWR | FALSE | 1 | 1 | 24 | 0.35304 |
| Pm | FPNWR | FALSE | 1 | 2 | 6 | 0.330707 |
| Pm | FPNWR | FALSE | 2 | 1 | 16 | 0.372194 |
| Pm | FPNWR | FALSE | 3 | 1 | 7 | 0.475378 |
| Pm | FPNWR | FALSE | 3 | 2 | 9 | 0.325753 |
| Pm | FPNWR | FALSE | 4 | 2 | 15 | 0.372333 |
| Pp | FPNWR | FALSE | 0 | 2 | 9 | 0.482157 |
| Pp | FPNWR | FALSE | 1 | 1 | 9 | 0.382486 |
| Pp | FPNWR | FALSE | 2 | 1 | 9 | 0.400637 |
| Pp | FPNWR | FALSE | 3 | 2 | 9 | 0.389779 |
| Pp | FPNWR | FALSE | 4 | 1 | 6 | 0.430343 |
| Pp | FPNWR | FALSE | 4 | 2 | 3 | 0.425342 |
| C | FSPSP | TRUE | 4 | 3 | 2 | 0.791426 |
| C | FSPSP | FALSE | 0 | 2 | 1 | 0.906407 |
| C | FSPSP | FALSE | 0 | 3 | 3 | 0.65881 |
| Cg | FSPSP | FALSE | 0 | 2 | 2 | 0.621183 |
| G | FSPSP | TRUE | 4 | 2 | 1 | 0.864612 |
| G | FSPSP | TRUE | 4 | 3 | 1 | 0.726691 |
| G | FSPSP | FALSE | 0 | 2 | 3 | 0.688246 |
| G | FSPSP | FALSE | 0 | 3 | 1 | 0.836061 |
| Ms | FSPSP | TRUE | 4 | 3 | 2 | 0.946693 |
| Ph | FSPSP | TRUE | 4 | 3 | 1 | 0.56927 |
| Ph | FSPSP | FALSE | 0 | 2 | 5 | 0.755784 |
| C | PSSF | FALSE | 0 | 3 | 2 | 0.631238 |
| C | PSSF | FALSE | 4 | 3 | 5 | 0.787776 |
| Cg | PSSF | FALSE | 0 | 2 | 1 | 0.645894 |
| Cg | PSSF | FALSE | 0 | 3 | 2 | 0.566351 |

| NRCS Habitat | Location | Control | Event # | FIRE | n | WAI (Poverall) |
|---|---|---|---|---|---|---|
| Cg | PSSF | FALSE | 4 | 2 | 2 | 0.727108 |
| Cg | PSSF | FALSE | 4 | 3 | 1 | 0.278604 |
| Ch | PSSF | FALSE | 0 | 3 | 3 | 0.616133 |
| Ch | PSSF | FALSE | 4 | 3 | 1 | 0.636008 |
| Cx | PSSF | FALSE | 4 | 2 | 1 | 0.577112 |
| Cx | PSSF | FALSE | 4 | 3 | 2 | 0.707396 |
| G | PSSF | FALSE | 0 | 2 | 4 | 0.724448 |
| G | PSSF | FALSE | 0 | 3 | 1 | 0.722727 |
| G | PSSF | FALSE | 4 | 1 | 1 | 0.709296 |
| G | PSSF | FALSE | 4 | 2 | 6 | 0.623231 |
| G | PSSF | FALSE | 4 | 3 | 1 | 0.903416 |
| Gx | PSSF | FALSE | 4 | 3 | 1 | 0.590104 |
| Hh | PSSF | FALSE | 0 | 2 | 1 | 0.62 |
| Hh | PSSF | FALSE | 4 | 3 | 4 | 0.591186 |
| Hp | PSSF | FALSE | 4 | 2 | 3 | 0.509184 |
| Hp | PSSF | FALSE | 4 | 3 | 2 | 0.55781 |
| Mf | PSSF | FALSE | 4 | 3 | 2 | 0.915821 |
| Ph | PSSF | FALSE | 0 | 1 | 1 | 0.188355 |
| Ph | PSSF | FALSE | 0 | 2 | 6 | 0.612718 |
| Ph | PSSF | FALSE | 4 | 2 | 4 | 0.435377 |
| Ph | PSSF | FALSE | 4 | 3 | 4 | 0.354776 |
| Pm | PSSF | FALSE | 0 | 3 | 2 | 0.526752 |
| Pm | PSSF | FALSE | 4 | 1 | 1 | 0.269827 |
| Pm | PSSF | FALSE | 4 | 2 | 1 | 0.453372 |
| Pm | PSSF | FALSE | 4 | 3 | 4 | 0.374992 |
| Ms | TTINWR | FALSE | 4 | 3 | 4 | 0.916473 |
| | | | | | | |

**Figure 2: Wetland Affinity Index (WAI) by Habitat**

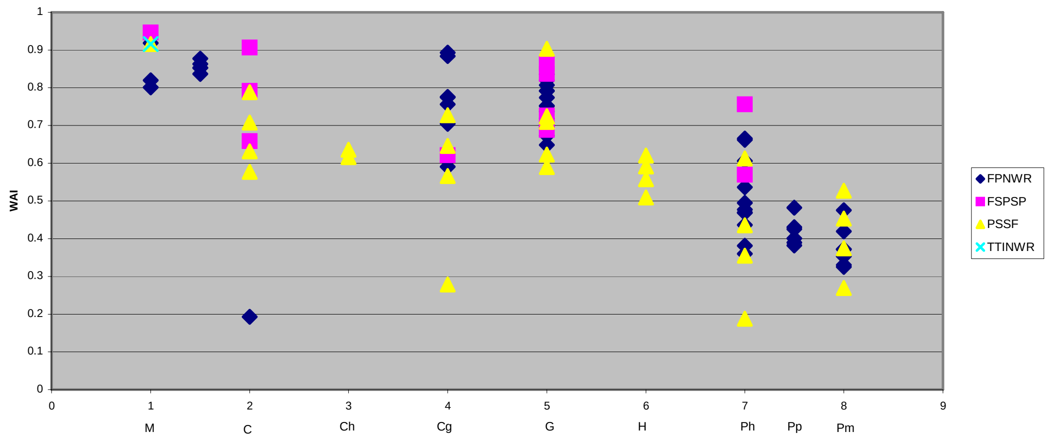
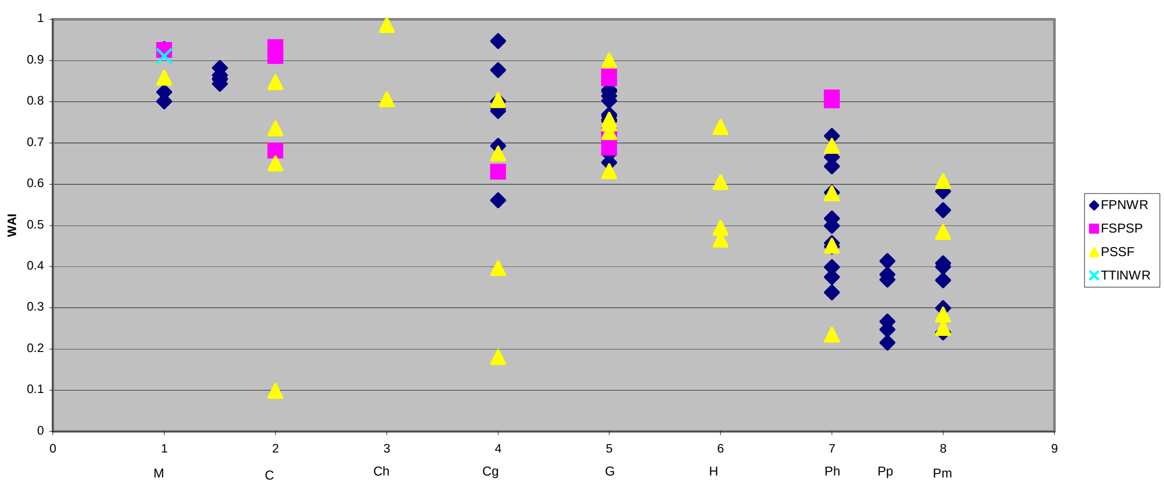



**Figure 3: Wetland Affinity Index (WAI) by Habitat - Only graminoids and forbs**




Approximate hydroperiod data is available for PSSF based on peizometers monitored since 1997, over an even longer time period at FSPSP using wells and staff gauges, and new wells installed by SFWMD at both of these sites will soon be able to provide more detailed information. Unfortunately, the hydrological data on FPNWR is lacking, especially for the earliest data. Data had been collected for rock island over the past eight years, however, these data have never been summarized and are not currently and may never be available. New wells installed by the United States Geological Survey (USGS) will help in the future, however, none were installed in the center portions of the FPNWR, those least influenced by drainage where control sites were located. Anecdotal observations by the authors and others, however, do support the general statement that hydroperiods are much shorter at PSSF than FPNWR, thus a general argument that all data from FPNWR are basically control sites.

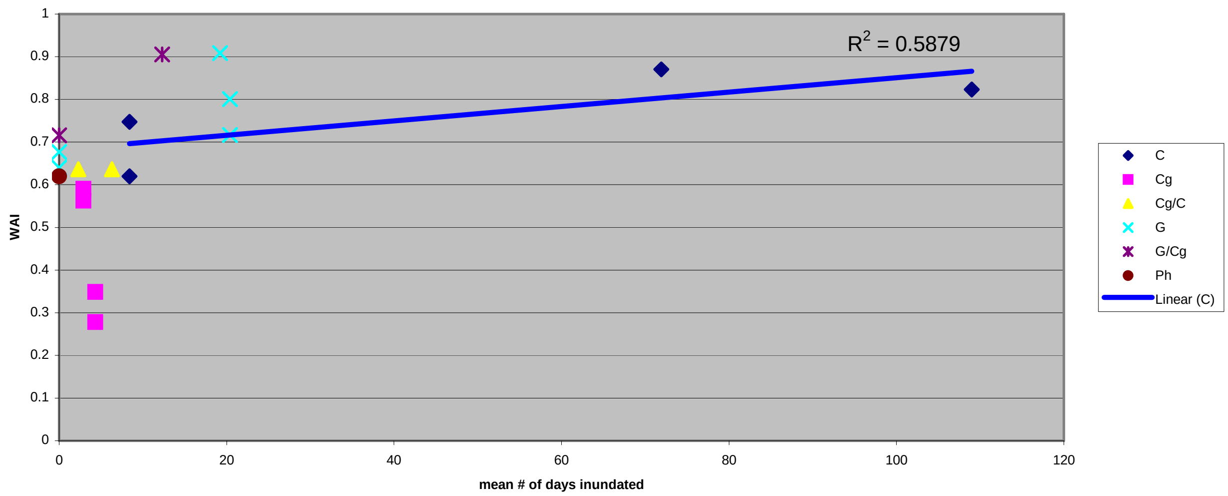
The primary and secondary goals of using the WAI for analysis will be tracking changes over time as restoration is completed and hydroperiod is lengthened for a majority of the sites as well as compare to control plots. In order to test the validity of using the WAI as an indicator of hydrological conditions, we have taken the mean hydroperiods calculated from NRCS peizometer data collected from 1997 to 2004 at PSSF which had transects sampled nearby in the same (or similar) habitats. In the future, mean hydroperiods before and after restoration will be calculated for each newly installed SFWMD well. Hopefully, the hydrological data from FPNWR and FSPSP will be analyzed as well.

Mean hydroperiod and WAI data for selected transects at PSSF are presented in Table 10. Preliminary results are encouraging as WAI does seem to suggest a positive relationship with cypress (C) habitats which have the widest range of observed hydroperiods (as # of days inundated) at PSSF (Figure 4). In other words, WAI appears to be an effective tool for looking at change in hydroperiod. The longer hydroperiod data comes from the SW portion of the forest off Lynch Road, west of Everglades Blvd. Positive trends are also observed, with steeper slopes, by data from wet prairie (G) and cypress with graminoid understory (Cg). It will be interesting to plot change in WAI with change in mean hydroperiod in future data collection events.

**Table 10: Wetland Affinity Index (WAI) and associated hydroperiod data by habitat at selected PSSF transects.**

| Transect habitat | Days inundated | WAI Poverall | Transect ID | NRCS Well | Well Habitat | Event # | COMMENTS |
|---|---|---|---|---|---|---|---|
| C | 8.4 | 0.62 | 56 | 23 | C | 0 | tran Ch former C, well C |
| C | 8.4 | 0.747206 | 56 | 23 | C | 4 | tran Ch former C, well C |
| C | 71.9 | 0.870543 | 6 | 6 | C | 4 | both C |
| C | 109 | 0.822976 | 4 | 10 | C | 4 | both C |
| Cg | 2.9 | 0.562571 | 25 | 27 | Cg | 4 | tran Hp/Cg, well C(g?) |
| Cg | 2.9 | 0.590104 | 41 | 27 | Cg | 4 | tran Gx/Cg, well Cg? |
| Cg | 4.3 | 0.278604 | 7 | 2 | Cg | 4 | both Cg |
| Cg | 4.3 | 0.349102 | 14 | 2 | Cg | 4 | both Cg |
| Cg/C | 2.3 | 0.636008 | 58 | 25 | Cg | 4 | tran Ch/C, well X, former Cg? |
| Cg/C | 6.3 | 0.636008 | 58 | 12 | Cg | 4 | tran Ch/C, well former Cg? could also be Hp former Cg |
| G | 0 | 0.639629 | 57 | 13 | G | 0 | both G; water to < 1' (high) below |
| G | 0 | 0.67662 | 57 | 13 | G | 4 | both G; water to < 1' (high) below |
| G | 19.2 | 0.908462 | 5 | 9 | G | 4 | both G |
| G | 20.4 | 0.716455 | 31 | 18 | G | 4 | both G |
| G | 20.4 | 0.800435 | 24 | 18 | G | 4 | both G |
| G/Cg | 0 | 0.715892 | 54 | 13 | G | 4 | tran Hp former Cg, well G; water to < 1' (high) below |
| G/Cg | 12.3 | 0.905223 | 27 | 7 | Ph | 4 | well Ph, former G?, tran Cg |
| Ph | 0 | 0.619615 | 30 | 22 | Ph | 4 | both Ph; water to < 1' (high) below |

**Figure 4: Wetland Affinity Index (WAI) vs. hydroperiod**

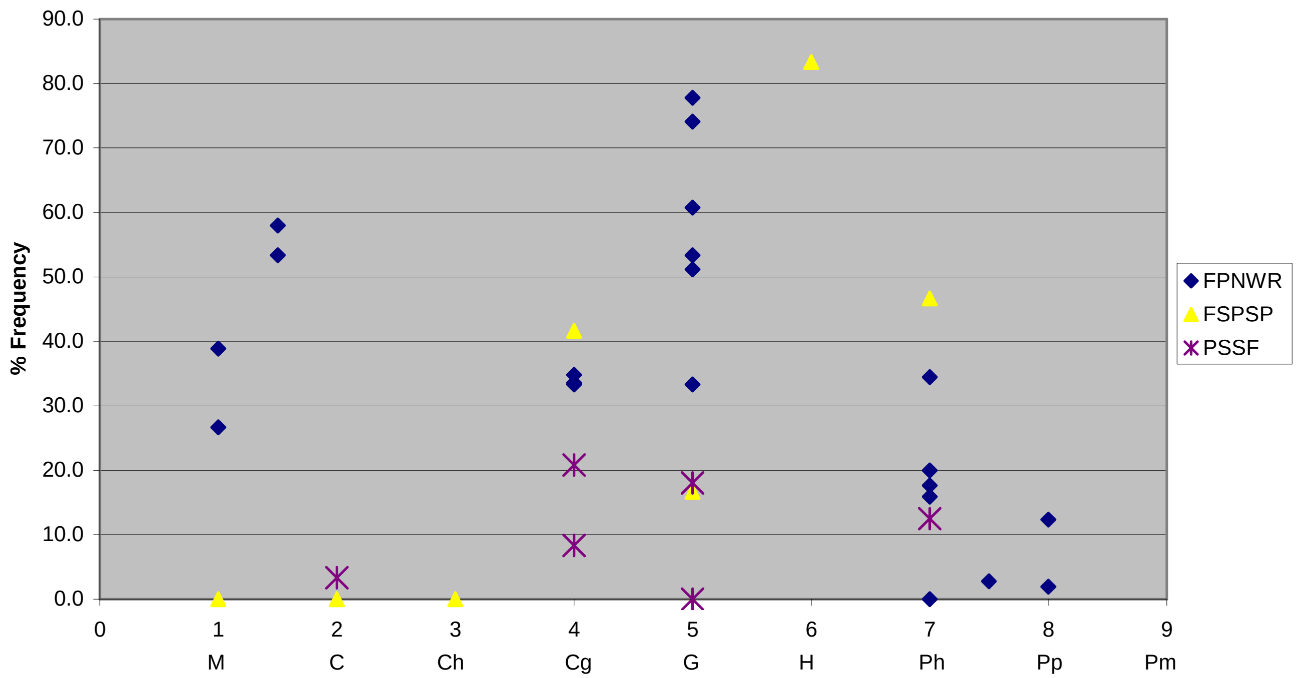



While conducting sampling at PSSF, especially in the wet prairies, we began to notice the lack of certain low coverage, high frequency of diminutive forb species typical of the prairies of FPNWR (as discussed in the FPNWR report; Barry 2006). Specifically, smallfruit primrosewillow (*Ludwigia microcarpa*) had much higher frequency on FPNWR than any of the other sites, occurring in 30-80% of the quadrats sampled in wet prairie (G), 17-34% of quadrats sampled in cypress with graminoid (Cg), and 16-30% of the quadrats sampled in hydric pine flatwoods (Ph) (Barry 2006). This compares to 0-11% of the quadrats in wet prairie (G), 0-4% in cypress with graminoid (Cg), and 0-12% of the quadrats sampled in hydric pine flatwoods (Ph) of PSSF. A few other species exhibited a similar pattern, though less dramatic, and are listed below in Table 11. Curtiss' primrosewillow (*Ludwigia curtissii*), which at times can be confused with smallfruit primrosewillow (*L. microcarpa*), was included with these data and their combined frequencies are shown by habitat, and site in Figure 5. Both species of mermaidweed (*Proserpinaca palustris, P. pectinata*) and both species of hornpod (*Mitreola petiolata, M. sessilifolia*), also cogeners often confused for each other, follow a similar pattern in these habitats, and in fact are nearly absent at PSSF in wet prairies (G) and hydric pine flatwoods (Ph) with shorter time since fire, and completely absent from hydric pine (Ph) with <1 year since fire at PSSF. These species, typical of lower strata in graminoid dominated short hydroperiod wetlands, appear to have nearly dropped out from these drained areas and may be useful indicators during restoration monitoring for PSRP. More detailed statistical analysis is suggested on these and perhaps other species which may have thus far been overlooked.

**Table 11: Percent Frequency by selected wetland forbs by habitat, location, fire.**

| NRCS Habitat | Location | Ctl. | FIRE | *Ludwigia curtissii* | *Ludwigia microcarpa* | *Proserpinaca palustris* | *Proserpinaca pectinata* | *Mitreola petiolata* | *Mitreola sessilifolia* |
|---|---|---|---|---|---|---|---|---|---|
| C | FSPSP | X | 3 | | | 33.3 | | | |
| C | FSPSP | | 2 | | | | 50.0 | | |
| C | FSPSP | | 3 | | | | 5.6 | | |
| C | PSSF | | 3 | 1.7 | 1.7 | | 1.7 | | |
| Cg | FPNWR | X | 2 | 16.7 | 16.7 | | | | |
| Cg | FPNWR | | 1 | | 34.8 | | 23.8 | 7.8 | |
| Cg | FPNWR | | 2 | | 33.6 | | 16.7 | 11.4 | |
| Cg | FSPSP | | 2 | | 41.7 | | | | |
| Cg | PSSF | | 2 | 8.3 | | | 4.2 | | |
| Cg | PSSF | | 3 | 16.7 | 4.2 | | | | |
| G | FPNWR | X | 2 | | 33.3 | 16.7 | 10.0 | | |
| G | FPNWR | | 1 | 1.0 | 50.1 | | 19.1 | 23.4 | |
| G | FPNWR | | 2 | | 60.8 | 1.4 | 24.8 | 22.5 | |
| G | FPNWR | | 3 | | 77.8 | | 77.8 | 27.8 | |
| G | FSPSP | X | 2 | | 16.7 | 66.7 | | | |
| G | FSPSP | X | 3 | 66.7 | 16.7 | 16.7 | | | 16.7 |
| G | PSSF | | 2 | 6.9 | 11.1 | | | | 5.6 |
| G | PSSF | | 3 | | | 16.7 | | | |
| G/Mf | FPNWR | | 1 | | 53.3 | | 30.0 | 78.3 | |
| G/Mf | FPNWR | | 2 | | 58.0 | | 53.5 | 9.4 | |
| Gx | FPNWR | | 1 | 1.9 | 72.2 | | 24.8 | 55.6 | |
| Gx | FPNWR | | 2 | | 53.3 | | 23.3 | 13.3 | |
| Mf | FPNWR | | 2 | | 26.7 | | 28.3 | 28.3 | |
| Mf | FPNWR | | 3 | | 38.9 | | 61.1 | 13.9 | |
| Ph | FPNWR | X | 1 | | 20.0 | | | 13.3 | |
| Ph | FPNWR | X | 2 | 2.8 | 31.7 | 5.6 | 3.3 | | 5.6 |
| Ph | FPNWR | | 1 | 0.9 | 16.7 | | 1.9 | 5.7 | 0.5 |
| Ph | FPNWR | | 2 | | 15.9 | | 4.8 | 1.6 | |
| Ph | FPNWR | | 3 | | | | | | 5.6 |
| Ph | FSPSP | | 2 | | 46.7 | | | | |
| Ph | PSSF | | 3 | | 12.5 | | | | 4.2 |
| Pm | FPNWR | | 1 | | 12.4 | | 0.8 | 1.1 | |
| Pm | FPNWR | | 2 | 0.3 | 1.7 | | 0.7 | 1.3 | 0.3 |
| Pp | FPNWR | | 1 | | 2.8 | | | | |

**Figure 5: Frequency of *Ludwigia curtissii* and *L. microcarpa* (combined) by habitat**




*Floristic Quality Index*

Preliminary analysis of groundcover data utilizing the Floristic Quality Index (FQI) was conducted to compare the relative weediness of the sites as a result of past ground disturbing activities. This list currently exists in draft (2006) form created by Steve Mortallero of USFWS Vero Beach office in cooperation with myself, staff at The Institute for Regional Conservation, and several other botanists/plant ecologists. The index was created based on work done by Wilhelm and Masters (1995). The list is currently out for review by as many South Florida botanists/plant ecologists as possible. Analysis of this type may help quantify effects of disturbance to plant species composition and dominance, both in the past and potential future disturbance. For example, this index may prove useful in evaluating the impacts of heavy mechanical treatment of cabbage palms at FPNWR.

Data from initial analysis of FQI is presented in Table 12. Both mean FQI and weighted mean FQI (weighted by percent cover) values are presented. Because the index values were still undecided for certain taxa and consisted of a range of values not yet agreed upon by the team of plant ecologists involved in the creation of this index, the authors chose values based on their own experience for the purpose of calculations in this report. These values will be re-calculated when the final version of the index is completed.

In general, when transects of all habitats by site were combined, PSSF exhibited the lowest FQI values which is consistent with expectations as more evidence of past ground disturbance was documented for transects at PSSF. This average difference, however, may be misleading, as some of the habitats sampled at PSSF were not sampled at FPNWR, or there were fewer samples of certain habitats at FPNWR (*i.e.* cypress and hammocks). Analysis of the hydric flatwoods (Ph) and wet prairie (G) data, which are most consistently sampled across sites, is however, also consistent with this trend. Interestingly, these habitats in FSPSP seem to show the highest values, thus suggesting that perhaps the past activities (pre 1989 when the National Wildlife Refuge status was given to FPNWR) may have had some lasting effects on the vegetation. Our personal observations are consistent with the idea that the hydric flatwoods and wet prairies sampled for this report at FSPSP have had less ground disturbance overall, and is consistent with the longer time under preservation. The difference may be further influenced by the choice of heavy mechanical control of cabbage palm which has inherent associated ground disturbance at FPNWR instead of using herbicide by foot. Further analysis should include some records of transects with observable past ground disturbance from all sites, and some of these data do exist in our notes but was not compiled at this time.

**Table 12: Floristic Quality Index (FQI) by site, habitat.**

| | weighted mean FQI | | | | mean FQI | | | |
|---|---|---|---|---|---|---|---|---|
| **NRCS Habitat** | **FSPPSP** | **FPNWR** | **PSSF** | **TTINWR** | **FSPPSP** | **FPNWR** | **PSSF** | **TTINWR** |
| C | 4.61 | 4.61 | 5.22 | | 4.59 | 5.00 | 5.13 | |
| Cg | 4.22 | 5.57 | 5.16 | | 4.64 | 5.44 | 4.74 | |
| Ch | | | 5.43 | | | | 5.41 | |
| Cx | | | 5.09 | | | | 4.52 | |
| G | 6.36 | 5.66 | 5.83 | | 5.73 | 5.23 | 5.26 | |
| G/Mf | | 6.17 | | | | 5.53 | | |
| Gx | | 5.76 | 4.45 | | | 5.47 | 4.33 | |
| Hh | | | 4.90 | | | | 4.46 | |
| Hp | | | 3.83 | | | | 4.24 | |
| Mf | | 6.38 | 1.83 | | | 5.45 | 3.62 | |
| Ms | 4.54 | | | 6.40 | 5.00 | | | 5.44 |
| Ph | 5.71 | 5.04 | 3.50 | | 5.45 | 5.16 | 4.37 | |
| Pm | | 5.18 | 5.05 | | | 5.15 | 4.94 | |
| Pp | | 4.63 | | | | 4.89 | | |
| combined | 5.09 | 5.45 | 4.57 | 6.40 | 5.08 | 5.26 | 4.64 | 5.44 |

*Discussion and Results Summary*

It seems apparent that the initial study results indicate plant community change, especially for cypress habitats, due to hydrological modification. Science also points to evidence for habitat degradation based upon FQI and associate plant species are in areas most affected by hydrological modification, although an idiot driving through the Picayune in his car could have observed that. Future analyses should be done on WAI, utilizing all available hydrological data as well as focusing on certain indicator species such as *Ludwigia curtissii* vs.

*L. microcarpa*, and *Proserpinaca palustris* vs. *P. pectinata* may be useful to gauge restoration efforts. FQI data should also be analyzed with actual data on ground disturbing activities.

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