CHARACTERIZING VEGETATION ADJACENT TO WATER BODIES OF AN URBANIZING WATERSHED IN WEST CENTRAL FLORIDA

By

MELISSA HOPE FRIEDMAN

A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2011

To all that have supported me through this endeavor and to all that embark on a similar journey

ACKNOWLEDGMENTS

Many individuals and parties played a role in the successful completion of this thesis. Firstly, I extend my sincere gratitude to all private landowners, homeowners, and businesses, in addition to the various federal, state, and local agencies for supporting this project through their assistance with or by directly granting access to properties. I am also greatly appreciative for one of the hardest working field crews on the planet: Erin M. Givens, Melinda J. Moss, Lynn M. Proenza, Carolyn C. Rhodes, and Mary E. Thornhill; their dedication to and persistence with collecting and storing accurate field data were invaluable. Special thanks to Shawn M. Landry and Rich Hammond from the University of South Florida for graciously providing historic aerials, and to the Southwest Florida Water Management District for graciously providing current aerials, both of which were integral to this projects methodology and analyses. In addition, my sincere gratitude and appreciation go out to my committee; Amr Abd-Elrahman, Michael G. Andreu, Robert J. Northrop, and Wayne C. Zipperer, for all of their help, unwavering support, and commitment to guiding me though this process. Furthermore, infinite gratitude and appreciation go out to my family and friends, especially my mom, dad, sister, brother, and Paige A. Harvey, for their continual encouragement, humor, and unconditional love throughout this endeavor. A very special thank you to Chumo and Houdina for making the analysis and writing process more enjoyable with their limitless love and snuggle breaks. Immeasurable gratitude and appreciation go out to Henry C. Wilson for being a continual sounding board and for his unconditional love, compassion, and partnership. Lastly, but certainly not least, boundless gratitude and appreciation go out to all of my spiritual guides; for I would not have embarked on this journey nor gotten through it without them.

TABLE OF CONTENTS

APPENDIX

LIST OF TABLES

LIST OF FIGURES

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

CHARACTERIZING VEGETATION ADJACENT TO WATER BODIES OF AN URBANIZING WATERSHED IN WEST CENTRAL FLORIDA

By

Melissa Hope Friedman

August 2011

Chair: Michael G. Andreu
Major: Forest Resources and Conservation

This study took place within an urban area of the Tampa Bay Watershed in West Central Florida that had varying frequencies and intensities of disturbance. Ninety-seven plots were randomly established within 50 feet of water bodies. Vegetation structure and species richness were investigated, and plant communities were characterized and quantified. Results from this study corroborated what other studies have found regarding vegetation adjacent to water bodies within an urban context in the Southeastern U.S.; introduced species richness and stem density, in addition to impervious surface area, increased as the frequency and intensity of disturbance increased. Additionally, cluster analyses resulted in a decrease in natural plant community assemblages as disturbance from urbanization increased, with no natural plant communities represented in areas with the most frequent and intensive disturbance. Plant communities function as a system rather than as individual entities, thus their functionality at the watershed scale is integral to the availability of clean freshwater. Subsequently, results from this study can assist in informing future decisions on conservation needs and urban growth management so that the Tampa

Bay Watershed can continue to function and provide services to all life that depends on such in the face of urbanization.

CHAPTER 1
INTRODUCTION

Over the last century Florida's population has grown from approximately half a million people to more than 18.5 million people, with 30% of the population increase occurring over the last 20 years (U.S. Census Bureau 2010). Zwick and Carr (2006) estimated that Central Florida is expected to experience more growth than any other region in the state of Florida by 2060. As of 2009, the U.S. Census Bureau (2010) estimated that Hillsborough County was the 3rd most populous county in the state and the most populous county in the Tampa Bay Watershed.

As the human population increases the continuity of the landscape becomes more fragmented and heterogeneous (Alberti 2005). Some of the earliest documented human influences within the present day Tampa Bay Watershed include converting large tracts of land for settlement, agriculture, and range land /pasture land in the early 1800's (Covington 1961). By the mid 20th century large tracts of land had been further converted, cleared, drained, or the like for the expansion of agriculture, pasture/range land, timber production, and urban development (Owen 2002). Such practices not only increased deforestation in Central Florida but also altered the hydrology (Haag and Lee 2010).

The hydrological regime is the most influential factor on vegetation dynamics in systems adjacent to water bodies (Mitsch and Gosselink 2000), which are defined in this study as a distinct feature (natural or anthropogenic) on the landscape where water (fresh, brackish, salt) accumulates and includes rivers, streams, canals, channels, lakes, ponds, bays, and coves. As urbanization increases in the Tampa Bay Watershed, vegetation dynamics shift from being driven by natural disturbances (e.g. hydrology) to being dominated by anthropogenic disturbances (Schomer et al. 1990). This in turn changes the location and assemblage of plant species (Alberti 2008) and thereby modifies how they function and hence the services they provide (Alberti 2008, Grimm et al. 2008, Vitousek et al. 2008).

An increase in urbanization has been shown to be directly correlated with an increase in introduced species richness (Burton and Samuelson 2008, Burton et al. 2005, Lowenstein and Lowenstein 2005) and stem densities (Burton and Samuelson 2008, Burton et al. 2005) in areas adjacent to water bodies in the Southeastern U.S.. In addition, impervious surface area has been shown to increase with increasing urbanization in the Tampa Bay Watershed (Xian and Crane 2005), which further impacts hydrology by decreasing infiltration and increasing surface water runoff, resulting in a decrease in freshwater recharge (Alberti 2008) and an increase in non-point source pollution (Paul and Meyer 2008). In fact, the Florida Department of Environmental Protection (FDEP) (2005, 2003) recently reported that urban areas in the Tampa Bay Watershed were not only one of the greatest sources of non-point source pollutants and excess nutrients into freshwater systems, but were also one of the greatest consumers of freshwater resources.

It has been suggested that one of the greatest challenges facing humanity in the next century is the availability of fresh potable water (Pearce 2006). Freshwater is a finite resource with just 1% of water on earth making up available freshwater. The availability and quality of freshwater in the Tampa Bay Watershed has been reduced by anthropogenic changes to the landscape that remove habitat and thus modify hydrological regimes, increase excess nutrients and pollutants into the environment, and by over use of freshwater resources (FDEP 2005, FDEP 2003). Cordell and Macie

(2002) suggested that as the human population continues to increase in the Southeastern U.S., including the area encompassing the Tampa Bay Watershed, water quality and availability will be further stressed while demands on freshwater resources continue to increase.

Vegetation, and even more so, plant communities adjacent to water bodies play an integral role in the availability and quality of freshwater by intercepting, absorbing, and storing precipitation, which in turn recharges groundwater supplies; and by filtering pollution and excess nutrients which thereby improves water quality. In addition, vegetation and plant communities adjacent to water bodies regulate storm water flows and thus reduce flooding; regulate water temperatures which reduce stress on aquatic ecosystems; and provide critical habitat for fish and wildlife (Haag and Lee 2010, Sprague et al. 2006), all of which ultimately benefit the health and well being of humans (Alberti 2005).

Few studies have investigated vegetation adjacent to water bodies within the urban context in the Southeastern U.S. (Burton and Samuelson 2008, Burton et al. 2005, Lowenstein and Lowenstein 2005), and none have been conducted in West Central Florida. In order to gain a better understanding of how vegetation has changed in the face of urbanization in West Central Florida, the first chapter of this thesis (chapter 2) investigated species richness and vegetation structure adjacent to water bodies in the Tampa Bay Watershed. Furthermore, because natural and anthropogenic disturbances influence vegetation dynamics, the second chapter of this thesis (chapter 3) characterized and quantified plant communities using the same dataset in order to better understand how plant communities are assembling and changing in the face of urbanization. Such information can assist in informing future decisions on conservation needs and urban growth management, so that not only demands for fresh potable water can be met, but also so that the Tampa Bay Watershed can continue to function in a manner that sustains all life dependent on it.

CHAPTER 2
SPECIES RICHNESS AND VEGETATION STRUCTURE IN AREAS ADJACENT TO WATER BODIES OF AN URBANIZING WATERSHED IN WEST CENTRAL FLORIDA

Introductory Remarks

Urban areas are composed of a mosaic of vegetation that ranges from being frequently and intensively disturbed or managed (e.g. active agriculture, mechanically maintained lawns) to being extensively managed or relatively left alone (e.g. remnant forest patches) by humans (Zipperer 2002a). While some studies have investigated species richness (Lowenstein and Lowenstein 2005, Burton and Samuelson 2008, Burton et al. 2005) and vegetation structure (Burton and Samuelson 2008, Burton et al. 2005) in areas adjacent to water bodies within an urban context in the Southeastern U.S., none have been conducted in West Central Florida. In order to gain a better understanding of how vegetation has changed in the face of urbanization, this chapter investigated species richness and vegetation structure with varying frequencies and intensities of disturbance in areas adjacent to water bodies within the Tampa Bay Watershed.

Methodology

Study Area

The 193,286 acre study area took place near the west coast of Florida in Hillsborough and Pasco counties, and included the City of Tampa proper (green) and the sub-basin watersheds (red) adjacent to the city (Figure 1-1). The study area sits between two major basins, the Tampa Bay Basin and Tampa Bay Tributaries Basin, both of which make up the Tampa Bay Watershed (Figure 1-2). This watershed spans over 1.6 million acres and encompasses most of Hillsborough, Manatee, and Pinellas counties in addition to portions of Pasco, Polk, and Sarasota counties. The annual temperature within the study area ranged from 61°F to 85°F with an average annual temperature of 73°F. Annual precipitation ranged from .01 inches to 17.5 inches, with an average annual precipitation of 3.68 inches (SERCC 2007).

Sample Plot Selection

A systematic random sampling design, represented by a hexagonal grid was projected over the 193,286 acre study area. Each hexagon consisted of 437 acres and a randomly generated fixed radius .10 acre plot was located within each hexagon. Plots that occurred within 50 feet of a water body (Figure 1-3), which includes rivers, streams, lakes, canals, ponds, channels, bays, and coves, regardless of origin (natural, anthropogenic) or type of water (fresh, brackish, salt), were included in this study and a total of 97 plots met this criteria.

Data Collection

Plot data were collected from February 2007 thru July 2008 and consisted of 3 strata: tree, shrub, and ground. The tree stratum was made up of woody stems ≥ 1 inch in diameter at breast height (DBH; 4.5 feet), the shrub stratum consisted of woody plants at least 1 foot tall but with a DBH < 1 inch, and the ground stratum consisted of woody and herbaceous vegetation < 1 foot tall. The methodology for data collection followed the guidelines suggested for an ecosystem analysis in the U.S. Department of Agriculture Forest Service i-Tree Software Suite User's Manual v1.0 (2006). Data collected on each plot included percent tree cover, percent shrub cover, percent ground cover (rock soil, duff/mulch/leaf litter, herbaceous vegetation, maintained grass (mowed), unmaintained grass, water, and impervious surface area; building, cement, and tar), tree and shrub species composition, tree height per species, average shrub height per species, crown width (north-south and east-west) and DBH of all trees. Trees and shrubs were identified to at least genus, with most identified to specific epithet; nomenclature followed Godfrey (1988).

Additional Data

The dominant soil drainage class was determined for each plot using the U.S. Department of Agriculture Natural Resource Conservation Service's (USDA/NRCS) soil survey data for Hillsborough (USDA/NRCS 2006) and Pasco (USDA/NRCS 2007) Counties. Drainage classes were chosen because they are directly related to the frequency and duration of hydroperiods (USDA/NRCS 2009), which is the most influential factor on vegetation in areas adjacent to water bodies within natural systems (Mitsch and Gosselink 2000, Sharitz and Mitsch 1993). Since local elevation is also greatly influenced by the hydrological regime (Light et al. 2002), average elevation was estimated within each plot radius using digital elevation model data from the U.S. Geological Survey National Elevation Dataset (2009).

Group Classification

Two criteria stratified sample plots into groups. The first stratification was based on the occurrence of mechanically maintained grass in the ground stratum in order to make a distinction between plots with more frequent and intensive and less frequent and intensive anthropogenic disturbance. Plots without maintained grass were considered "forested", and plots with mechanically maintained grass were considered "inhibited" since the frequent and persistent action of mowing grass inhibits natural forest dynamics (Zipperer 2002b). Plots were additionally stratified by observing vegetation cover on aerials between 1948 through 1952 and then by comparing them with vegetation cover on aerials in 2007. Plots that had little to no change in vegetation cover were designated as "remnant" and plots that showed distinct changes in vegetation cover (cleared or sparsely vegetated in the past to now densely vegetated, or *vice versa*) were designated as “emergent” (Figure 1-4).

Group Descriptions and Comparisons

Total, native, introduced, and invasive species richness were tallied for each group as a whole in addition to the tree and shrub strata within each group. Native species were those whose native range included Florida and introduced species were those with a native range that did not include Florida, both of which were determined with Godfrey (1988) and the USDA/NRCS online plant database (2010). Invasive species were identified with the most up to date list provided by the Florida Exotic Pest Plant Council (2009), in addition to the University of Florida’s Center for Aquatic and Invasive Plants online database (2009a). Vegetation that could not be identified beyond genera were included in total species richness counts. Genera that had species that were only native or introduced to Florida were evaluated as such, and genera that had both native and introduced species in Florida were omitted from nativity richness counts.

Structural metrics were calculated for the tree, shrub, and ground strata within a group and for each group as a whole. The true average (sum/total number of plots in a group) was calculated for tree size-density relationship per acre or basal area/acre (BA/acre), tree density per acre or trees per acre (TPA), tree diameter class/acre, percent tree, shrub, and ground cover/acre, relative frequency, and relative cover. Average (sum/total number of entries) tree diameter (DBH) and tree and shrub heights were calculated differently than the rest of the group metrics in order to provide values that were true to the physiological characteristics of trees and shrubs. Standard deviations were calculated for all metrics except relative frequency and relative cover.

Since sample sizes within each group were not equal, dominant soil drainage class and average elevation were presented as relative proportions for each group.

Results

Out of 97 plots a total of three groups were determined. They consisted of 46 forested/remnant (FR) plots, 31 forested/emergent (FE) plots, and 20 inhibited/emergent (IE) plots.

Species Richness

All groups in this study had the presence of native, introduced, and invasive species (Table 1-1), with the forested groups being most similar. Even though the IE group had the least number of plots it had the greatest species richness. However, 69% of the IE species richness was made up of species introduced to Florida, whereas introduced species made up just 12% of species richness in the FR and FE groups respectively. This same trend was observed among strata, with a greater proportion of native than introduced species present in both forested groups in the tree (FR = 92%, FE = 90%) and shrub (FR = 86%, FE = 86%) strata (Table 1-2). Conversely, a greater proportion of introduced than native species was present in the IE group, with 60% and 71% introduced species present in the tree and shrub strata respectively. In addition, more than half of the species that occurred in both forested groups (FR = 59%, FE = 52%) were present in both the tree and shrub strata, while just 17% overlapped among strata in the IE group. Of those, 94% (FR), 88% (FE), and 50% (IE) were native to Florida.

Structure

Almost all (99%) of the stems in the FR group were made up of native species on average, 66% of which were in the smallest diameter class (Table 1-3). Eighty-six percent of the stems in the FE group were made up of native species on average, and 83% of those occurred in the smallest diameter class. A little more than half (51%) of the stems in the IE group were made up of native species on average, with 76% of those occurring in the smallest diameter class. While the IE group had the greatest proportion (49%) of introduced stems on average, 100% of the introduced stems that occurred in the FE group were invasive to Florida, whereas 29% and 17% of the introduced stems in the IE and FR groups on average were invasive to Florida respectively. Overall, the FE and IE groups had a greater proportion of stems in the smallest diameter class (FR = 67%, FE = 83%, IE = 85%) and the FR group had the greatest proportion of stems in the largest diameter class (FR = 6%, FE = 2%, IE = 5%) (Table 1-4).

The FR group had the greatest average value for all structural metrics in the tree and shrub strata (Table 1-5) except for average percent shrub cover, which was greatest in the FE group. Similarly, the IE group had the smallest average value for all structural metrics except for average DBH and average shrub height, which were lowest in the FE group. Forested groups had a similar average TPA and the FE and IE groups had a similar average tree height, while the greatest differences between all three groups occurred in average BA/acre and average percent tree cover.

As expected, the forested groups had only unmaintained grass in the ground stratum, with a greater proportion occurring in the FE group than the FR group (Table 1-6). In addition, forested groups had little to no rock and impervious surface area (ISA), and similar amounts of soil, duff/mulch/leaf litter, and herbaceous vegetation when compared to the IE group. The IE group was the only group with maintained grass, which contributed to 35% of the average groundcover. In addition, the IE group was the only group with a substantial amount of ISA (25%). Water was present in all groups but had the greatest proportion in the FE group (20%) and the lowest proportion in the IE group (11%).

Hydrology and Elevation

The majority (83%) of the plots in the FR group had a very poorly drained (class 5) soil drainage class (Figure 1-5), where soils are frequently ponded much of the year (Table 1-7) (Soil Survey Staff 1993). An additional 11% of the FR plots had a poorly drained soil drainage class (class 4), where the soil remains wet at shallow depths anywhere from 3 to 12 months a year (Table 1-7). The FE group was a little more evenly distributed among soil drainage classes 4 and 5, with 52% of the plots in class 4 and 39% in class 5. Lastly, the IE group had the widest distribution of soil drainage classes among plots than the forested groups, with 30% of the plots occurring in class 3, 40% in class 4, and 15% in class 5, where soil moisture in class 3 occurs at greater depths than class 4 and 5 and frequency of inundation is more variable, occurring anywhere from 1 to 12 months a year. This same group was the only group that had a plot with an urban (class 7) soil drainage class, which was designated in areas that were covered with ≥ 85% ISA, thus making the actual drainage class unidentifiable (USDA 1989).

The greatest relative proportion of plots in the FR group occurred at two elevation classes: 35% in the 20.1 to 30 ft. class and 35% in 30.1 to 40 ft. class, with most of the remaining 30% occurring at elevations between 40.1 to 70 feet (Figure 1-6). The greatest relative proportion (29%) of plots in the FE group occurred at an elevation between 40.1 to 50 ft., and the next highest relative proportion (13%) of plots occurred in the 50.1 to 60 ft. class. An additional 20% of the plots in the FE group occurred in both the 30.1 to 40 ft. class and the 80.1 to 90 ft. class. Sixty percent of the plots in the IE group occurred at an elevation that was ≤ 1 to 10 ft, with an additional 20% occurring between 50.1 to 70 feet.

Discussion

The three groups in this study were differentiated based on two factors; whether vegetation cover was relatively unchanged (remnant) or showed distinct differences (emergent) in the same location over an approximate 60 year span, and whether grass was mechanically maintained (inhibited) or not (forested). The first factor may have been associated with natural disturbance regimes (e.g. hydrology, flooding, hurricanes) (Mitsch and Gosselink 2000, Oliver and Larson 1996) and/or disturbances from human activities associated with urbanization (e.g. agriculture, timber operations, hydrological alterations) (Schomer et al. 1990), whereas the second factor (maintained grass) is not only associated with disturbance from human activities associated with urbanization but also implies management on altered landcover types (e.g. active pasture land and developed areas; residential, commercial, and industrial areas) (FNAI 2010) that inhibits natural forest dynamics (Zipperer 2002b).

The two forested groups (FR and FE) were more similar in terms of species richness and structure but distinct differences also occurred between these two groups, while the IE group was clearly different from the two forested groups. Total, native, introduced, and invasive species richness proportions were very similar between the two forested groups as a whole, and in the tree and shrub strata of these same groups. Introduced species richness was much less abundant overall and within the tree and shrub strata of the forested groups (≤ 14%) than in the IE group (≥ 60%). This is likely because development practices associated with altered landcover types that include maintained grass generally remove existing vegetation from an area to be developed, as was found in a study conducted by Sharpe et al. (1986) in Southeastern Wisconsin. Then, the remaining pervious surface is replanted with vegetation commonly available through the local nursery trade, which tends to favor a high degree of introduced species (Walker et al. 2009). In addition, > 50% of the species richness in both forested groups overlapped between the tree and shrub strata; while the inhibited/emergent group had < 17% species overlap between these strata. Overlap of species in the tree and shrub strata is an important part of forest development and resilience over time (Oliver and Larson 1996). A lack thereof indicates that there is less opportunity for the replacement of canopy species from the shrub stratum in the IE group than in the forested groups. In the forested groups, canopy species can be replaced by other canopy species that emerge from the forest floor (Oliver and Larson 1996), whereas in the IE group most if not all of the species are planted within a specific stratum and are maintained as such (Bradley 1995, Schomer et al. 1990).

Structurally, both emergent groups (FE and IE) had greater proportions of stems in the smallest diameter class overall and the FR group had the greatest proportion of stems in the largest diameter class overall. This same trend was observed by Zipperer (2002a) when investigating remnant and emergent forest patches in an urban area in the Northeastern U.S. These studies observed the same trend because remnant vegetation was established several decades prior to vegetation in the emergent groups. This is further evidenced with both forested groups (FR and FE) having a similar average TPA but the average BA/acre in the FR group was twice that of the FE group. The FR group also had the highest average values for all structural metrics, with the exception of shrub cover, which was greater in the FE group. Canopy cover reduces the amount of light available to the forest floor and thus decreases understory development (Oliver and Larson 1996). However, the hydroperiod is considered to be the most influential factor on vegetation dynamics in areas adjacent to water bodies (Mitsch and Gosselink 2000, Sharitz and Mitsch 1993), with less inundation associated with increased shrub cover (FNAI 2010, Wharton et al. 1982), as was also exhibited in the FE group by the greater frequency of plots with better drained soils and thus shorter hydroperiods than the FR group.

The proportion of native stems decreased when going from the FR group to the IE group and the proportion of introduced stems increased when going in the same direction; FR = 1%, FE = 14%, and IE = 49% respectively. Burton and Samuelson (2008) also observed an increase in introduced stems in the Georgia Piedmont with increasing disturbance from urbanization in areas adjacent to water bodies. However, a category I invasive species was largely responsible for such an occurrence in the Burton and Samuelson (2008) study, which subsequently resulted in a decrease in total species richness with increased urbanization. This is because category I invasive species are known to take over or homogenize entire areas (FLEPPC 2009, Gordon 1998). The proportion of introduced stems and species richness in this study were largely made up of non-invasive species, which explains why this study observed an opposite trend in species richness with increasing urbanization.

Though the IE group had the greatest proportion of introduced stems, all introduced stems in the FE group were invasive to Florida. Disturbances that create situations that are favorable for emergent vegetation may also make such areas vulnerable to colonization by invasive species (Kowarik 2008, Light et al. 2002, Gordon 1998), while less intensive management in the FE group than that of the IE group may allow invasives to persist. Though the FR group had the greatest average DBH of all three groups, the IE group had a greater average DBH than the FE group. This is likely because management associated with the IE group (mechanically maintained grass or mowing) reduces small diameter recruitment (Burton and Samuelson 2008, Zipperer 2002a) and thus favors larger diameter trees. However, the IE group still had the lowest average BA/acre, TPA, and tree and shrub heights and cover of all three groups.

Both forested (FR and FE) groups had > 90% of their plots in the two wettest soil drainage classes (4 and 5) other than water, however, the FR group had a greater proportion of plots in the soil drainage class with the longest cumulative annual pattern (6 to 12 months) of the two forested groups (Table 1-6, Figure 1-3). In addition, the greatest proportion of groundcover in these same groups was duff/mulch/leaf litter (FR = 49%, FE = 40%). The combination of fluctuating water levels and a high proportion of duff/mulch/leaf litter are beneficial for ecosystems adjacent to water bodies, since this groundcover type is an integral source of soil organic matter and nutrients, which are accumulated, distributed, and decomposed by fluctuating waters (Sharitz and Mitsch 1993). On the other hand, the IE group had just 55% of its plots in soil drainage classes 4 and 5, and it had the greatest variation of soil drainage classes among the 3 groups, with 1 unidentifiable soil drainage class (urban) due to a large percentage of impervious surface area (ISA) (≥ 85%) (USDA 1989). Furthermore, 60% of the average groundcover in the IE group was made up of a combination of maintained grass (35%) and ISA (25%). While Burton and Samuelson (2008) did not look specifically at maintained grass, their results showed that percent cover of grass was greater in the more urbanized land covers they investigated: agriculture, recently developed, and urbanized; which is consistent with FNAI (2010) descriptions of altered landcover types associated with maintained grass. In addition, Xian and Crane (2005) found that the percent of ISA increased as urbanization increased in the Tampa Bay Watershed.

Interestingly, the presence of rock in the FR group occurred in one plot that was located along the shore and included a rock wall for a nearby building. In addition, the FE group had one plot with the presence of ISA due to an adjacent residential home. Though the average proportion of rock and ISA in each forested group was less than 1%, the presence of such suggests that these groups were subject to disturbances associated with urbanization. Moreover, 60% of the plots in the IE group occurred at elevations ≤ 10 feet, whereas 7% and 13% of the plots in the FR and FE groups occurred at this same elevation respectively. Such an occurrence suggests that altered landcover types associated with maintained grass (e.g. pasture land and developed areas; residential, commercial, and industrial areas) (FNAI 2010b) had a greater affinity towards lower elevations in areas adjacent to water bodes within Tampa and its surrounding sub-basin watersheds. Since groundwater resources are closer to the surface in Central, Florida than any other part of the state (Haag and Lee 2010), contaminants associated with urban areas can be exchanged into the groundwater much more quickly than they might otherwise in other parts of the state (FDEP 2003).

Overall, there were greater differences in species richness, structure, hydrology, and elevation between the forested and inhibited groups than between the remnant and emergent groups. Since all plots that made up each group were located within the urban context, it is likely that all groups experienced disturbance from both anthropogenic and natural sources. However, the frequency and intensity of these disturbances were greater in the emergent groups than in the FR group, since vegetation cover in the latter group remained relatively unchanged over the last 60 years and had the lowest proportion of introduced species, stems, and no ISA. In addition, disturbances associated with anthropogenic management in the IE group were more frequent and intense than the disturbances in the FE group, since management in the IE group inhibited natural forest dynamics and thus became the driver of these dynamics. Furthermore, the IE group had the greatest proportion of introduced species, ISA, and maintained grass of any other group, all of which are associated with increasingly disturbed and developed urban areas. Finally, the FE group had an intermediate kind of disturbance, since vegetation cover increased or emerged over the last 60 years and included a greater proportion of introduced species than the FR group, but natural forest dynamics were not inhibited by the same anthropogenic management that occurred in the IE group.

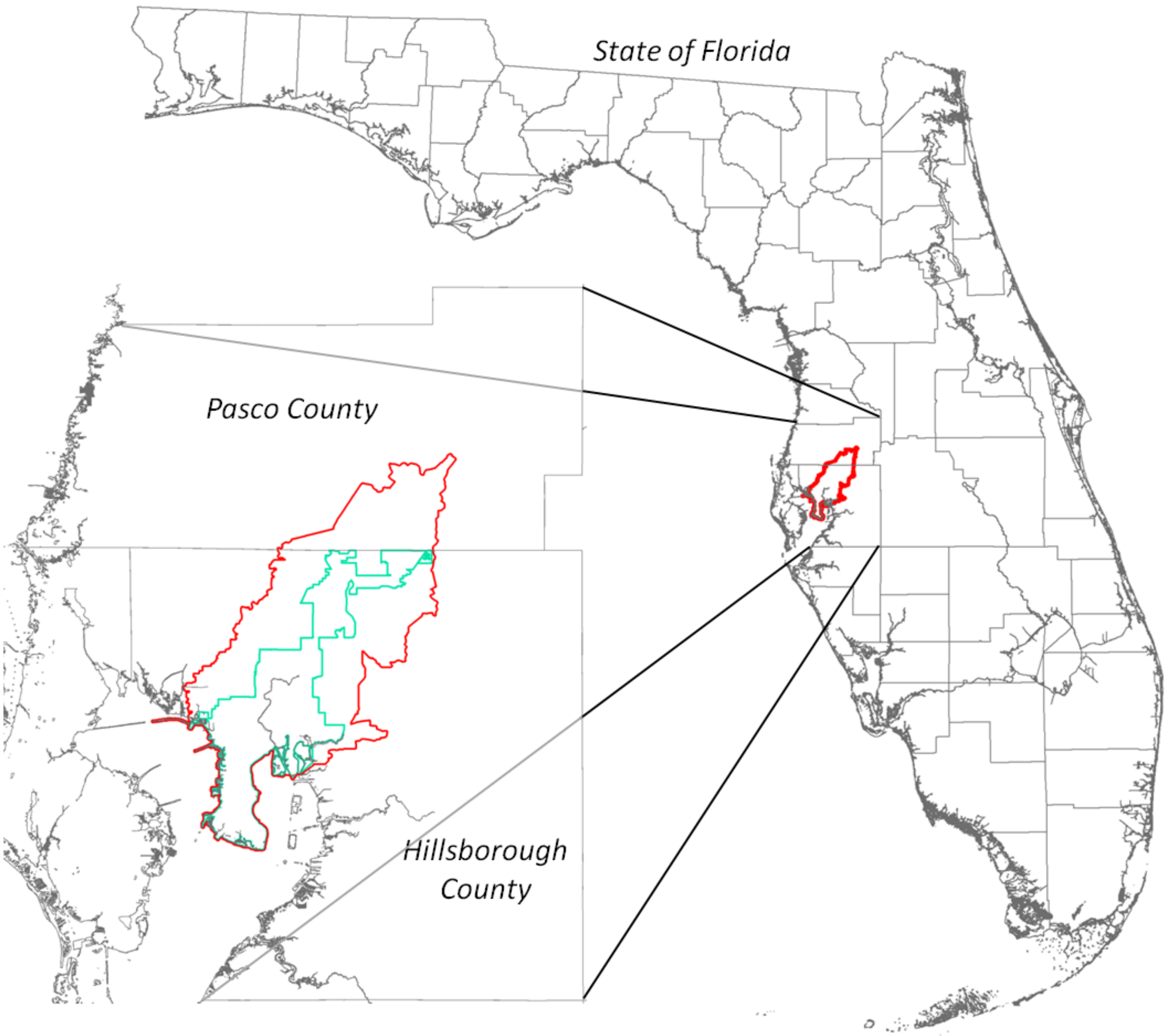

Figure 1-1. Study area within Hillsborough and Pasco Counties, Florida. The green outline depicts the City of Tampa's political boundary and the red outline depicts the boundary of the sub-basin watersheds adjacent to the city.

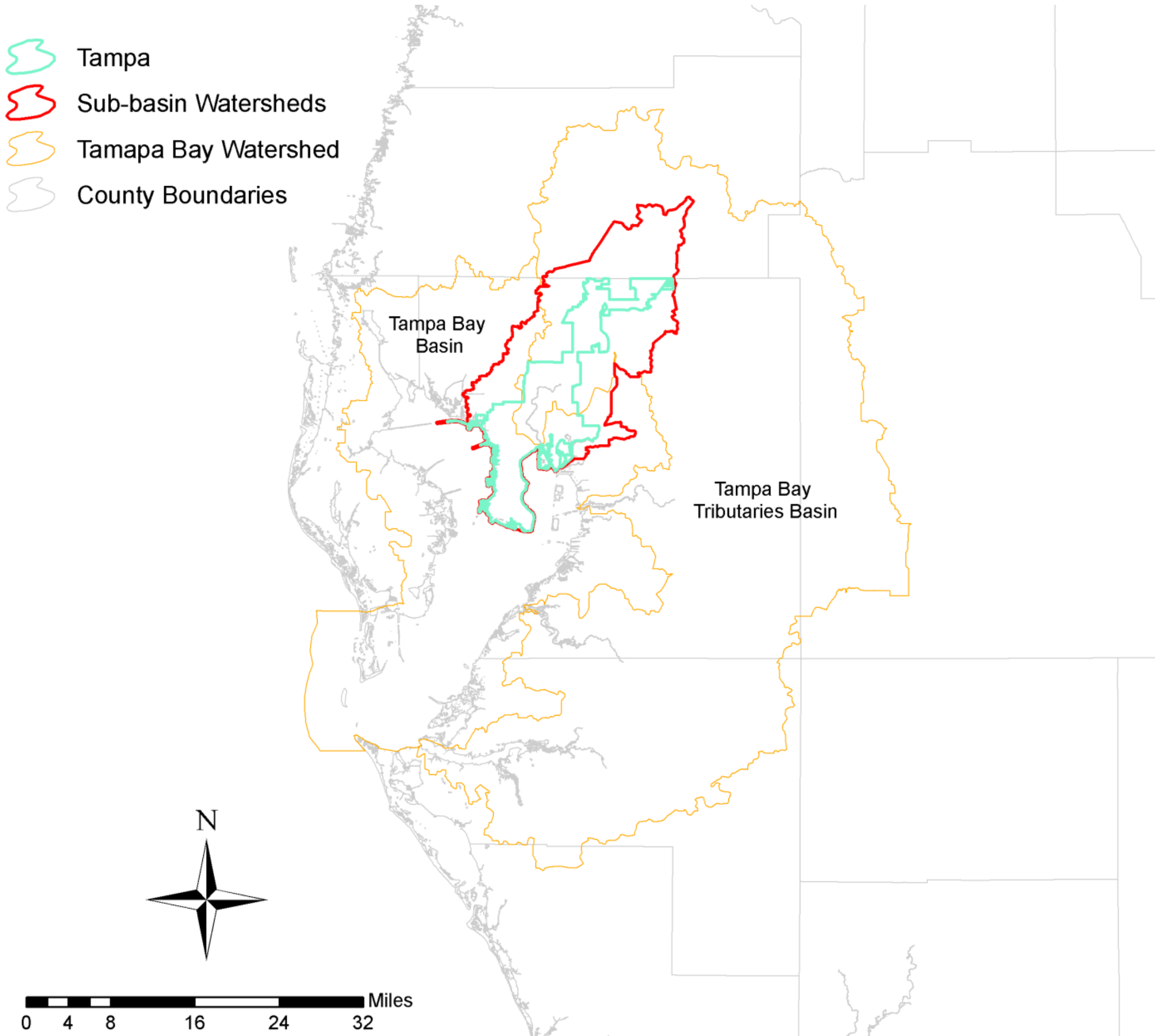

Figure 1-2. Location of study area within the Tampa Bay Watershed, Florida.

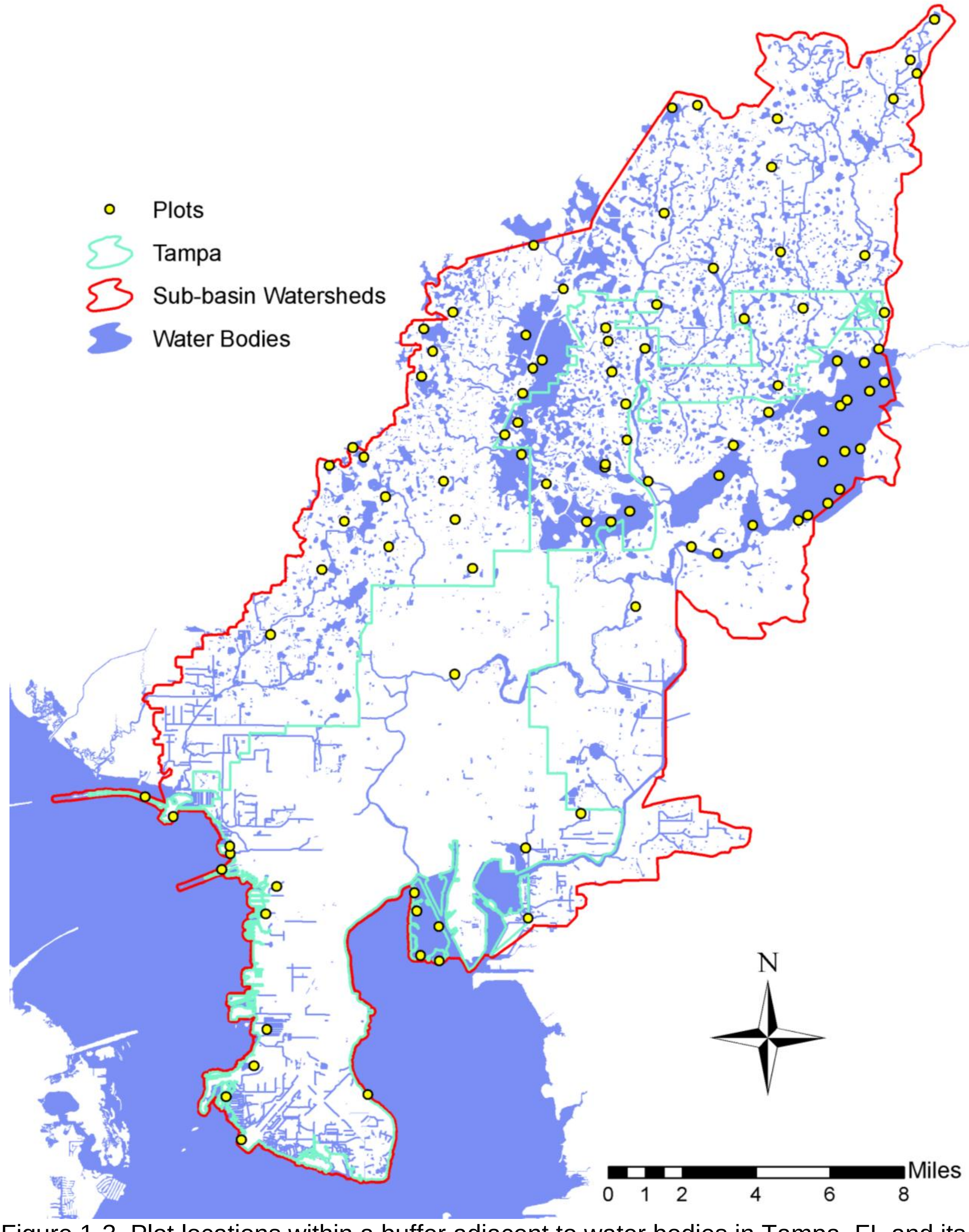

Figure 1-3. Plot locations within a buffer adjacent to water bodies in Tampa, FL and its adjacent sub-basin watersheds.

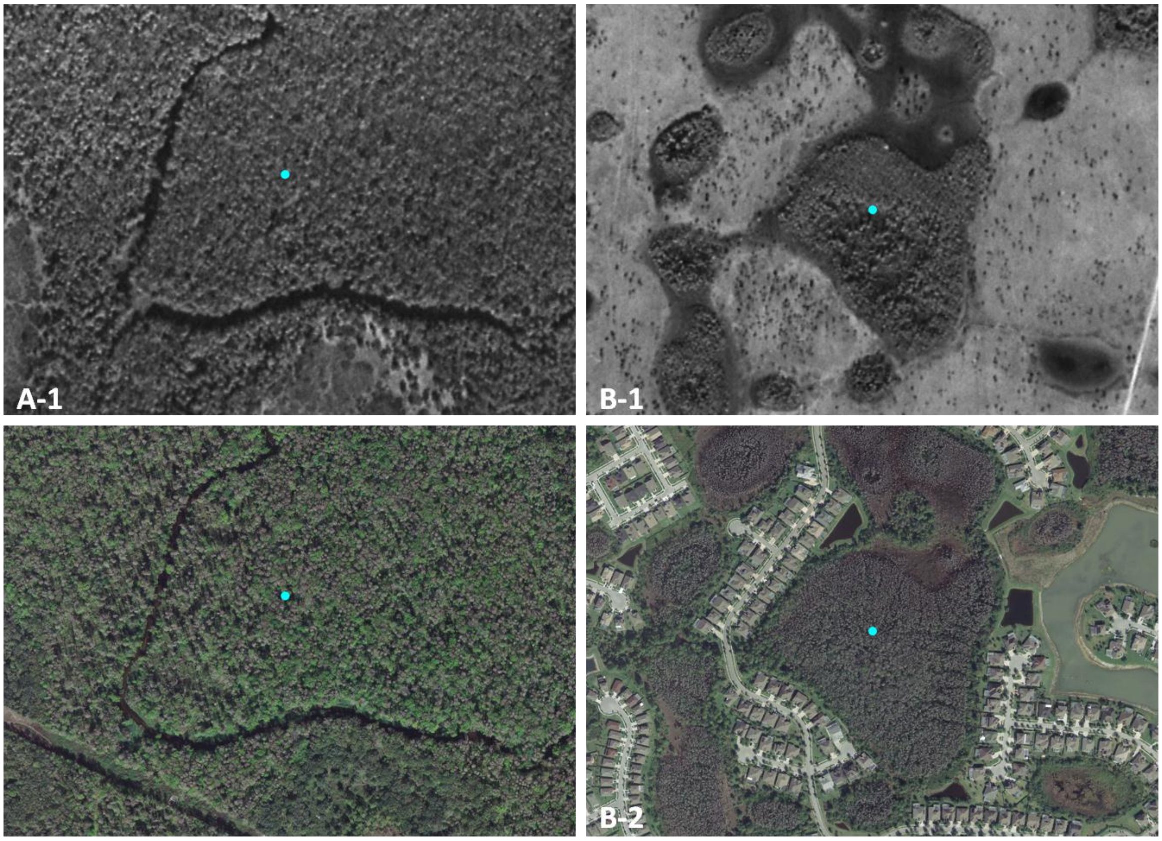

Figure 1-4. Example of vegetation cover comparisons when determining remnant (A) and emergent (B) plot status using aerials from 1948 (A-1, B-1) to 2007 (A-2, B-2) in an urbanizing watershed in West Central Florida.

Table 1-1. Total, native, introduced, and invasive species richness of forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

Species Richness	FR	FE	IE
Total	54***	50*	71***
Native	45	43	21
Introduced (Invasive’)	6 (4)	6 (5)	47 (10)

* Number of genuses excluded from native, introduced, and invasive counts due to inability to classify their status.
' Number of invasives within introduced counts; not additive.

Table 1-2. Total, native, introduced, and invasive species richness in the tree and shrub strata of forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

Species Richness	FR	FE	IE
Trees			
Total	41**	39	36*
Native	36	35	14
Introduced (Invasive')	3 (1)	4 (4)	21 (6)
Shrubs			
Total	45*	37*	47**
Native	38	31	13
Introduced (Invasive')	6 (4)	5 (4)	32 (6)
Species Among Strata			
Total	32	26	12
Native	30	23	6
Introduced (Invasive')	2 (1)	3 (3)	6 (2)

* Number of genuses excluded from native, introduced, and invasive counts due to inability to classify their status.

' Number of invasives within introduced counts; not additive.

Table 1-3. Average stem density/acre and standard deviation (in parentheses following values) of native, introduced, and invasive stems in forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

	FR (*n* = 46)	FE (*n* = 31)	IE (*n* = 20)
DBH Class (inches)	Average Native Stems/Acre		
1.0 - 6.0	378.9 (±452.7)	409.0 (±635.9)	58.5 (±125.9)
6.1 - 12.0	118.5 (±81.1)	63.5 (±107.5)	8.5 (±17.6)
12.1 - 16.0	41.1 (±33.1)	12.9 (±22.1)	3.0 (±5.7)
> 16.1	32.6 (±27.8)	6.5 (±11.1)	6.5 (±11.4)
Total	571.1 (±456.9)	491.9 (±643.9)	76.5 (±136.2)
DBH Class (inches)	Average Introduced Stems/Acre		
1.0 - 6.0	6.7 (±27.5)	69.4 (±290.5)	69.5 (±87.6)
6.1 - 12.0	0.7 (±4.4)	9.4 (±48.4)	2.5 (±6.4)
12.1 - 16.0	0.0	1.9 (±10.8)	0.0
> 16.1	0.0	2.6 (±14.4)	0.5 (±2.2)
Total	6.30 (±31.7)	83.2 (±363.7)	72.5 (±93.3)
DBH Class (inches)	Average Invasive' Stems/Acre		
1.0 - 6.0	1.1 (±7.4)	69.4 (±290.5)	19.0 (±35.5)
6.1 - 12.0	0.0	9.4 (±48.4)	1.5 (±4.9)
12.1 - 16.0	0.0	1.9 (±10.8)	0.0
> 16.1	0.0	2.6 (±14.4)	0.50 (±2.2)
Total	1.1 (±7.4)	83.2 (±363.7)	21.0 (±39.2)

' Average number of invasive stems/acre within introduced stems/acre; not additive

Table 1-4. Average stem density/acre and standard deviation (in parentheses following values) of stems overall in forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

	FR (*n* = 46)	FE (*n* = 31)	IE (*n* = 20)
DBH Class (inches)	Average Stems/Acre Overall		
1.0 - 6.0	384.6 (±451.5)	478.4 (±673.0)	117.0 (±149.3)
6.1 - 12.0	119.1 (±80.3)	72.9 (±112.6)	11.0 (±18.0)
12.1 - 16.0	41.1 (±33.1)	14.8 (±23.5)	3.0 (±5.7)
> 16.1	32.6 (±27.8)	9.0 (±17.2)	7.0 (±11.3)
Total	577.4 (±454.3)	575.2 (±697.7)	138.0 (±160.6)

Table 1-5. Average structural characteristics and standard deviation (in parentheses following values) for the tree and shrub strata of forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

Group Characteristics	FR (*n* = 46)	FE (*n* = 31)	IE (*n* = 20)
Trees			
BA/acre	212.6 (±11.5)	91.4 (±6.8)	33.6 (±9.5)
TPA	420.7 (±96.7)	391.9 (±237.5)	84.0 (±58.4)
DBH (inches)	5.8 (±5.8)	3.8 (±3.9)	4.2 (±4.8)
Height (feet)	34.9 (±21.4)	24.3 (±14.2)	21.1 (±10.1)
% Cover	73.0 (±22.8)	53.9 (±35.3)	33.5 (±29.8)
Shrubs			
Height (feet)	5.7 (±2.8)	4.6 (±2.2)	4.9 (±2.5)
% Cover	32.2 (±27.2)	38.1 (±28.4)	14.3 (±8.0)

Table 1-6. Average percent groundcover/acre and standard deviation (in parentheses following values) in forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

	FR (*n* = 46)	FE (*n* = 31)	IE (*n* = 20)
Rock	0.2 (±1.5)	0.0	4.8 (±8.1)
Soil	3.7 (±13.2)	2.2 (±7.5)	1.8 (±3.3)
Duff/Mulch/Leaf Litter	49.2 (±35.3)	40.0 (±37.4)	11.3 (±12.2)
Herbaceous Vegetation	24.8 (±24.4)	18.7 (±26.0)	8.2 (±19.9)
Maintained Grass	0.0	0.0	35.2 (±24.4)
Unmaintained Grass	6.8 (±15.5)	17.9 (±27.2)	3.5 (±6.9)
Water	15.3 (±33.0)	20.3 (±34.3)	10.7 (±22.1)
Impervious Surface Area	0.0	0.8 (±3.9)	24.8 (±23.3)

Table 1-7. Soil drainage classes in this study, their depth to water, and the range of time water is present annually; adapted from the Soil Survey Manual (Soil Survey Division Staff 1993).

Soil Drainage	Class	Depth (feet) to Free Water	Cumulative Annual Pattern
Well Drained	1	3 - 5	n/a
Moderately Well Drained	2	1.5 - 3	1 month - continuously
Somewhat Poorly Drained	3	.8 - 1.5	1 month - continuously
Poorly Drained	4	< .8 - 1.5	3 - 12 months
Very Poorly Drained	5	< .8	6 months - continuously
Water	6	0	continuously
Urban	7	n/a*	n/a*

* n/a = not applicable

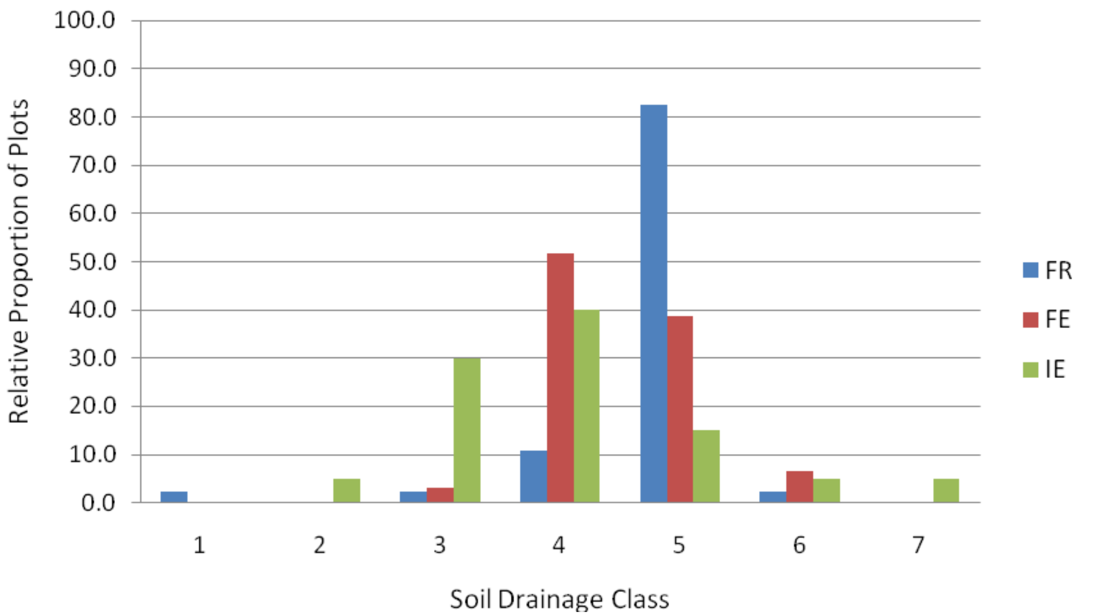

Figure 1-5. Relative proportion of soil drainage classes in forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

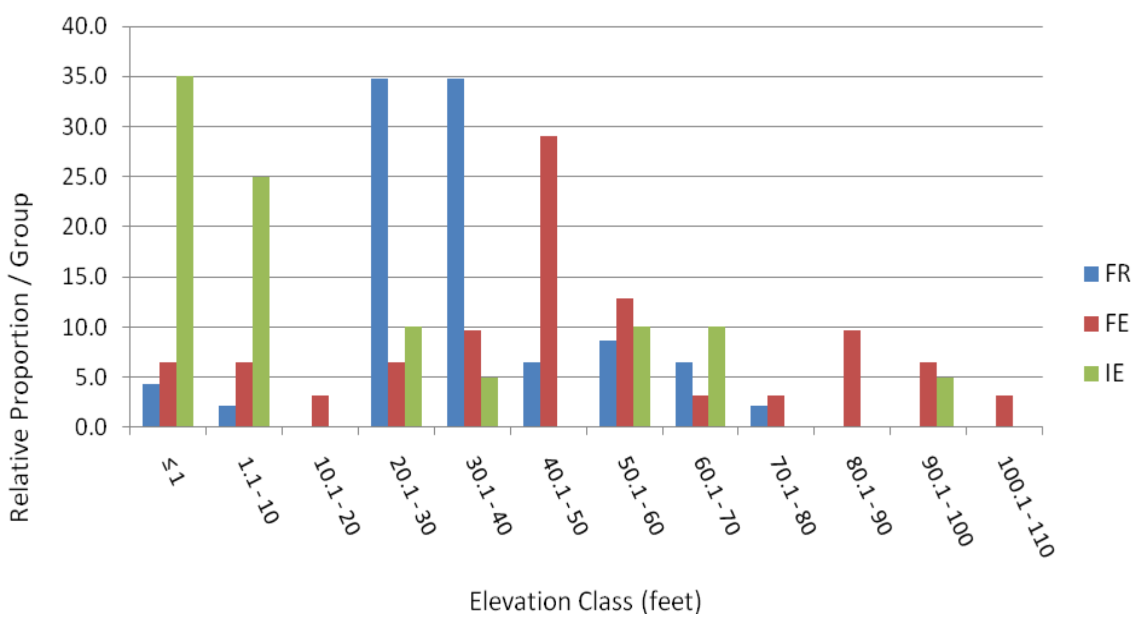

Figure 1-6. Relative proportion of elevation classes in forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in an urbanizing watershed in West Central Florida.

CHAPTER 3
THE CHARACTERIZATION AND QUANTIFICATION OF PLANT COMMUNITIES IN AREAS ADJACENT TO WATER BODIES OF AN URBANIZING WATERSHED IN WEST CENTRAL FLORIDA

Introductory Remarks

While results from the previous chapter clearly show that vegetation is changing in the face of urbanization in the Tampa Bay Watershed, this study was additionally interested in characterizing and quantifying the plant communities within each of these groups of varying frequencies and intensities of disturbance, since Sprague et al. (2006) found that plant communities play an integral role in watershed functionality in the Chesapeake Bay Watershed in the Northeastern U.S.

Florida Natural Areas Inventory (2010) is the only comprehensive resource that provides descriptive information about plant communities that occur throughout Florida and Schomer et al. (1990) provided a broader and less in depth account of plant communities specifically in the Tampa Bay Watershed. However, neither resource provided quantitative information to go along with their descriptions. Such information is desirable because it provides a basis from which to measure change. While some studies have provided quantitative information on the composition and structure of plant communities in Florida (Darst and Light 2008, Light et al. 2002, Wharton et al. 1990, Vince et al. 1989, Gunderson 1977, Pool et al. 1977), they generally focused on one community type and none were conducted in the Tampa Bay Watershed. Thus, characterizing and quantifying plant communities within groups of varying frequencies and intensities of disturbance will add to the existing body of literature that is currently available, in addition to providing insight into how these communities differ in an urbanizing watershed.

Methodology

All methods in Chapter 1 were the same as those in this chapter, except calculations of all metrics were applied to community types within groups. Additionally, the true average elevation was calculated for each community cluster, and minimum and maximum values were also presented. Further information on community methodology follows in the next two subsections.

Community Analyses

A hierarchical agglomerative cluster analysis was conducted on the forested/remnant (FR), forested/emergent (FE), and inhibited/emergent (IE) groups in order to identify the vegetative communities present within them (Kachigan 1991, McCune and Grace 2002). A data matrix of percent cover for each species within a plot was used for each cluster analysis. Species that occurred in both the tree and shrub strata were differentiated by species codes, thus vertical structure was included in cluster analyses. Species that were present in < 2 plots within a group were deleted from the data matrix prior to cluster analyses in order to reduce noise and encourage clustering based on ecological preferences rather than species abundances (McCune and Grace 2002).

A combination of the Sørensen distance measure and flexible β group linkage method of -.25 was used for each cluster run to avoid distortion or chaining in outputs (McCune and Grace 2002); thus plots that were more similar to one another clustered closer together (Gotelli and Ellison 2004). Chaining represents the addition of one plot to a group of plots (cluster) already amassed, so the less chaining there is the greater the ability to clearly distinguish community clusters. The recommended maximum percent chaining is 25% (McCune and Grace 2002).

Results from each cluster analysis were viewed using a dendrogram tree, which was scaled by Wishart's objective function (1969); a measurement of the amount of information remaining (a declining percent) as additional plots cluster together (McCune and Grace 2002). Community clusters were determined based on the distance at which the dendrogram tree was pruned. Optimal pruning distance was guided by two factors. Firstly, the occurrence of long limbs within a dendrogram tree leads to an umbrella of more homogeneous plots and denotes community types that are more likely to occur in nature, and secondly, clustered plots needed to be biologically meaningful (McCune and Grace 2002).

Community Classification and Description

Community clusters were compared to descriptions of natural community types in Florida with the aid of the Florida Natural Areas Inventory (FNAI) "*Guide to the natural communities of Florida: 2010 edition*" (2010). Species deleted for noise reduction during cluster analyses were included in community descriptions. An importance value (IV) ((relative frequency + relative cover)/2*100) was calculated for each species in the tree and shrub strata within each community cluster in order to determine and compare species dominance between community clusters in this study and natural community types described by FNAI (2010). Dominance was represented by those species that collectively accounted for ≥ 75% of the total IV, starting with the largest IV first and then cumulatively adding IV's until a total IV of 75% or greater was reached. Species mentioned by FNAI as being common to a natural community type but with a range outside of Central Florida (specific to South or North Florida) were not considered in this analysis.

FNAI acknowledged that the vegetation associated with natural community types may no longer exist in areas where the landscape has either been severely modified or completely changed (FNAI 2010). As a result, they identified the most commonly altered landcover types as a way to further classify the remaining cover on the landscape that did not reflect recurring vegetative populations via natural ecological processes (e.g. hydrology and fire) (FNAI 2010). Clusters that did not resemble natural community types were investigated at the plot level and classified into one of such landcover types primarily by comparing aerial photos from the late 1940's and early 1950's to 2007, and furthermore by comparing vegetative information associated with these altered landcover types when it was provided in FNAI (2010) descriptions.

Results

Cluster Analyses

The cluster analysis for the FR group resulted in 4.38% chaining and identified 7 natural community types that were consistent with FNAI descriptions (FNAI 2010), with 36% of the information remaining where pruning occurred (Figure 2-1). According to FNAI (2010) descriptions, 5 of the community clusters consisted of freshwater forested wetlands: alluvial forest, basin/dome swamp, bottomland forest, floodplain swamp, and hydric hammock; with the 6th community cluster being a marine/estuarine vegetated wetland: mangrove swamp. Basin and dome swamps can be challenging to distinguish from one another because they have a similar species composition, the same set of dominant species, and can take on the same physical shape (circular to irregular). However the dome swamp always occurs adjacent to pyrogenic communities and the basin swamp may or may not occur adjacent to such communities, allowing basin swamps to accumulate more peat than dome swamps (FNAI 2010). Therefore, additional information such as fire frequency of adjacent community type and depth of peat accumulation would be needed in order to clearly distinguish the two community types from one another. Since such additional data were not collected in this study, basin and dome swamps could not be definitively distinguished. As a result they were analyzed as one community type and are referred to as the basin/dome swamp. The cluster analysis stratified the basin/dome swamp into two distinct clusters, one dominated by *Nyssa sylvatica*; basin/dome swamp (*N. sylvatica*) and one dominated by *Taxodium ascendens*; basin/dome swamp (*T. ascendens*). This split increased the number of community clusters to a total of 7.

The cluster analysis for the FE group resulted in 7.92% chaining and identified 5 natural community types consistent with FNAI descriptions, with 44% of the information remaining where pruning occurred. Ten of the 31 plots or 32% of the plots that clustered together did not resemble the natural communities described by FNAI. The cluster analysis was rerun with the 21 remaining plots and resulted in the same community clusters as with all 31 plots, however chaining increased to 10.29% while the information remaining where pruning occurred decreased to 36% (Figure 2-2). The natural community clusters consisted of 1 upland hardwood forest: mesic hammock; 3 freshwater forested wetlands: basin/dome swamp (*T. ascendens*), bottomland forest, hydric hammock; and 1 marine/estuarine vegetated wetland: mangrove swamp (FNAI 2010). Since the remaining 10 plots did not resemble natural community types, they were classified into an altered landcover type, with 1 plot occurring in *semi-improved pasture*, 1 in a *clearing*, 1 was *developed*, and 1 was an *invasive exotic monoculture*. The remaining 6 plots most closely resembled an *impoundment/artificial pond*. Since altered landcover classifications did not align with how plots clustered, they were not valid community types and thus were not further analyzed.

The cluster analysis for the IE group resulted in 5.32% chaining but no clusters resembled natural community types consistent with FNAI (2010) descriptions, thus the dendrogram depicting this group's cluster analysis was not included. As with the 10 plots that did not resemble natural community types in the FE group, all 20 plots in the IE group were also classified into an altered landcover type, 19 of which fit best into the *developed* altered landcover type and 1 plot best fit into the *road* classification. And like the altered landcover types in the FE group, they did not align with how plots clustered in the IE group either; hence they were not valid community types and as a result were not further analyzed.

Community Comparison to FNAI Descriptions

Forested/remnant (FR) group

The alluvial forest cluster was composed of 9 total species, 8 of which were common to alluvial forest communities (FNAI 2010) (Table 2-1). All 8 species were present in the tree stratum and made up a cumulative IV of 93.24. *Fraxinus pennsylvanica* (IV = 47.27), *Acer rubrum* (IV = 14.84), *Taxodium distichum* (IV = 8.22), and *Cephalanthus occidentalis* (IV = 6.76) were the dominant species in this same stratum, all of which were common to alluvial forests except for *C. occidentalis*. In the shrub stratum 6 of the 7 species present were common to alluvial forests and made up a cumulative IV of 45.69, with 2 out of the 3 dominant species being common to this community type: *C. occidentalis* (IV = 54.31), *F. pennsylvanica* (IV = 12.22), and *T. distichum* (IV = 11.25).

The basin/dome swamp cluster dominated by *Taxodium ascendens* was made up of 22 total species, 14 of which were common to basin/dome swamp communities (FNAI 2010) (Table 2-2A). All 14 species were present in the tree stratum and made up a cumulative IV of 87.37. Dominant species in this same stratum were *T. ascendens* (IV = 46.42), *Ilex cassine* (IV = 9.57), *Myrica cerifera* (IV = 8.89), *Persea borbonia* (IV = 7.70), and *Quercus laurifolia* (IV = 5.18), all of which were common to basin/dome swamp communities except for *P. borbonia*. In the shrub stratum 7 species were common to basin/dome swamp communities and together made up a cumulative IV of 59.51. Two of the 5 species dominant in this community were not common to basins/dome swamps, the most dominant of which was the category I invasive *Ludwigia peruviana* (IV = 21.40) (FLEPPC 2009) and then the weedy native *Baccharis halimifolia* (IV = 7.31) (Godfrey 1988). The remaining 3 dominant species consisted of *M. cerifera* (IV = 19.05), *C. occidentalis* (IV = 18.99), and *Lyonia lucida* (IV = 8.96). Though two additional category I invasives (FEPPC 2009) *Sapium sebiferum* and *Schinus terebinthifolius*, were present in this cluster, together they made up less than 5% of the shrub species importance but brought the total IV of category I invasives up to 25.82 in the shrub stratum. And while *S. sebiferum* was present in the tree stratum it made up less than 2% species importance.

The basin/dome swamp cluster dominated by *Nyssa sylvatica* was made up of 14 total species, 11 of which were common to basin/dome swamp communities (FNAI 2010) (Table 2-2B). Eight of the 11 species were present in the tree stratum and made up a cumulative IV of 98.69. Among these, 3 were dominant in the same stratum: *N. sylvatica* (IV = 43.20), *A. rubrum* (IV = 23.69), and *I. cassine* (IV = 11.88). In the shrub stratum 6 of the 8 species present were common to basin/dome swamps and made up a cumulative IV of 83.64. Dominant species in this same stratum were *L. lucida* (IV = 24.43), *C. occidentalis* (IV = 22.16), *A. rubrum* (IV = 10.80), *M. cerifera* (IV = 10.80), and *P. borbonia* (IV = 8.52), all of which were common to basin/dome swamps except for *P. borbonia*.

The bottomland forest cluster was made up of 38 total species, 14 of which were common to bottomland forest communities (FNAI 2010) (Table 2-3). Thirteen of the 14 species were present in the tree stratum and made up a cumulative IV of 74.41. Dominant species in the same stratum consisted of *Q. laurifolia* (IV = 29.27), *A. rubrum* (IV = 10.16), *Ulmus americana* (IV = 9.08), *Liquidambar styraciflua* (IV = 9.07), *T. distichum* (IV = 7.38), *T. ascendens* (IV = 5.69), and *Sabal palmetto* (IV = 5.62), with the latter 2 species uncommon to bottomland forests. Eight of the shrub species present were common to bottomland forests and made up a cumulative IV of 30.54. Dominant species in the same stratum consisted of *S. palmetto* (IV = 27.29), *Sabal minor* (IV = 11.01), *L. lucida* (IV = 6.01), *Serenoa repens* (IV = 5.01), *A. rubrum* (IV = 4.89), *L. styraciflua* (IV = 4.73), *Itea virginica* (IV = 4.18), *M. cerifera* (IV = 3.94), *Gleditsia* spp. (IV = 3.67), *Callicarpa americana* (IV = 3.56), and *Prunus serotina* (IV = 2.70), 4 of which were common to bottomland forest communities (Table 2-3). Four of the species present in this cluster were introduced to Florida; *Citrus aurantium, Peltophorum pterocarpum, Cinnamomum camphora, and S. sebiferum,* with the latter two listed as category I invasives (FLEPPC 2009). Of these, all were present in the tree stratum with a cumulative IV of 5.64 and only *P. pterocarpum* was present in the tree stratum (IV = 3.09).

The floodplain swamp cluster was made up of 25 total species, 12 of which were common to floodplain swamp communities (FNAI 2010) (Table 2-4). Nine of the 12 were present in the tree stratum and made up a cumulative IV of 88.95. Of these, 5 made up species dominance in the same stratum: *T. distichum* (IV = 45.03), *U. americana* (IV = 10.59), *Q. laurifolia* (IV = 10.19), *N. sylvatica* (IV = 7.30), and *A. rubrum* (IV = 6.05). Six of the shrub species present were common to floodplain swamps and made up a cumulative IV of 63.91. Six species were also dominant in this same stratum but only 4 were common to floodplain swamps: *Q. laurifolia* (IV = 22.69), *I. virginica* (IV = 11.16), *C. occidentalis* (IV = 9.96), and *S. palmetto* (IV = 8.18), with the remaining 2 consisting of the category I invasive *L. peruviana* (IV = 17.18), and the native *L. lucida* (IV = 7.58).

The hydric hammock cluster was made up of 26 total species, 14 of which were common to hydric hammocks (FNAI 2010) (Table 2-5). Twelve of these were present in the tree stratum and made up a cumulative IV of 94.01. Among these, 4 species dominated the tree stratum: *Carpinus caroliniana* (IV = 29.57), *S. palmetto* (IV = 27.24), *L. styraciflua* (IV = 14.37), and *Quercus nigra* (IV = 6.70). In the shrub stratum 10 of the 14 species common to hydric hammock communities were present and made up a cumulative IV of 76.52. Five species were dominant in this same stratum but only 3 were common to hydric hammocks: *S. palmetto* (IV = 43.05), *C. americana* (IV = 11.63), and *L. styraciflua* (IV = 6.58), with the remaining species being *S. repens* (IV = 13.35) and *P. borbonia* (IV = 3.41). One introduced species; *Citrus aurantium*, was present but made up < 1% of the IV in the tree stratum.

The mangrove swamp cluster was made up of 3 total species, all of which were common to mangrove swamp communities (FNAI 2010) (Table 2-6). *Avicennia germinans* and *Rhizophora mangle* were the only two species present in the tree stratum with *R. mangle* (IV = 60.22) more dominant than *A. germinans* (IV = 39.78). *R. mangle* (IV = 56.25) was also the most dominant species in the shrub stratum in addition to *B. frutescens* (IV = 22.92), a species characteristic of mangrove swamp communities but not commonly occurring (FNAI 2010).

Forested/emergent (FE) group

This basin/dome swamp cluster dominated by *Taxodium ascendens* was composed of 13 total species, 9 of which were common to basin/dome swamp communities (FNAI 2010) (Table 2-7). Seven of the 9 species were present in the tree stratum and made up a cumulative IV of 84.97. Dominant species in this same stratum were *Taxodium ascendens* (IV = 44.41), *Magnolia virginiana* (IV = 22.45), and *Persea borbonia* (IV = 15.03), all of which were common to basin/dome swamps except for *P. borbonia*. Six of the 9 species present in the shrub stratum were common to basin/dome swamps and made up a cumulative IV of 79.32. These same 6 dominated the shrub stratum: *Myrica cerifera* (IV = 23.64), *Lyonia lucida* (IV = 22.05), *Cephalanthus occidentalis* (IV = 8.41), *Ilex cassine* (IV = 8.41), *M. virginiana* (IV = 8.41), and *T. ascendens* (IV = 8.41) in addition to one other species not common to basins/dome swamps; *Sabal palmetto* (IV = 8.41). One category I invasive species, *Ludwigia peruviana* (FLEPPC 2009), was present but not a dominant component in this cluster and contributed less than 6% of shrub species importance.

The bottomland forest cluster was made up of 27 total species, 9 of which were common to bottomland forest communities (FNAI 2010) (Table 2-8). All 9 species were present in the tree stratum and made up a cumulative IV of 80.98. Dominant species in the same stratum were *Quercus laurifolia* (IV = 24.64), *M. cerifera* (IV = 16.85), *Nyssa sylvatica* (IV = 11.47), *Taxodium distichum* (IV = 11.07), *I. cassine* (IV = 8.29), and *P. borbonia* (IV = 4.79), all of which were common to bottomland forests except *P. borbonia*. In the shrub stratum, 4 species were common to bottomland forest communities and made up a cumulative IV of 46.19. Eight species were dominant in this same stratum but only 4 were common to bottomland forests: *M. cerifera* (IV = 26.96), *Q. laurifolia* (IV = 10.60), *I. cassine* (IV = 4.51), and *Acer rubrum* (IV = 4.12), with the remaining species being *Serenoa repens* (IV = 14.07), *S. palmetto* (IV = 9.66), *Rubus* spp. (IV = 4.83), and *P. borbonia* (IV = 4.19). While not dominant components of this cluster, 2 category I invasive species, *L. peruviana* and *Sapium sebiferum* (FLEPPC 2009), were present, with the latter contributing < 5% to tree species importance and the former contributing < 2% to shrub species importance.

The hydric hammock cluster was made up of 13 total species, 7 of which were common to hydric hammock communities (FNAI 2010) (Table 2-9). Six of these were present in the tree stratum and made up a cumulative IV of 95.98. Four of the 6 dominated this same stratum: *Quercus virginiana* (IV =37.57), *Liquidambar styraciflua* (IV = 23.88), *Q. laurifolia* (IV = 11.83), and *Pinus elliottii* (IV = 9.31). In the shrub stratum, 3 species were common to hydric hammocks and made up a cumulative IV of 38.30. Dominant species in the same stratum included *S. repens* (IV = 40.45), *Callicarpa americana* (IV = 23.41), *L. styraciflua* (IV = 8.18), and one category I invasive species *Cinnamomum camphora* (IV = 7.84), with *S. repens* and *C. camphora* uncommon to hydric hammocks.

This mangrove swamp cluster was made up of 10 total species, 2 of which were common to mangrove swamp communities (FNAI 2010) (Table 2-10). Both species were present in the tree stratum and made up a cumulative IV of 95.86. *Avicennia germinans*, a characteristic species of mangrove swamps, dominated the tree stratum (IV = 95.86). *A. germinans* was the only species common to mangrove swamps that was present in the shrub stratum and had an IV of 32.58. This species was also the most dominant species in the shrub stratum in addition to *S. repens* (IV = 21.97) and the category I invasive *Schinus terebinthifolius* (IV = 21.97) (FLEPPC 2009).

The mesic hammock cluster was made up of 22 total species, 11 of which are common to mesic hammock communities (FNAI 2010) (Table 2-11). Nine of the 11 were present in the tree stratum and made up a cumulative IV of 67.98. Dominant species in this same stratum included *Quercus nigra* (IV = 26.55), *Quercus hemisphaerica* (IV = 22.47), *T. ascendens* (IV = 13.99), *Vaccinium corymbosum* (IV = 6.78), and *Quercus geminata* (IV = 6.72), with *T. ascendens* and *Q. geminata* uncommon to mesic hammocks. In the shrub stratum, 6 species were common to this community type and made up a cumulative IV of 70.97. Dominance in this same stratum was largely made up of *S. repens* (IV = 48.59), with the remaining species being a mix of those common and uncommon to mesic hammock communities (Table 2-11); all of which had an IV ≤ 5.51 and are listed in their order of dominance: *Vaccinium arboreum*, *T. distichum*, *Vaccinium corymbosum*, *Viburnum odoratissimum*, *L. styraciflua*, *Lyonia ferruginea*, *M. cerifera*, *Quercus laevis*, *S. palmetto*, and *Viburnum obovatum*.

Community Species Richness

In the FR group the bottomland forest had the greatest total and native species richness overall and in both the tree and shrub strata, while the mangrove swamp had the least total species richness overall and in both the tree and shrub strata (Table 2-12). The basin/dome swamp (*T. ascendens*), bottomland forest, and hydric hammock clusters had the presence of introduced species in the tree stratum, with the basin/dome swamp (*T. ascendens*) the only cluster with the presence of an invasive species. In the shrub stratum the basin/dome swamp (*T. ascendens*), bottomland forest, and floodplain swamp clusters all had the presence of introduced and invasive species, with the greatest introduced species richness in the bottomland forest and the greatest invasive species richness in the basin/dome swamp (*T. ascendens*) cluster.

The FE group had similar trends as the FR group, with the bottomland forest having the greatest total and native species richness overall and in both the tree and shrub strata, and the mangrove swamp having the least total and native species richness overall and in the shrub stratum, with the basin/dome swamp (*T. ascendens*) and the mangrove swamp having the lowest tree species richness. The bottomland forest, hydric hammock, and mangrove swamp clusters had the presence of introduced species in the tree stratum; all of which were also invasive species (Table 2-13). All clusters had the presence of invasive species in the shrub stratum except for the mesic hammock whose introduced species was not invasive.

When looking at species richness of cluster types that occurred in both the FR and FE groups (basin/dome swamp (*T. ascendens*), bottomland forest, hydric hammock, and mangrove swamp), overall native species richness was greater for clusters in the FR group than the FE group, except for the mangrove swamp cluster which had a greater overall native species richness in the FE cluster. This same trend was observed with introduced and invasive species richness in the basin/dome (*T. ascendens*) and bottomland forest clusters but the hydric hammock and mangrove swamp clusters in the FE group had a greater overall introduced and invasive species richness, with the majority of introduced and invasive species in the shrub stratum of the FR community clusters and in the tree stratum of the FE community clusters.

Community Structure

In the FR group the mangrove swamp stood out from all other cluster types, with the greatest average TPA and the lowest average BA/acre, DBH, tree height, and percent tree cover (Table 2-14) occurring in this cluster. The floodplain swamp cluster had the greatest average BA/acre, DBH, and tree height and the basin/dome swamp (*N. sylvatica*) had the greatest percent tree cover. In the shrub stratum, the mangrove swamp did not stand out as it did in the tree stratum. Instead, the alluvial forest cluster had the greatest average shrub height and the hydric hammock had the lowest. The latter community also had the greatest percent shrub cover and the floodplain swamp had the lowest.

As with the FR group, the mangrove swamp in the FE group had the greatest average TPA and the lowest average BA/acre, DBH, and tree height (Table 2-15). The basin/dome swamp (*T. ascendens*) had the greatest average BA/acre and the lowest percent tree cover while the mesic hammock had the greatest average tree height and percent tree cover. The hydric hammock cluster had the greatest average DBH and percent tree cover while having the lowest average TPA. In the shrub stratum, the mangrove swamp and the hydric hammock had the lowest percent shrub cover and the mesic hammock had the greatest. The hydric hammock also had the lowest average shrub height while the basin/dome swamp (*T. ascendens*) had the greatest average shrub height.

Though the average BA/acre was similar for the basin/dome swamps dominated by *T. ascendens* in both the FR and FE groups, the FE group had a greater average TPA. Yet the average tree height and average percent tree cover were still greater in the FR group, while average shrub height and percent shrub cover were greater in the FE group. In the bottomland forest clusters all structural metrics were greatest in the FR group except the average percent shrub cover, which was greater in the FE group. In the hydric hammock clusters the average BA/acre and TPA were greatest in the FR group, but the FR cluster had almost 3 times greater average TPA than the FE cluster. In addition, the FE cluster had a greater average DBH and percent tree cover. This same community cluster in the FR group had a greater shrub height and percent cover on average than the cluster in the FE group. The mangrove swamp cluster in the FE group had a greater BA/acre and TPA than the FR group on average; however, the FE cluster had an average TPA 2 times greater than that in the FR group. Though average DBH and percent tree cover were similar between the FR and FE groups, the FR group had a greater tree height on average. In the shrub stratum, the mangrove swamp cluster in the FR group had a greater average shrub height while the FE cluster had a greater average percent tree cover.

Community Diameter Distribution

In the FR group the mangrove swamp cluster had the greatest number of stems/acre on average that were made up of native species, with 87% of the stems occurring in the smallest diameter class (Table 2-16). This same cluster was also the only cluster that did not have stems present in the two largest diameter classes. The floodplain swamp cluster had the least number of total native stems/acre on average but the greatest relative percent (30%) occurring in the two largest diameter classes. Though the presence of introduced and invasive stems were mostly in the smaller diameter classes, the bottomland forest cluster had the greatest number of introduced stems/acre on average, however none were invasive, whereas the basin/dome swamp (*T. ascendens*) was the only cluster in the FR group with the presence of invasive stems.

As with the FR group, the mangrove swamp cluster in the FE group had the greatest number of total native stems/acre on average (Table 2-17); however, almost

100% of the stems in this cluster were in the smallest diameter class. The hydric hammock cluster had the least number of total native stems/acre on average in the FE group. And like the FR group, the bottomland forest cluster of the FE group had the greatest number of introduced stems/acre on average; however, all introduced stems in the FE group were made up of invasive species whereas only one cluster with introduced stems in the FR group had invasive species (Table 2-16).

Overall, the mangrove swamp cluster of the FE group had a greater number of total stems/acre on average then the same cluster type in the FR group. In addition, the mangrove swamp cluster in the FE group had the presence of invasive stems whereas the cluster in the FR group had no introduced or invasive stems. The bottomland forest clusters had the greatest number of introduced stems/acre on average than any other community cluster in this study. However, the FE cluster had a slightly higher number of introduced stems/acre on average, all of which were made up of an invasive species, whereas the introduced stems in the FR cluster were not invasive. Though the hydric hammock cluster in the FR group had a greater total number of native stems/acre on average than the same cluster in the FE group, 43% of the stems were in the 3 largest diameter classes compared to 50% of the stems in the same community cluster of the FE group. Additionally, the hydric hammock cluster in the FE group had the presence of invasive stems, whereas this same community cluster in the FR group did not. Both the basin/dome swamp (*T. ascendens*) and bottomland forest clusters had a greater number of native stems/acre on average in the 2 smallest diameter classes of the FE group than the same community clusters of the FR group, while on the converse, these community clusters had a greater number of stems/acre on average in the 2 largest diameter classes of the FR group than the FE group.

Community Ground Cover

Rock, maintained grass, and impervious surface area were absent from the clusters in the FR group, except for the mangrove swamp cluster which had a low (3%) average percent rock present (Table 2-18). Bare soil was present in 3 out of 7 clusters with the greatest average proportion occurring in the hydric hammock cluster and the lowest average proportion occurring in the bottomland forest cluster. Duff/mulch/leaf litter was present in all clusters except the mangrove swamp, with the floodplain swamp having the lowest average percent cover and the basin/dome swamp (*T. ascendens*) cluster having the greatest average percent cover. Herbaceous vegetation was the only cover type present in all clusters, with the lowest average percent cover in the mangrove swamp and the greatest average percent cover in the floodplain swamp. Of the clusters that had unmaintained grass and water as part of their groundcover, the basin/dome swamp cluster (*N. sylvatica*) had the greatest average percent cover of unmaintained grass and the hydric hammock cluster had the lowest, where the mangrove swamp had the greatest average percent cover of water and the bottomland forest had the lowest.

As with the FR group, rock, maintained grass, and impervious surface area were absent from all clusters in the FE group, except for the mesic hammock cluster which had a low (5.3%) average percent impervious surface area present (Table 2-19). In addition, bare soil had the greatest average percent cover in the mesic hammock cluster and the lowest average percent cover in the bottomland forest cluster of the FE group. All clusters in the FE group had the presence of duff/mulch/leaf litter and herbaceous vegetation, however, the greatest average percent cover of the former and lowest average percent cover of the latter occurred in the mesic hammock cluster, while the greatest average percent cover of the latter occurred in the basin/dome swamp (*T. ascendens*) cluster and the lowest average percent cover of the former occurred in the mangrove swamp cluster. The bottomland forest cluster had the greatest average percent cover of unmaintained grass and the mesic hammock cluster had the lowest. Finally, the mangrove swamp was the only cluster with the presence of water in the ground cover.

The basin/dome swamp (*T. ascendens*) cluster in both the FR and FE groups had the presence of only duff/mulch/leaf litter and herbaceous vegetation; however, ¾ of the cluster in the FR group were made up of the former and ¾ of the cluster in the FE group were made up of the latter (Tables 2-18 and 2-19). The bottomland forest cluster had the presence of the same ground cover classes in both the FR and FE groups except for the presence of water, which occurred in the cluster in the FR group. The greatest proportion of average percent ground cover for this same community cluster was made up of duff/mulch/leaf litter for both FR and FE groups. The greatest proportion of ground cover in the hydric hammock clusters of both FR and FE groups was made up of duff/mulch/leaf litter on average, and while the FE cluster had a greater proportion of herbaceous vegetation and unmaintained grass on average than the FR cluster, the FR cluster had a greater proportion of bare soil. Almost 82% of the ground cover in the mangrove swamp cluster of the FR group was made up of water on average, with the remaining ground cover occurring as unmaintained grass, herbaceous vegetation, and rock (Table 2-18). The ground cover of the same community cluster in the FE group was made up of the same cover classes as in the FR group, with the exclusion of rock and the addition of duff/mulch/leaf litter. And like the FR cluster, water made up the greatest proportion of ground cover at 70%, with the remaining cover types being equally distributed.

Community Hydrology and Elevation

In this study soil drainage classes ranged from 1 to 7 (Table 2-20). Areas with greater than 85% impervious surface area had a drainage class called ‘urban’ (class 7) because USDA (1989) could not identify soil classes under those conditions. The most common (mode) soil drainage class for all clusters in the FR group was a 5 (Table 2-21) or very poorly drained (Table 2-20), with the exception of the mangrove swamp cluster. This cluster was made up of 3 plots, none of which had a common soil drainage class and thus no mode could be determined for this cluster. Average elevation among clusters in the FR group ranged from .4 to 47.9 feet, with the mangrove swamp at the lowest average elevation and the basin/dome swamp (*N. sylvatica*) at the highest average elevation.

The most common soil drainage class for all clusters in the FE group was a 4 (Table 2-21) or poorly drained (Table 2-20), with the exception of the basin/dome swamp (*T. ascendens*) cluster, which had the same soil drainage class in all plots that made up this cluster. Average elevation among clusters in the FE group ranged from 1.0 to 70.9 feet, with the mangrove swamp having the lowest average elevation and the hydric hammock having the highest average elevation.

Both basin/dome swamp (*T. ascendens*) clusters had the same soil drainage class but the cluster in the FR group occurred at a lower average elevation than the FE cluster. The bottomland forest and hydric hammock clusters in the FR group had a soil drainage class that had water at shallower depths and longer annual periods of accumulation than the FE group. These same clusters were also present at lower average elevations in the FR group than the FE group. Lastly, the most frequent soil drainage class for the mangrove swamp cluster in the FR group could not be determined, but this cluster had soil drainage classes of 3, 5, and 6, where the most frequent soil drainage class in the FE group was a 4 and the soil drainage classes for this cluster were 4, 4, and 6 (Table 2-20). This same community cluster type had a slightly lower elevation in the FR group than the FE group.

Discussion

Cluster Analyses

All plots in the FR group and approximately 66% of the plots in the FE group aggregated into clusters that had a species composition consistent with the natural community types described by FNAI. Chaining in the FR cluster analysis (4.38%) was lower than the final FE cluster analysis (10.29%), suggesting the number of plots aggregating into a community cluster was more evenly distributed in the FR group than the FE group (Williams et al. 1966). This could simply be a function of sample size or could also suggest that there was greater homogeneity within clusters in the FR group than the FE group (Gotelli and Ellison 2004, McCune and Grace 2002). However, the amount of information remaining (36%) where pruning occurred was equal for both the FR and FE groups, thus the same amount of information was used when interpreting community types for both groups (McCune and Grace 2002).

Approximately 33% of the plots in the FE group and all plots in the IE group aggregated into clusters that did not resemble natural community types. For both the FE and IE groups, reclassifying plots into an altered landcover type from clusters that did not resemble natural community types did not help to further understand why plots clustered the way they did. In fact, the majority of the plots in each group were of one altered landcover type, which highlighted the heterogeneity of vegetation within these cover types rather than identified distinct vegetative assemblages. One of the main purposes for conducting a cluster analysis is to take an ecological dataset (in this case the percent cover of each species within each plot for a group) and divide it into more homogeneous subsets that are biologically meaningful (McCune and Grace 2002). However, vegetation tends to become more heterogeneous with increasing disturbance from urbanization (Kowarik 1990) so it is not surprising that vegetation assemblages could not be further identified using data from altered landcover types. However, the fact that each plot could be classified into an altered landcover type suggests that there were additional factors likely related to these landcover types that further influenced the composition and structure of vegetation there. While Grove et al. (2006) did not look specifically at vegetative species, they did find that human lifestyles and behaviors best predicted vegetation cover on altered landcover types in an urban area in Baltimore, MD and suggested that income and education would also be useful predictors of vegetation cover in this same setting. Thus, it is probable that a socioeconomic investigation will provide further insight into the vegetation assemblages associated with anthropogenically altered landcover types (Alberti 2005).

Natural Community Clusters

Alluvial forest

Species composition of the alluvial forest community is highly dependent on the hydroperiod where it occurs and the composition of species in this cluster was very similar to FNAI descriptions of this community type in Peninsular Florida (FNAI 2010). However, *Nyssa sylvatica* and *Taxodium distichum* are two species known to occur within this community type as minor components (FNAI 2010) and while not the most dominant species, *T. distichum* was a dominant component of the tree stratum in this cluster. Additionally, *Cephalanthus occidentalis* was the most dominant species in the shrub stratum but is not listed by FNAI as one that occurs within this community. *C. occidentalis* is commonly found where surface water is present most of the time (Godfrey 1988), and the soil drainage class in this cluster (very poorly drained) supports such conditions. Alluvial forests occur adjacent to or intermixed with bottomland forests at greater elevations and floodplain swamps at lower elevations, with *C. occidentalis*, *N. sylvatica*, and *T. distichum* all common to floodplain swamps, which also tend to have longer hydroperiods than alluvial forests (FNAI 2010).

In the shrub stratum vegetation can be “slightly” to “moderately” abundant (FNAI 2010), and though it is uncertain what slightly or moderately equate to quantitatively, relative shrub cover (18%) in this community cluster was likely consistent with FNAI descriptions (Table 2-14). Groundcover tends to be variable in abundance (FNAI 2010) and greater than half (58%) of the average cover was duff/mulch/leaf litter, which is an important source of soil organic matter and soil nutrients in ecosystems with fluctuating water levels (Sharitz and Mitsch 1993, Wharton et al. 1982).

Though alluvial forests tend to occur at elevations just above floodplain swamps (FNAI 2010), the floodplain forest cluster in this study occurred at a higher elevation on average than the alluvial forest cluster. Elevations may vary due to local hydrological regimes that simultaneously build and erode sediment (Mitsch and Gosselink 2000). In addition, plots that made up community clusters were randomly located across the study area, making elevations variable not only among plots that made up clusters but also between community clusters.

Basin/dome swamp

Basin/dome swamps are typically dominated by a mix of both *Taxodium ascendens* and *N. sylvatica* (FNAI 2010). In the FR group, the basin/dome swamp community was aggregated into two clusters, one dominated by *T. ascendens* and one dominated by *N. sylvatica*, while the one occurring in the FE group was only dominated by *T. ascendens*. In the *T. ascendens* clusters, *N. sylvatica* made up ≤ 5% tree species importance in the FR group and was completely absent from the FE group, while in both groups *T. ascendens* made up a little less than half of the tree species importance (Table 2-2 and 2-7) and the majority of the stems/acre on average. Similarly, in the *N. sylvatica* cluster, *T. ascendens* was completely absent and *N. sylvatica* made up the majority of large stems/acre on average (Appendix A) and a little less than half of the species importance in the tree stratum (Table 2-2). While reasons for the absence of *N. sylvatica* from the *T. ascendens* clusters are uncertain, there are several possible explanations for *N. sylvatica*'s dominance in basin/dome swamps. Wharton et al. (1982) found that *N. sylvatica* dominated swamps that were continually flooded and had stagnant water. Though this study did not collect information about water flow, the soil drainage class on all basin/dome swamp clusters (*T. ascendens and N. sylvatica*) was the same (very poorly drained) and therefore not likely the reason for *N. sylvatica*'s dominance in the FR cluster. Gunderson (1984) found that *N. sylvatica* tends to dominate when *Taxodium* spp. are absent. Selection for *Taxodium* spp. during logging practices of the late 19th and early 20th centuries (Ewel 1990) may have contributed to the absence of *T. ascendens* from the *N. sylvatica* cluster. *Taxodium* spp. were commonly girdled prior to felling, making regeneration largely dependent on seed since girdling reduces coppice sprouts in this species (Gunderson 1977). However, seed trees were rarely left after logging (Gunderson 1977) and *Taxodium* spp. seed may only remain viable for a short time (Schneider and Sharitz 1986), thus confounding the absence of *T. ascendens* from the *N. sylvatica* cluster.

Persea borbonia was a dominant component of the tree stratum in both *T. ascendens* clusters and of the shrub stratum in the *N. sylvatica* cluster (Table 2-2 and 2-7) but is not mentioned by FNAI (2010) as being a species common in basin or dome swamps. However, the density of bay species tends to increase when fire has been absent from basin/dome swamp communities (Ewel 1990). In addition, shrub density is generally limited in basin/dome swamps but also increases when fire has been infrequent (FNAI 2010). Though *Persea* spp. had the 4th and 3rd greatest average BA/acre of all woody trees in the FR and FE groups of both *T. ascendens* clusters respectively (Appendix A and B) and average percent shrub cover was 57% and 44% in the *T. ascendens* FR and FE clusters respectively (Table 2-14 and 2-15), further research focused specifically on these metrics with and without fire would be needed in order to determine if their current density (BA/acre and percent shrub cover) was in fact due to a lack of fire. Another species uncommon to basin/dome swamps but present in the FE cluster was *Sabal palmetto*. *S. palmetto* is known to occur in floodplain swamps, which can be located adjacent to basin/dome swamps, and was likely present due to this reason (FNAI 2010).

All basin/dome swamp clusters had the presence of at least one weedy native in the shrub stratum; *Baccharis halimifolia*, *Rubus* spp. and *Sambucus nigra*, all of which are known to colonize disturbed wet areas (Godfrey 1988). However the *N. sylvatica* cluster only had the presence of native species, where the *T. ascendens* dominated clusters had the presence of category I invasives, which consisted of *Ludwigia* *peruviana*, *Sapium sebiferum* and *Schinus terebinthifolius*, all known to displace native communities (FLEPPC 2009) and known to inhabit the same areas as the weedy natives in these clusters (Godfrey 1988, Langland and Burkes 1998). Interestingly, the *T. ascendens* FR cluster had greater invasive species richness than the *T. ascendens* FE cluster, and was the only cluster with such species in the tree stratum, though all stems were in the smallest diameter class. Regardless, the fact that all clusters had the presence of species (native or introduced) common to disturbance suggests some form of it has taken place, though it has likely been greater in the *T. ascendens* clusters due to the presence of invasive species.

The drainage class for all basin/dome swamp clusters was very poorly drained; meaning water accumulates at least half of the year, which is typical of basin/dome swamps (Ewel 1990). Each basin/dome swamp cluster also had the presence of herbaceous vegetation on average (e.g. ferns, other vegetation < 1 foot tall) in the groundcover, with < 33% of this groundcover type in each of the FR clusters and > 75% of this same groundcover type in the FE cluster on average. Though herbaceous cover tends to be variable in basin/dome swamps (FNAI 2010) the presence of a greater proportion of this cover type in the FE cluster may be a function of light, since the FE cluster had the least proportion of canopy cover on average than the FR clusters, and Marois and Ewel (1983) found that the presence of grasses and sedges in cypress swamps were more strongly correlated with the availability of light rather than hydrological conditions.

Bottomland forest

Bottomland forest hydrology is highly variable (Wharton et al. 1982) and these communities are generally located adjacent to or within a matrix of hydric hammocks (at higher elevations) and alluvial forests and floodplain swamps (at lower elevations) (FNAI 2010). Hydrological variability and the tendency for bottomlands to occur with a mix of such community types lends itself to a species composition that is highly diverse, as is evidenced by both the FR and FE bottomland clusters having the greatest native species richness of all clusters within their respective groups. For example, *Carya glabra* commonly occurs in upland communities such as mesic hammocks and the drier areas of hydric hammocks (FNAI 2010) but was present in both the tree and shrub stratum in the FR community. Additionally, like alluvial forests, *N. sylvatica* and *T. distichum* may be present in bottomland forests but should not be dominant components of this community (FNAI 2010); however, *T. distichum* was a dominant component of the tree stratum in the FR and FE clusters, as well as *N. sylvatica* in the same stratum of the FE cluster. Hydric hammocks can be the most challenging to distinguish from bottomlands because they comprise a similar suite of species and occur within a matrix of adjacent communities that are common to both (FNAI 2010). However, hydric hammock canopies are dominated by palms and evergreen oaks; cumulative IV in the tree stratum: FR = 30.01 and FE = 28.01, whereas bottomland forests are made up of a mix of evergreen and deciduous species typical of both hydric and mesic conditions; cumulative IV in the tree stratum: FR = 94.64 and FE = 89.81 (FNAI 2010).

As with the basin/dome swamp clusters, both bottomland clusters had the presence of weedy natives in the shrub stratum, all of which are known to colonize disturbed wet areas (Godfrey 1988). The FR cluster had the presence of *B. halimifolia* and *B. halimifolia, Rubus* spp., and *S. nigra* were present in the FE cluster, with *Rubus* spp. being the only weedy native that was a dominant component of the FE cluster.

Though the bottomland forest clusters had the greatest number of introduced stems/acre on average than the other community clusters in their respective groups, none were dominant components of the tree stratum in either cluster (Table 2-3 and 2-8) and only the FE cluster had invasive stems. Four introduced species were present in the FR cluster but only two were invasive, whereas all introduced species in the FE cluster were invasive. *S. sebiferum* was the category I invasive that was common among both bottomland clusters and is known to specifically invade bottomland forests (FNAI 2010, Langland and Burks 1998). The category I invasive *Cinnamomum camphora* was present in the FR cluster and the category I invasive *L. peruviana* was present in the FE cluster, both of which also commonly colonize areas with disturbance (Godfrey 1988).

Topography within bottomlands is variable due to the fluctuating hydrological regime that simultaneously builds and erodes sediments along the floodplain where they occur. This results in areas of lower elevation with longer hydroperiods and areas of higher elevation with drier conditions (Sharitz and Mitsch 1993, Wharton et al. 1982). Though the minimum elevation was similar among both clusters, the maximum elevation was greatest in the FE cluster, in addition to the average elevation. As expected, the most frequent drainage class in the FR cluster (5; very poorly drained) had a longer hydroperiod than the most frequent drainage class in the FE cluster (4; poorly drained). Average percent shrub cover is also variable in bottomland forests and tends to decrease with longer hydroperiods and greater canopy cover (Wharton et al. 1982). Based on the most frequent drainage class and average percent canopy cover being slightly greater (75%) in the FR cluster than the FE cluster (66%), it is not surprising that the FR cluster had slightly less shrub cover on average (33%) than the

FE cluster (44%), further corroborating what Wharton et al. (1982) found. Interestingly, average vegetative groundcover (herbaceous vegetation and unmaintained grass) was greater in the FE cluster (34%) than the FR cluster (28%), and tends to be denser when shrub cover is sparse and vice versa (FNAI 2010). However, the dominant soil drainage class in the FE group was better drained than the FR groups cluster and likely further supported greater vegetative groundcover for that reason.

Floodplain swamp

The floodplain swamp is one of the more frequently inundated community types that occurred in this study, and has the least number of species that are common to it with the exception of the mangrove swamp. Not surprisingly, this cluster had the least number of stems/acre and TPA on average of all clusters in the FR group. However, the floodplain swamp cluster had the greatest average proportion (30%) of stems/acre in the two larger diameter classes combined than any other community cluster in the study, which attributed to it having the greatest average BA/acre, average DBH, and average tree height of all clusters in the FR group.

The canopy of floodplain swamps is generally closed and can be completely dominated by *T. distichum* but more often shares dominance with *Nyssa* spp. (FNAI 2010). The canopy in this cluster made up 69% tree cover on average and *T. distichum* was the most important species in this same stratum. Though *N. sylvatica* was also a dominant component of the same stratum it was 6 times less important than *T. distichum*. *T. distichum* and *T. ascendens* generally do not occur within the same community type because *T. distichum* is common to areas with flowing water and *T. ascendens* is common to areas with stagnant water (Ewel 1990). However, *T.*

ascendens was sparsely present in this cluster and has been known to occur in isolated depressions of floodplain swamps (FNAI 2010).

Shrub and ground cover are generally sparse because of the frequent presence of water, but are able to establish themselves on ridges that are located at higher elevations within the floodplain swamp (FNAI 2010). Though the average proportion of shrub cover was just 14%, the category I invasive *L. peruviana* was the second most important species in the shrub stratum. *B. halimifolia*, a weedy native species, was also present in the shrub stratum but was not a dominant component. While *L. peruviana* and *B. halimifolia* are common to disturbed areas (Godfrey 1988) they were only present in just 1 of the 9 plots (plot 877) that made up the floodplain swamp cluster, suggesting that disturbance was localized rather than a common occurrence in floodplain swamps within the study area. A large proportion (46%) of average ground cover consisted of herbaceous vegetation. Though this is almost ½ of the total average ground cover, flood tolerant herbs are known to occur in floodplain swamps (FNAI 2010) and the lack of average cover in the shrub and tree stratum may favor a denser herbaceous groundcover.

Lastly, like the other clusters in the FR group, the most frequent soil drainage class was very poorly drained, which is consistent with the long hydroperiods known to occur in floodplain swamps (FNAI 2010). Variation in average elevation among the plots that made up this cluster was likely due to a combination of the community types that can occur adjacent to floodplain swamps (alluvial forests, bottomland forests, and/or hydric hammocks) in addition to the natural variation in floodplain swamp topography.

Hydric hammock

Hydric hammocks are typically dominated by a combination of *Quercus* spp. and *S. palmetto* but like the other community clusters in this study, species composition is largely influenced by the frequency and duration of inundation (FNAI 2010, Vince et al. 1989). While both *Quercus* spp. and *S. palmetto* were present in the FR and FE hydric hammock clusters, their importance in each cluster varied and together made up less than half (44%) of the tree species importance (2-5) in the FR cluster and 63% of the tree species importance in the FE cluster (Table 2-9). Interestingly, *S. palmetto* contributed a greater proportion (63%) to the FR cluster than *Quercus* spp.; whereas *Quercus* spp. contributed the greater proportion (86%) to the FE cluster than *S. palmetto*. Vince et al. (1989) found that *S. palmetto* can tolerate longer periods of inundation than *Quercus* spp. in hydric hammocks and is likely the reason for its greater importance in the FR cluster than in the FE cluster. In addition, *Quercus virginiana* was the most important species in the tree stratum of the FE cluster, which Vince et al. (1989) found to occur in the areas of hydric hammocks that were less frequently flooded. Furthermore, hardwoods such as *Quercus* spp. are not as tolerant to fire as *S. palmetto*, and a lack of fire may further explain the greater importance of *Quercus* spp. in the FE cluster. Though the occurrence of fire is less frequent in hydric hammocks than in more fire adapted communities, Vince et al. (1989) suggested it does play a role in species composition; however, they found that the greatest influence on species composition in hydric hammocks was the hydroperiod.

Like the other natural community types present in this study, many of the species that occurred in hydric hammock clusters were also common to the natural community types that occur adjacent to them, such as those in the drier uplands (e.g. mesic hammock) and those in the more frequently flooded lowlands (e.g. alluvial forests, basin swamps, bottomland forests, and floodplain swamps) (FNAI 2010, Vince et al. 1989). *Serenoa repens*, a species common to mesic hammocks (FNAI 2010) was present in both the FR and FE clusters and was the most dominant component of the shrub stratum in the FE cluster, further supporting the overall drier or predominantly better drained conditions in the FE cluster than the FR cluster. *C. glabra* and *Magnolia grandiflora* are also common to mesic hammocks and while neither was present in the FE cluster they were not dominant components of the tree stratum in the FR cluster. On the converse, species typical of more frequently submerged areas such as *T. distichum* and *N. sylvatica* may occur intermixed with hydric hammock communities but like the alluvial and bottomland forest communities should not be dominant components (FNAI 2010). Both species were present in the FR cluster but made up less than 1% and 2% species importance in the tree and shrub strata respectively, and only *T. distichum* was present in the FE cluster and made up less than 1% of the species importance in the tree stratum. One species that was not present in either hydric hammock cluster but considered common to this community type was *Juniperus virginiana*. Vince et al. (1989) noted that this species was also absent in 60% of the hydric hammocks they investigated around the state of Florida, with the exception of the northern gulf coast region and upper St. Johns River, where they were locally abundant. Vince et al. (1989) suggested that the presence of *J. virginiana* was restricted to more saline hydric hammocks, not because it required saline conditions but because it was able to compete better in such circumstances, implying that the hydric hammock communities in this study were in fresh water.

The FE cluster had a greater occurrence of species characteristic of disturbance than the FR cluster. The FR cluster had the presence of 1 introduced species, *Citrus aurantium*, but it was present in just 1 of the 8 plots that made up this cluster. *C. aurantium* has become naturalized in Florida (Godfrey 1988) since it was introduced by the Spanish in the late 1700's and made up < 1% of the species importance in the tree stratum. The FE cluster however, had the presence of 1 weedy native in the shrub stratum and 1 category I invasive in both the tree and shrub strata, each with a greater importance value than *C. aurantium* in the FR cluster. The weedy native, *B. halimifolia*, was not a dominant component of the shrub stratum in the FE cluster, and the category I invasive, *C. camphora*, (FLEPPC 2009) was a dominant component of the shrub stratum but not of the tree stratum. Both species in the FE cluster are common to disturbed areas (Godfrey 1988) with *C. camphora* a common invasive of hydric hammocks (FNAI 2010).

Tree cover was greater in the FE cluster than the FR cluster on average and shrub cover was greater in the FR cluster than the FE cluster on average. Such an occurrence is not surprising since understory establishment in hydric hammocks is largely a function of openings in the canopy (Platt and Schwartz 1990). Ground cover of hydric hammocks is generally a light to moderate mixture of graminoids and ferns (FNAI 2010). While it is uncertain if the herbaceous vegetation in this study included ferns (ground cover data was collected in broad classes), there was a greater proportion of herbaceous vegetation and unmaintained grass on average in the FE cluster (37%) than the FR cluster (18%). This was not expected since there was less canopy cover in the FR cluster. However, soil drainage class and elevation also play a role in ground cover establishment, since Vince et al. (1989) found that ground cover was absent from the low wet portions of the hydric hammocks they studied, and the most frequent soil drainage class of the FR cluster had a longer hydroperiod than the FE cluster. In addition, the FE cluster had greater variation in elevation and an overall higher average elevation than the FR cluster, which likely supported drier conditions in the FE cluster than the FR cluster.

Mangrove swamp

Mangrove swamps are naturally low in species richness (Olmsted and Loope 1984) and both the FR and FE clusters had the least number of species than any other community type within their respective groups. The common suit of species in mangrove swamps are capable of inhabiting both freshwater and saltwater environments (Teas 1979), but they have a competitive advantage in saline conditions (Kuenzler 1974) and thus thrive in flat coastal areas (FNAI 2010). Both clusters had the presence of *Avicennia germinans* and *Rhizophora mangle*, 2 of the 4 main species common to mangrove swamps, but the latter species was most important in the tree and shrub strata of the FR cluster and the former species was most important in the tree and shrub strata of the FE cluster. In addition to flat coastal areas, mangrove swamps commonly occur in locations where the wave energy is low (Odum et al. 1982) and the water level regularly fluctuates; either from tidal changes or freshwater runoff (Odum and McIvor 1990). *R. mangle* is common in the deeper portions of mangrove swamps and *A. germinans* in the more moderately inundated portions of these swamps (Odum and McIvor 1990), thus the dominance of *R. mangle* in the FR cluster and *A. germinans* in the FE cluster suggests that the FR cluster was more submerged than the FE cluster.

The FE cluster had greater species richness overall than the FR cluster, with only 1 additional species in the FR cluster and 8 in the FE cluster. *Borrichia frutescens*, a native but weedy species in the shrub stratum (Godfrey 1988), was the only other species present in the FR cluster and can occur along the edges of mangrove swamps or in openings within these swamps (FNAI 2010). Carlton (1977) documented *B. frutescens* in what he called mangrove-marsh sites on Florida's Gulf coast, and its presence may be a function of these two communities occurring intermixed with one another, as was found by (Olmsted and Loope 1984). However, the additional 8 species in the FE cluster were uncommon to mangrove swamps, 7 of which occurred in just 1 of the 3 plots (plot 132) that made up this cluster. This plot was dry and unforested in the 1948 aerial and in the 2007 aerial extensive mosquito ditching had occurred at and around this plots location. Mosquito ditching increases the flow of saltwater landward (Ball 1980) and was likely the reason a mix of species known to colonize a variety of habitat types and moisture regimes occurred in one location, including native species known to inhabit areas with disturbance (*B. halimifolia*, *Myrica cerifera*, and *Prunus serotina*) (Godfrey 1988) and the category I invasive *S. terebinthifolius* (FLEPPC 2009), also known to invade areas with disturbance as well as mangrove swamps (FNAI 2010, Langland and Burks 1998).

Both clusters had a large number of stems/acre on average but the FE cluster had 34% more stems/acre on average than the FR cluster. However, 99% of the average stems/acre in the FE cluster were in the smallest diameter class, whereas 13% of the average stems/acre in the FR cluster occurred in the second largest diameter class. This was not surprising since the vegetation in the FE cluster has emerged since 1948 and the vegetation in the FR cluster was established prior to that time and thus, had more time for growth and development. This is further evidenced by the FR cluster having a greater average tree height than the FE cluster, since both *A. germinans* and

R. mangle can reach the same maximum heights (Godfrey 1988). The larger stems that did occur in the FE cluster made up less than 1% of the total number of stems/acre on average and were composed of *Q. virginiana*, another species uncommon to mangrove swamps (FNAI 2010). In addition, the FE cluster had the presence of *S. terebinthifolius* in the tree stratum, albeit less than 1% of average stems/acre were composed of this species.

Though mangrove swamps generally lack an understory (FNAI 2010) average shrub cover was greater in the FE cluster (37%) than the FR cluster (20%). This is partly due to many of the stems being too short and/or not having the minimum diameter to be considered a tree in this study. The majority of the average percent ground cover in both clusters was made up of water but the FR cluster had a greater proportion (82%) than the FE cluster (70%). While the average elevation in both clusters suggested they were almost at sea level, the FE cluster was at a slightly higher average elevation than the FR cluster, further supporting the somewhat drier conditions in the FE cluster. Furthermore, the soil drainage classes in each plot that made up these clusters suggests the FR cluster had a greater presence of more poorly drained conditions than the FE cluster, with the exception of one plot (102) in the FR cluster. This plot had a soil drainage class of 3 or somewhat poorly drained, meaning the depth to free water was greater than the other two plots that made up this cluster and the hydroperiod was more variable (Table 2-20). Though this plot occurred on the Tampa Bay coastline, a rock wall that bordered a nearby building was present within the plot and likely influenced the overall soil drainage class within it; however, the plot was clearly tidally influenced. This same plot was the source of the remaining average percent ground cover in the FR cluster, including rock which is an uncommon ground cover in mangrove swamps (FNAI

2010). Similarly, one plot 132 was also the source of the remaining average ground cover in the FE cluster and was the least submerged of all plots in that cluster.

Mesic hammock

While mesic hammocks develop on higher ground in naturally fire protected areas, they are frequently born out of pine-dominated communities that have been taken over by hardwoods due to a lack of fire (FNAI 2010). Mesic hammocks can also occur where water levels in hydric hammocks have lowered due to drought or human alterations in the hydrology (Haag and Lee 2010). Mature mesic hammocks are typically dominated by *Q. virginiana* and *S. palmetto*, however the former was absent from this cluster and the latter had an importance value a little greater than 1.0 in the tree stratum. On the other hand, pine-dominated communities that have more recently been invaded by hardwood species tend to have a dense canopy of *Quercus hemisphaerica* and *Quercus nigra* (FNAI 2010). Though it is unclear what quantitatively represents a "dense canopy", both species were the two most dominant in the tree stratum and made up 49% of the tree species importance and 64% relative cover (Appendix B). Communities that were historically pine-dominated and no longer resemble or function as the fire maintained systems they once were due to hardwood encroachment are considered successional hardwood forests (FNAI 2010). In addition to *Q. hemisphaerica* and *Q. nigra*, successional hardwood forests tend to include species that are remnant from the community it once was, such as *Pinus elliottii*, *Quercus laevis*, *Serenoa repens*, and *Vaccinium arboreum*, (FNAI 2010) all of which were present in this cluster. Excluding *Q. laevis*, these same species were also mentioned as being common to mesic hammocks, however; *P. elliottii* forms an emergent layer in the mature mesic hammock (FNAI 2010) as opposed to being a remnant in the successional hardwood forest (FNAI

2010). In this cluster *P. elliottii* was likely remnant because it takes at least 30 years for this species to reach a 9 inch DBH (UF 2009b) and the average DBH of *P. elliottii* in this cluster was 18 inches. In addition, this community cluster was in the FE group, further supporting its transition from one community type to another over the last 60 years.

Though this cluster may be a more recently established mesic hammock, several additional species that were in this cluster were considered uncommon to mesic hammocks but were common to either the drier (e.g. xeric hammock) or wetter (e.g. hydric hammock) community types known to occur next to or intermixed with mesic hammocks. For example, *Quercus geminata* was present in the mesic hammock cluster but is characteristic of xeric hammocks (FNAI 2010). On the converse, *T. distichum* is capable of occurring in the wetter portions of hydric hammocks but is not a dominant component of them, and such was the case in this mesic hammock cluster (FNAI 2010). In addition to adjacency, mesic hammocks can also occur in ecotones between wetland and upland communities, as was found in a study conducted by Bridges and Reese (1996) in Central Florida. *T. ascendens*, a species common to basin swamps (FNAI 2010), was a dominant component of the tree stratum in the mesic hammock cluster. Though it was only present in one of the four plots (plot 875) that made up this cluster, it composed almost 60% of the stems in that plot, which happened to be located between a mesic hammock and a depression in the landscape. Lastly, only one introduced species was present in this cluster, *Viburnum odoratissimum*, and like *T. ascendens* it was present in just one of four plots (plot 318) that made up this cluster. This plot happened to occur in a residential neighborhood which was also the source of 100% of the impervious surface area in the average percent ground cover of this cluster. *V.*

odoratissimum is sold in Florida nurseries (FNGLA 2010) and is readily available to landscape companies and the general public.

The more recently established mesic hammock is described as having a closed canopy and the canopy in the shrub stratum is also dense (FNAI 2010). Though it is not certain if the canopy in this cluster was closed, it did have extensive tree cover (85%) on average and the average proportion of shrub cover was 58%. Duff/mulch/leaf litter made up 89% of the ground cover on average and the heavy accumulation of such, in addition to shrub cover, helps to maintain soil moisture in these hammocks (USFWS 1999). Like the majority of the FE clusters, the most frequent soil drainage class was poorly drained. Though FNAI (2010) described mesic hammocks as occurring on soils that rarely flooded, Cavender-Bares et al. (2004) found that oak species common to mesic hammocks occurred within a variety of moisture conditions that ranged from xeric to almost hydric sites. While the most frequent soil drainage class was consistent with almost all of the other community clusters in the FE group, the average elevation was lower than any other community type in this same group, with the exception of the mangrove swamp. And though mesic hammocks are thought to be an upland community, they also commonly occur on ridges within floodplain and basin swamps (FNAI 2010, Sharitz and Mitsch 1993) and have been known to occur in narrow areas between pine flatwoods and wetland communities in Central Florida (Bridges and Reese 1996), which was likely the case with the mesic hammock cluster in this study.

Concluding Remarks

While all natural community clusters that occurred in this study resembled those described by FNAI (2010), there was a lot of variation within them. All natural community clusters in this study had a species composition that overlapped with at least one additional community type known to occur adjacent to or intermixed with the community of interest, with the exception of the mangrove swamp in the FR group. One reason for overlap is because plot locations were randomly located across the study area rather than targeted for specific community types or polygons, and because these communities can occur within close proximity to one another (FNAI 2010), two community types could have been sampled within one plot. This also likely contributed to the variation in elevation observed not only among plots within a community cluster but between community clusters, since distinct changes in plant communities can occur with small changes in elevation (Sharitz and Mitsch 1993, Myers and Ewel 1990, Wharton et al. 1982). Elevation may have also varied within a plot due to local hydrological regimes that simultaneously build and erode sediments (Mitsch and Gosselink 2000, Sharitz and Mitsch 1993), resulting in areas of lower elevation with longer hydroperiods and areas of higher elevation with shorter hydroperiods (Sharitz and Mitsch 1993, Wharton et al. 1982). In addition, topographic fluctuations in the landscape can add to variation in elevation since community clusters were made up of plots that were located throughout the study area.

Hydrological fluctuations also influence soil properties such as organic matter. A reduction in inundation can result in an increase in the oxidation and thus decomposition of soil organic matter, which decreases water holding capacities in soils (Light et al. 2002). In this study, soil drainage classes were consistent with the hydroperiods known to occur within each community type. However, community clusters in the FE group had a soil drainage class that was predominantly drier or less inundated overall than the soil drainage class of the community clusters in the FR group. Interestingly, the basin/dome swamp (*T. ascendens*), bottomland forest, hydric hammock, and mangrove swamp community types were present in both the FR and FE groups. One reason for this occurrence is because the hydroperiods within these community types are naturally variable (FNAI 2010, Light et al. 2002, Odum and McIvor 1990, Vince et al. 1989, Wharton et al. 1982). In addition, the soil drainage classes that were used in this study were very broad and thus captured the same community types within differing dominant soil drainage classes. However, two of the most frequently inundated community types in this study (floodplain swamp and alluvial forest) were only present in the FR group and the least inundated community type in this study (mesic hammock) was only present in the FE group, which further suggests that the FR group had predominantly more saturated conditions overall than the FE group.

The hydrological regime is not only greatly influential on local elevation and soil drainage, but is also the most influential factor on which species are able to compete best in a particular location, since greater inundation can prevent less flood tolerant species from establishing but too much inundation can kill even the most flood tolerant species over time (Wharton et al. 1982), while reduced flows or not enough inundation can allow less flood tolerant species to establish and can change plant communities associated with greater inundation to drier community types over time (Light et al. 2002). Since local elevation and soil properties also play a role in which species are able to compete best in a particular location, it is the hydrological regime that is the most important factor in determining natural plant communities in ecosystems adjacent to water bodies (Light et al. 2002, Mitsch and Gosselink 2000).

Most of the natural community types that occurred in this study were regarded as freshwater forested wetlands by FNAI (2010), some of which are considered to be river swamps (Ewel 1990) or true riparian communities (alluvial forest, bottomland forest, floodplain swamp, and hydric hammock) because their soil moisture is connected to adjacent stream and river flows (Mitsch and Gosselink 2000, Ewel 1990, Vince et al. 1989), and some of which are considered to be still water swamps (Ewel 1990) (basin/dome swamp) because they generally occur in isolated depressions and have standing water (FNAI 2010). While still water swamps tend to be isolated, basin swamps can act as headwaters for major rivers (e.g. Hillsborough River relies on the Green Swamp for much of its hydrological function) (FDEP 2008) and can experience infrequent flooding from neighboring floodplain swamps (Monk and Brown 1965), while dome swamps generally acquire runoff from the surrounding uplands (Fowlkes et al. 2003) and can occur as a series of swamps that act as a conduit for water flow during heavy rain events (Haag and Lee 2010). In addition, one upland hardwood forest community (mesic hammock) and one estuarine wetland (mangrove swamp) were present. Though mesic hammocks are thought to occur in the uplands the mesic hammock community in this study was mostly present on higher ground (ridges) adjacent to or within forested wetlands, while the mangrove swamp was the only community type that was more competitive in saline conditions (Kuenzler 1974). However, effluence from freshwater forested wetlands is ultimately transported into estuaries and the ocean (Odum and McIvor 1990, Wharton et al. 1982), thus all natural community types in this study were hydrologically linked.

The hydrological regime is also the most important source of disturbance in ecosystems adjacent to water bodies (Light et al 2002, Wharton et al. 1982). Fire was also an important source of disturbance for some of the communities in this study (basin/dome swamps, hydric hammocks, and mesic hammocks) (FNAI 2010, Vince et al. 1989), but was not as broadly applicable to all community types that were present.

Regardless, both disturbance types are important for reducing competition from other species that could otherwise establish themselves if the frequencies and intensities of these regimes were to change (Light et al 2002, Vince et al. 1989, Wharton et al. 1982), and therefore are integral to maintaining species composition and structure within the community types that were present in this study.

However, as discussed in the previous chapter, disturbances that maintain natural plant communities can also allow for the introduction of introduced species (Gordon 1998). Community clusters in both the FR (basin/dome swamp (*Taxodium ascendens*), bottomland forest, floodplain swamp, and hydric hammock) and FE (basin/dome swamp (*T. ascendens*), bottomland forest, hydric hammock, mangrove swamp, and mesic hammock) groups had the presence of either introduced species (*Citrus aurantium, Peltophorum pterocarpum, Viburnum odoratissimum*), invasive species (*Cinnamomum camphora, Ludwigia peruviana, Sapium sebiferum, Schinus terebinthifolius*), or both, with all invasive species in this study being category I invasives. While invasive species presence was only dominant in the shrub stratum of some of these community types (FR: basin/dome swamp (*T. ascendens*) and floodplain swamp, FE: hydric hammock and mangrove swamp) and was negligible in the rest (FR: bottomland forest, FE: basin/dome swamp (*T. ascendens*) and bottomland forest), their presence raises concerns that these community types may decline over time (Gordon 1998) since category I invasive species are known to take over native plant communities (FLEPPC 2009, Langland and Burkes 1998). In addition, all communities with introduced species (invasive and non-invasive) had the presence of weedy native species. Gordon (1998) noted that weedy native species tend to increase with the presence of introduced species in Florida, and further suggested that such an occurrence can actually create more homogeneous conditions in the long run as native species are outcompeted and the frequency and density of introduced species and weedy natives increase over time.

Another type of disturbance that influences the composition and structure of plant communities is site history and current land use (Oliver and Larson 1996, Schomer et al. 1990). Since all plots that made up each group were located within the urban context, it is likely that all groups experienced disturbance from both natural and anthropogenic sources. However, as was discussed in the previous chapter, all plots that made up the FR group had vegetation that remained relatively unchanged over the last 60 years (remnant). Additionally, all plots aggregated into clusters that resembled natural community types, and thus no plots were classified as altered landcover types. Disturbances in the FE and IE groups were likely more intensive than that which occurred in the FR group, since vegetation emerged over the last 60 years. However, disturbances in the FE group were still likely due to a combination of natural and anthropogenic sources, since this group had a mix of plots that aggregated into clusters that both resembled and did not resemble natural community types. However, disturbances in the IE group were primarily, if not completely, associated with anthropogenic sources, since all plots were classified not only as altered landcover types, but as those specifically associated with more frequent and intensive management (maintained grass) that therefore drives vegetation dynamics.

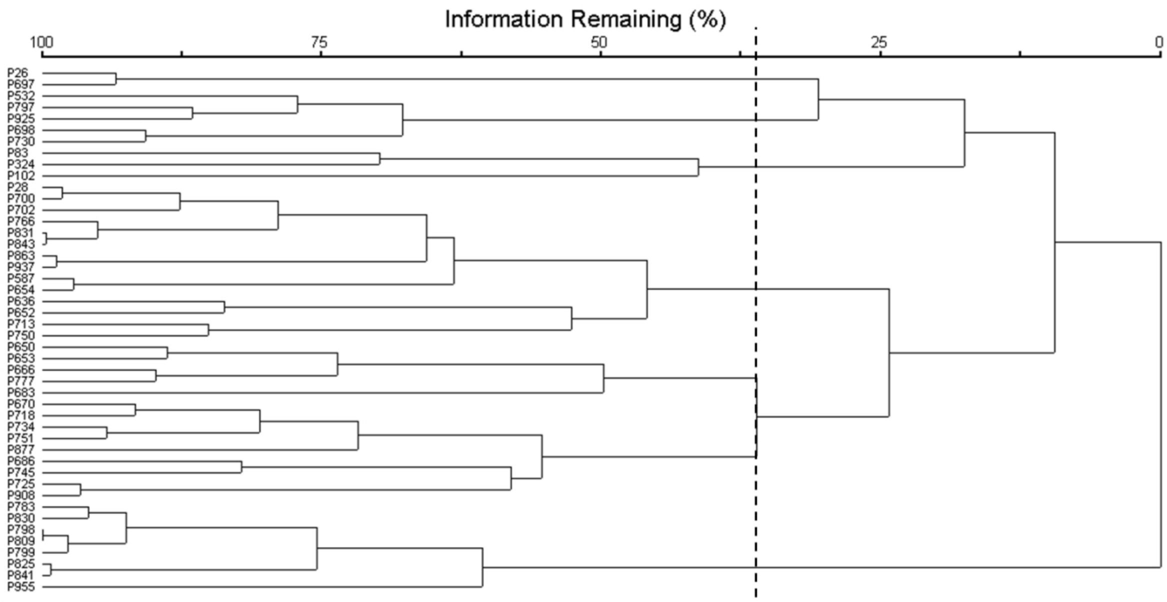

Figure 2-1. Dendrogram tree depicting cluster results for the FR group in an urbanizing watershed in West Central Florida; vertical dotted line denotes where dendrogram pruning occurred.

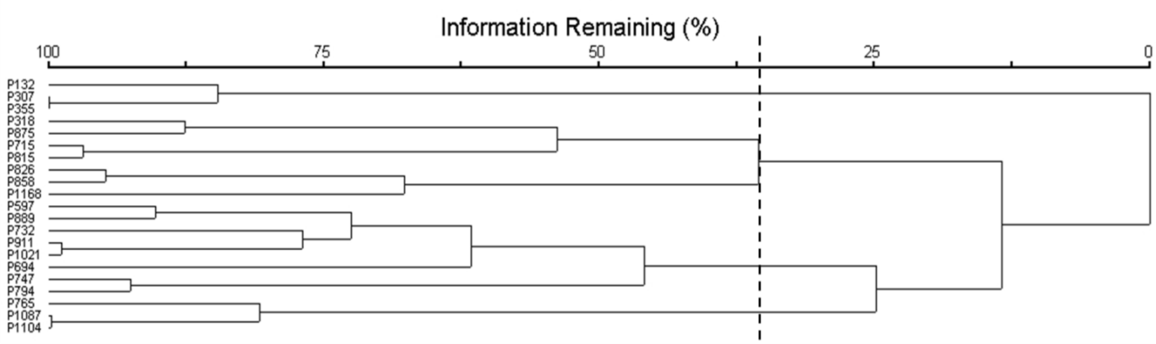

Figure 2-2. Dendrogram tree depicting cluster results for 21 of the 31 plots in the FE group in an urbanizing watershed in West Central Florida; vertical dotted line denotes where dendrogram pruning occurred.

Table 2-1. Species importance in the tree and shrub strata of the alluvial forest cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Alluvial Forest			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum	14.84	5.28	+
Carpinus caroliniana			+
Carya aquatica	3.33		+
Cephalanthus occidentalis	6.76	54.31	
Cornus foemina			+
Crataegus viridis			+
Forestiera acuminata			+
Fraxinus pennsylvanica	47.27	12.22	+
Gleditsia aquatica			+
Hypericum spp.			+
Ilex decidua			+
Nyssa sylvatica	1.98		+
Quercus laurifolia	6.59	5.28	+
Sabal minor			+
Salix caroliniana	5.83	5.28	+
Taxodium ascendens			+
Taxodium distichum	8.22	11.25	+
Ulmus americana	5.18	6.39	+

+ Species that FNAI (2010) considers characteristic of this community type.
+ Species common but not dominant in this community (FNAI 2010).

Table 2-2. Species importance in the tree and shrub strata of the basin/dome swamp cluster dominated by *Taxodium ascendens* (A) and *Nyssa sylvatica* (B) in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

	Basin/Dome Swamp				
	A		**B**		
	Taxodium ascendens		***Nyssa sylvatica***		
Species	**IV Tree**	**IV Shrub**	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum	3.82	5.66	23.69	10.80	+
Baccharis halimifolia		7.31			
Carpinus caroliniana					+[B]
Cephalanthus occidentalis	0.43	18.99	0.57	22.16	+
Cornus foemina	0.26				+[B]
Cyrilla racemiflora					+
Fraxinus pennsylvanica					+[B]
Gordonia lasianthus				7.84	+
Hypericum spp.					+[D]
Ilex cassine	9.57		11.88		+
Itea virginica				7.61	+
Leucothoe racemosa					+[B]
Liquidambar styraciflua	4.27				+[B]
*Ludwigia peruviana**		21.40			
Lyonia lucida	0.23	8.96		24.43	+
Magnolia virginiana	0.70		8.90		+
Myrica cerifera	8.89	19.05	3.11	10.80	+
Nyssa sylvatica	4.56		43.20		+
Persea borbonia	7.70	2.66		8.52	
Persea palustris	0.22		3.80		+
Pinus elliottii					+
Prunus caroliniana	2.46				
Quercus laurifolia	5.18		3.52		+[B]
Quercus nigra	1.88	2.04			+[B]
Salix caroliniana	0.93	2.60			+[D]
Sambucus nigra		2.66		7.84	
*Sapium sebiferum**	1.14	2.38			
*Schinus terebinthifolius**		2.04			
Taxodium ascendens	46.42	2.21			+
Taxodium distichum	1.33	2.04	1.31		
Ulmus americana					+[B]

+ Species that FNAI (2010) considers characteristic of this community type.
* Species invasive to Florida.
[B] Species common only to basin swamps.
[D] Species common only to dome swamps.

Table 2-3. Species importance in the tree and shrub strata of the bottomland forest cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Species	IV Tree	IV Shrub	FNAI	Species	IV Tree	IV Shrub	FNAI
Bottomland Forest							
Acer rubrum	10.16	4.89	+	*Nyssa sylvatica*	2.89		+
Baccharis halimifolia		1.03		*Peltophorum pterocarpum***	3.09	1.41	
Callicarpa americana		3.56		*Persea borbonia*	0.29	1.25	
Carpinus caroliniana	2.42		+	*Persea palustris*	0.11	1.30	+
Carya aquatica	0.63	1.41		*Pinus elliottii*	0.20		
Carya glabra	4.14	1.30		*Pinus taeda*			+
Celtis laevigata	3.12	1.09	+	*Prunus caroliniana*		1.41	
*Citrus aurantium***		1.41		*Prunus serotina*		2.70	
*Cinnamomum camphora**		1.41		*Quercus hemisphaerica*	0.16		
Cornus foemina			+	*Quercus laurifolia*	29.27	1.20	+
Crataegus spp.		1.09		*Quercus nigra*	0.09		+
Crataegus marshallii	0.45	1.09		*Quercus virginiana*	0.50		+
Fraxinus pennsylvanica	2.84	1.41		*Sabal minor*		11.01	+
Gleditsia spp.	0.96	3.67		*Sabal palmetto*	5.62	27.29	
Gordonia lasianthus			+	*Sapium sebiferum**		1.41	
Ilex spp.º	0.41			*Sebastiana fruticosa*			+
Ilex cassine	0.18		+	*Serenoa repens*		5.01	
Ilex decidua			+	*Taxodium ascendens*	5.69		
Ilex opaca			+	*Taxodium distichum*	7.38		+
Itea virginica		4.18		*Ulmus americana*	9.08	2.39	+
Liquidambar styraciflua	9.07	4.73	+	*Vaccinium arboreum*			+
Lyonia lucida		6.01		*Vaccinium corymbosum*			+
Magnolia virginiana			+	*Viburnum obovatum*	1.12	1.41	
Myrica cerifera	0.14	3.94	+				

+ Species that FNAI (2010) considers characteristic of this community type.
+ Species common but not dominant in this community (FNAI 2010).
* Species invasive to Florida.
** Species introduced to Florida.
º Native/introduced status cannot be determined.

Table 2-4. Species importance in the tree and shrub strata of the floodplain swamp cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Floodplain Swamp			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum	6.05	7.16	+
Baccharis halimifolia		3.98	
Callicarpa americana		3.38	
Carpinus caroliniana	1.69		
Carya aquatica	0.41		+
Carya glabra	0.77		
Cephalanthus occidentalis		9.96	+
Cyrilla racemiflora			+
Fraxinus caroliniana			+
Fraxinus pennsylvanica	2.55	4.78	+
Gleditsia spp.	0.24		
Ilex cassine	2.13		+
Itea virginica		11.16	+
*Ludwigia peruviana**		17.18	
Lyonia lucida		7.58	
Magnolia virginiana	0.48		
Myrica cerifera	0.89	3.98	
Nyssa sylvatica	7.30		+
Persea palustris	1.05		
Prunus caroliniana	0.67		
Quercus spp.º	0.25		
Quercus laurifolia	10.19	22.69	+
Quercus nigra	5.02		
Sabal palmetto		8.18	+
Taxodium ascendens	4.70		+
Taxodium distichum	45.03		+
Ulmus americana	10.59		+

+ Species that FNAI (2010) considers characteristic of this community type.
* Species invasive to Florida.
º Native/introduced status cannot be determined.

Table 2-5. Species importance in the tree and shrub strata of the hydric hammock cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Hydric Hammock			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum	0.19		+
Callicarpa americana	0.19	11.63	+
Carpinus caroliniana	29.57	3.30	+
Carya glabra	1.93		
Celtis laevigata	1.46	1.64	+
*Citrus aurantium***	0.70		
Cornus foemina			+
Diospyros virginiana			+
Fagus grandifolia	0.65		
Ilex cassine	0.36	1.72	
Juniperus virginiana			+
Liquidambar styraciflua	14.37	6.58	+
Magnolia grandiflora	0.31		
Magnolia virginiana	3.98	2.12	+
Morus rubra	1.18		
Myrica cerifera		1.72	+
Nyssa sylvatica	0.27		
Persea borbonia		3.41	
Persea palustris			+
Pinus elliottii			+
Pinus taeda			+
Quercus hemisphaerica	0.36	1.69	
Quercus laurifolia	3.51	1.72	+
Quercus nigra	6.70	3.17	+
Quercus virginiana	5.65		+
Rhapidophyllum hystrix			+
Sabal minor		1.58	+
Sabal palmetto	27.24	43.05	+
Serenoa repens		13.35	
Taxodium distichum	0.22	1.72	
Ulmus americana	0.97		+
Vaccinium arboreum		1.58	
Viburnum obovatum	0.19		+

+ Species that FNAI (2010) considers characteristic of this community type.
** Species introduced to Florida.

Table 2-6. Species importance in the tree and shrub strata of the mangrove swamp cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Mangrove Swamp			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Avicennia germinans	39.78	20.83	+
Borrichia arborescens˜			
Borrichia frutescens˜		22.92	
Conocarpus erectus			+
Laguncularia racemosa			+
Rhizophora mangle	60.22	56.25	+

+ Species that FNAI (2010) considers characteristic of this community type.
˜ Species not common but when present are characteristic of this community.

Table 2-7. Species importance in the tree and shrub strata of the basin/dome swamp (*Taxodium ascendens*) in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Basin/Dome Swamp			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum			+
Carpinus caroliniana			+[B]
Cephalanthus occidentalis		8.41	+
Cornus foemina			+[B]
Cyrilla racemiflora			+
Fraxinus pennsylvanica			+[B]
Gordonia lasianthus			+
Hypericum spp.			+[D]
Ilex cassine	5.29	8.41	+
Itea virginica			+
Leucothoe racemosa			+[B]
Liquidambar styraciflua			+[B]
*Ludwigia peruviana**		5.91	
Lyonia lucida		22.05	+
Magnolia virginiana	22.45	8.41	+
Myrica cerifera	7.08	23.64	+
Nyssa sylvatica			+
Persea borbonia	15.03		
Persea palustris	1.58		+
Pinus elliottii			+
Quercus laurifolia	2.36		+[B]
Quercus nigra	1.81		+[B]
Rubus spp.		6.36	
Sabal palmetto		8.41	
Salix caroliniana			+[D]
Taxodium ascendens	44.41	8.41	+
Ulmus americana			+[B]

+ Species that FNAI (2010) considers characteristic of this community type.
* Species invasive to Florida.
[B] Species common only to basin swamps.
[D] Species common only to dome swamps.

Table 2-8. Species importance in the tree and shrub strata of the bottomland forest cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Bottomland Forest							
Species	**IV Tree**	**IV Shrub**	**FNAI**	**Species**	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum	3.32	4.12	+	*Persea borbonia*	4.79	4.19	
Baccharis halimifolia		3.76		*Persea palustris*			+
Callicarpa americana		2.47		*Pinus elliottii*	0.15		
Carpinus caroliniana			+	*Pinus palustris*	0.49		
Celtis laevigata			+	*Pinus taeda*			+
Cornus foemina			+	*Quercus laurifolia*	24.64	10.60	+
Crataegus marshallii	0.24			*Quercus nigra*			+
Diospyros virginiana	3.41	3.44		*Quercus virginiana*	0.34		+
Fraxinus pennsylvanica	0.22			*Rubus* spp.		4.83	
Gordonia lasianthus			+	*Sabal minor*			+
Hypericum spp.		4.01		*Sabal palmetto*	3.03	9.66	
Ilex cassine	8.29	4.51	+	*Salix caroliniana*	0.15		
Ilex decidua			+	*Sambucus nigra*		2.08	
Ilex opaca			+	*Sapium sebiferum**	4.50		
Ilex vomitoria	0.17			*Sebastiana fruticosa*			+
Liquidambar styraciflua	0.45		+	*Serenoa repens*		14.07	
*Ludwigia peruviana**		1.90		*Taxodium distichum*	11.07		+
Lyonia lucida	1.87	3.40		*Ulmus americana*	4.55		+
Magnolia virginiana			+	*Vaccinium arboreum*			+
Myrica cerifera	16.85	26.96	+	*Vaccinium corymbosum*			+
Nyssa sylvatica	11.47		+				

+ Species that FNAI (2010) considers characteristic of this community type.
+ Species common but not dominant (FNAI 2010).
* Species invasive to Florida.

Table 2-9. Species importance in the tree and shrub strata of the hydric hammock cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Hydric Hammock			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum			+
Baccharis halimifolia		7.27	
Callicarpa americana		23.41	+
Carpinus caroliniana			+
Celtis laevigata			+
Cornus foemina			+
*Cinnamomum camphora**	2.13	7.84	
Diospyros virginiana			+
Juniperus virginiana			+
Liquidambar styraciflua	23.88	8.18	+
Magnolia virginiana			+
Myrica cerifera			+
Persea palustris			+
Pinus elliottii	9.31		+
Pinus palustris	0.94		
Pinus taeda			+
Prunus caroliniana		6.14	
Quercus laurifolia	11.83		+
Quercus nigra	4.58	6.70	+
Quercus virginiana	37.57		+
Rhapidophyllum hystrix			+
Sabal minor			+
Sabal palmetto	8.81		+
Serenoa repens		40.45	
Taxodium distichum	0.94		
Ulmus americana			+
Viburnum obovatum			+

+ Species that FNAI (2010) considers characteristic of this community type.
* Species invasive to Florida.

Table 2-10. Species importance in the tree and shrub strata of the mangrove swamp cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Mangrove Swamp			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Avicennia germinans	95.37	32.58	+
Baccharis halimifolia	0.25	11.74	
Conocarpus erectus			+
Laguncularia racemosa			+
Myrica cerifera		11.74	
Prunus serotina	0.20		
Quercus geminata	0.42		
Quercus virginiana	2.59		
Rhizophora mangle	0.49		+
*Schinus terebinthifolius**	0.42	21.97	
Serenoa repens		21.97	
Yucca filamentosa	0.25		

+ Species that FNAI (2010) considers characteristic of this community type.
* Species invasive to Florida.

Table 2-11. Species importance in the tree and shrub strata of the mesic hammock cluster in an urbanizing watershed in West Central Florida, and species presence compared to FNAI (2010) community descriptions.

Mesic Hammock			
Species	**IV Tree**	**IV Shrub**	**FNAI**
Acer rubrum	1.34		
Callicarpa americana			+
Carya glabra			+
Celtis laevigata			+
Diospyros virginiana	0.41		+
Ilex glabra			+
Ilex opaca			+
Ilex vomitoria			+
Liquidambar styraciflua	2.68	4.15	+
Lyonia ferruginea		4.15	
Magnolia grandiflora			+
Myrica cerifera		4.15	+
Osmanthus americanus			+
Persea palustris	2.04	3.88	
Pinus elliottii	1.83		+
Pinus taeda			+
Prunus caroliniana	0.89		+
Quercus geminata	6.72		
Quercus hemisphaerica	22.47		+
Quercus laevis		4.15	
Quercus laurifolia	3.20	3.88	
Quercus nigra	26.55		+
Quercus virginiana			+
Sabal palmetto	1.20	4.15	+
Serenoa repens		48.59	+
Taxodium ascendens	13.99		
Taxodium distichum	1.76	4.42	
Vaccinium arboreum	5.17	5.51	+
Vaccinium corymbosum	6.78	4.42	+
Viburnum obovatum	1.06	4.15	
*Viburnum odoratissimum***		4.42	
Ximenia americana			+

+ Species that FNAI (2010) considers characteristic of this community type.
** Species introduced to Florida.

Table 2-12. Total, native, introduced, and invasive species richness overall and in both the tree and shrub strata for each cluster type in the FR group (AF = alluvial forest, BNS = basin/dome swamp (*Nyssa sylvatica*), BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, FS = floodplain swamp, HH = hydric hammock, and MS = mangrove swamp) in an urbanizing watershed in West Central Florida.

Species Richness	AF	BNS	BTA	BF	FS	HH	MS
Overall							
Total	9	14	22	38*	25*	26	3
Native	9	14	19	33	23	25	3
Introduced (Invasive')	0	0	3 (3)	4 (2)	1 (1)	1 (0)	0
Tree Stratum							
Total	9	9	18	26*	18*	21	2
Native	9	9	17	24	17	20	2
Introduced (Invasive')	0	0	1 (1)	1 (0)	0	1 (0)	0
Shrub Stratum							
Total	7	8	14	28	11	16	3
Native	7	8	11	24	10	16	3
Introduced (Invasive')	0	0	3 (3)	4 (2)	1 (1)	0	0

* 1 genus excluded from native/introduced counts due to inability to classify their status.
' Number of invasives within introduced counts; not additive

Table 2-13. Total, native, introduced, and invasive species richness overall and in both the tree and shrub strata for each natural community type in the FE group (BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, HH = hydric hammock, MS = mangrove swamp, and MH = mesic hammock) in an urbanizing watershed in West Central Florida.

Species Richness	BTA	BF	HH	MS	MH
Overall					
Total	13	27	13	10	21
Native	12	25	12	9	20
Introduced (Invasive')	1 (1)	2 (2)	1 (1)	1 (1)	1 (0)
Trees					
Total	8	20	9	8	16
Native	8	19	8	7	16
Introduced (Invasive')	0	1 (1)	1 (1)	1 (1)	0
Shrubs					
Total	9	15	7	5	13
Native	8	14	6	4	12
Introduced (Invasive')	1 (1)	1 (1)	1 (1)	1 (1)	1 (0)

' Number of invasives within introduced counts; not additive.

Table 2-14. Average characteristics and standard deviations (in parentheses following values) for natural community clusters in the FR group for both the tree and shrub strata (AF = alluvial forest, BNS = basin/dome swamp (*Nyssa sylvatica*), BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, FS = floodplain swamp, HH = hydric hammock, and MS = mangrove swamp) in an urbanizing watershed in West Central Florida.

Cluster Characteristics	AF (*n* = 5)	BNS (*n* = 2)	BTA (*n* = 5)	BF (*n* = 14)	FS (*n* = 9)	HH (*n* = 8)	MS (*n* = 3)
Tree Stratum							
BA/acre	226.0 (±140.9)	234.0 (±16.4)	169.6 (±81.5)	249.7 (±106.7)	260.9 (±87.5)	193.1 (±53.3)	36.3 (±37.6)
TPA	268.0 (±178.0)	495.0 (±261.6)	566.0 (±338.9)	414.3 (±220.3)	304.4 (±162.6)	488.8 (±238.9)	582.0 (±789.0)
DBH (inches)	3.9 (±4.5)	6.4 (±5.3)	4.8 (±3.8)	7.5 (±6.7)	9.5 (±7.2)	6.4 (±5.5)	2.2 (±1.2)
Height (feet)	29.2 (±19.5)	38.0 (±16.3)	32.2 (±16.0)	38.6 (±24.0)	48 (±25.2)	31.7 (±16.7)	17.8 (±3.5)
% Tree Cover	76.3 (±17.5)	85.0 (±7.1)	66.0 (±30.1)	75.0 (±20.7)	69.4 (±21.0)	76.3 (±14.6)	65.0 (±56.4)
Shrub Stratum							
Height (feet)	6.9 (±2.3)	6.1 (±0.6)	5.4 (±1.9)	5.8 (±3.3)	5.6 (±2.5)	5.3 (±2.7)	6.0 (±4.7)
% Shrub Cover	18.0 (±10.4)	27.5 (±31.8)	44.0 (±35.1)	33.2 (±30.0)	13.9 (±18.7)	58.1 (±16.3)	20.0 (±8.7)

Table 2-15. Average characteristics and standard deviations (in parentheses following values) for natural community clusters in the FE group for both the tree and shrub strata (BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, HH = hydric hammock, MS = mangrove swamp, and MH = mesic hammock) in an urbanizing watershed in West Central Florida.

Cluster Characteristics	BTA (*n* = 3)	BF (*n* = 8)	HH (*n* = 3)	MS (*n* = 3)	MH (*n* = 4)
Tree Stratum					
BA/acre	163.4 (±89.6)	100.9 (± 6.3)	110.7 (±43.6)	46.1 (±12.4)	143.5 (±75.2)
TPA	673.3 (±605.3)	381.3 (±306.9)	176.7 (±142.2)	1206.7 (±604.5)	350.0 (±244.0)
DBH (inches)	4.5 (±3.3)	4.0 (±3.8)	8.3 (±6.5)	1.8 (±0.9)	6.2 (±5.5)
Height (feet)	28.2 (±11.4)	27.8 (±16.0)	30.8 (±13.3)	13.6 (±3.5)	32.5 (±15.5)
% Tree Cover	56.7 (±23.6)	66.3 (±26.2)	85.0 (±10.6)	68.3 (±30.6)	85.0 (±17.8)
Shrub Stratum					
Height (feet)	6.5 (±1.9)	4.4 (±1.6)	3.7 (±1.5)	4.8 (±1.1)	5.1 (±3.3)
% Shrub Cover	56.7 (±23.6)	43.8 (±27.1)	36.7 (±38.9)	36.7 (±33.3)	57.5 (±40.5)

Table 2-16. Average stem density/acre of native and introduced stems for cluster types in the FR group (AF = alluvial forest, BNS = basin swamp (*Nyssa sylvatica*), BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, FS = floodplain swamp, HH = hydric hammock, and MS = mangrove swamp) in an urbanizing watershed in West Central Florida.

DBH Class (inches)	Native (stems/acre)						
	AF (*n* = 5)	BNS (*n* = 2)	BTA (*n* = 5)	BF (*n* = 14)	FS (*n* = 9)	HH (*n* = 8)	MS (*n* = 3)
1.0 - 6.0	1038.0 (±805.0)	385.0 (±148.5)	488.0 (±348.8)	227.1 (±212.3)	122.2 (±75.8)	280.0 (±191.5)	1130.0 (±763.7)
6.1 - 12.0	102.0 (±93.6)	145.0 (±21.2)	166.0 (±64.7)	111.4 (±62.0)	113.3 (±106.8)	153.8 (±71.7)	165.0 (±120.2)
12.1 - 16.0	34.0 (±43.9)	60.0 (±14.1)	38.0 (±37.7)	47.1 (±28.9)	55.5 (±37.8)	28.8 (±18.9)	0.0
> 16.1	16.0 (±15.2)	35.0 (±7.1)	8.0 (±17.9)	49.3 (±28.4)	43.3 (±28.3)	27.5 (18.3)	0.0
Total	1190.0 (±842.9)	625.0 (±176.78)	700.0 (±395.2)	434.0 (±230.2)	334.3 (±159.9)	490.0 (±243.1)	1295.0 (±143.5)
DBH Class (inches)	Introduced (stems/acre)						
1.0 - 6.0	0.0	0.0	10.0' (±22.4)	12.9^ (±48.1)	0.0	3.8^ (±7.4)	0.0
6.1 - 12.0	0.0	0.0	0.0	2.1^ (±8.0)	0.0	0.0	0.0
12.1 - 16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
> 16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	10.0' (±22.4)	15.0^ (±56.1)	0.0	3.8^ (±7.4)	0.0

Standard deviation is in parentheses following average values.
' All introduced species are also invasive.
^ No introduced species are invasive.

Table 2-17. Average stem density/acre of native and introduced species for cluster types in the FE group (BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, HH = hydric hammock, MS = mangrove swamp, and MH = mesic hammock) in an urbanizing watershed in West Central Florida.

DBH Class (inches)	Native (stems/acre)				
	BTA (n = 3)	BF (n = 8)	HH (n = 3)	MS (n = 3)	MH (n = 4)
1.0 - 6.0	550.0 (±567.1)	471.3 (±535.0)	86.7 (±115.5)	1953.3 (±309.2)	205.0 (±172.3)
6.1 - 12.0	196.7 (±164.4)	78.8 (±90.6)	40.0 (±17.3)	0.0	152.5 (±178.0)
12.1 - 16.0	3.3 (±5.8)	27.5 (±35.4)	20.0 (±10.0)	3.3 (±5.8)	15.0 (±17.3)
> 16.1	6.7 (±5.8)	8.8 (±14.6)	26.7 (±11.5)	0.0	10.0 (±14.1)
Total	756.7 (±674.2)	586.3 (±519.4)	173.3 (±144.7)	1956.7 (±306.6)	382.5 (±273.3)
DBH Class (inches)	Introduced (stems/acre)				
1.0 - 6.0	0.0	20.0' (±56.6)	10.0' (±17.3)	10.0' (±17.3)	0.0
6.1 - 12.0	0.0	1.3' (±3.5)	0.0	0.0	0.0
12.1 - 16.0	0.0	0.0	0.0	0.0	0.0
> 16.1	0.0	0.0	0.0	0.0	0.0
Total	0.0	21.3' (±60.1)	10.0' (±17.3)	10.0' (±17.3)	0.0

Standard deviation is in parentheses following average values.
' All introduced species are also invasive.

Table 2-18. Average relative percent ground cover and standard deviation (in parentheses following values) for natural community clusters in the FR group (AF = alluvial forest, BNS = basin/dome swamp (*Nyssa sylvatica*), BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, FS = floodplain swamp, HH = hydric hammock, and MS = mangrove swamp) in an urbanizing watershed in West Central Florida.

	AF (n = 5)	BNS (n = 2)	BTA (n = 5)	BF (n = 14)	FS (n = 9)	HH (n = 8)	MS (n = 3)
Rock	0.0	0.0	0.0	0.0	0.0	0.0	3.3 (±5.8)
Bare Soil	0.0	0.0	0.0	1.1 (±2.9)	5.0 (±11.7)	13.8 (±28.1)	0.0
Duff/Mulch/Leaf Litter	58.0 (±30.9)	23.0 (±30.7)	70.0 (±28.3)	62.9 (±28.5)	32.2 (±37.6)	68.1 (±28.9)	0.0
Herbaceous Vegetation	36.0 (±26.3)	22.0 (±18.9)	30.0 (±28.3)	16.4 (±15.1)	46.1 (±33.7)	17.5 (±16.3)	1.7 (±2.9)
Maintained Grass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unmaintained Grass	6.0 (±10.8)	16.0 (±21.9)	0.0	11.4 (±20.8)	0.0	0.6 (±1.8)	13.3 (±23.1)
Water	0.0	39.0 (±53.4)	0.0	8.2 (±25.5)	16.7 (±29.3)	0.0	81.7 (±31.8)
Impervious Surface Area	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2-19. Average relative percent ground cover and standard deviation (in parentheses following values) for natural community clusters in the FE group (BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, HH = hydric hammock, MS = mangrove swamp, and MH = mesic hammock) in an urbanizing watershed in West Central Florida.

	BTA (n = 3)	BF (n = 8)	HH (n = 3)	MS (n = 3)	MH (n = 4)
Rock	0.0	0.0	0.0	0.0	0.0
Bare Soil	0.0	0.6	1.7	0.0	2.5 (±5.0)
Duff/Mulch/Leaf Litter	25.0 (±22.9)	65.0 (±33.4)	58.3 (±28.4)	10.0 (±17.3)	88.5 (±17.0)
Herbaceous Vegetation	75.0 (± 22.9)	8.1 (±8.8)	23.3 (±12.6)	10.0 (±17.3)	2.5 (±5.0)
Maintained Grass	0.0	0.0	0.0	0.0	0.0
Unmaintained Grass	0.0	26.3 (±35.7)	16.7 (±15.3)	10.0 (±17.3)	1.3 (±2.5)
Water	0.0	0.0	0.0	70.0 (±52.0)	0.0
Impervious Surface Area	0.0	0.0	0.0	0.0	5.3 (±10.5)

Table 2-20. Soil drainage classes that occurred in this study, their depth to free water, and time water is present annually; adapted from Soil Survey Manual (Soil Survey Division Staff 1993).

Soil Drainage	Class	Depth (feet) to Free Water	Cumulative Annual Pattern
Well Drained	1	3 - 5	n/a
Moderately Well Drained	2	1.5 - 3	1 month - continuously
Somewhat Poorly Drained	3	.8 - 1.5	1 month - continuously
Poorly Drained	4	< .8 - 1.5	3 - 12 months
Very Poorly Drained	5	< .8	6 months - continuously
Water	6	0	continuously
Urban	7	n/a	n/a

n/a = not applicable

Table 2-21. Range and mode of soil drainage classes, and minimum, maximum, average, and standard deviation (in parentheses following values) of elevation for each cluster in the FR group (AF = alluvial forest, BNS = basin/dome swamp (*Nyssa sylvatica*), BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, FS = floodplain swamp, HH = hydric hammock, and MS = mangrove swamp) in an urbanizing watershed in West Central Florida.

Soil	AF (*n* = 5)	BNS (*n* = 2)	BTA (*n* = 5)	BF (*n* = 14)	FS (*n* = 9)	HH (*n* = 8)	MS (*n* = 3)
Range	N/A*	N/A*	N/A*	1-5	4-5	N/A*	3-6
Mode	5	5	5	5	5	5	N/A**
Elevation (feet)							
Min/Max	23.5/32.9	32.1/63.7	31.9/69.1	20.8/55.9	27.9/66.9	32.3/79.4	0/1.1
Average	26.3 (±3.9)	47.9 (±22.4)	42.6 (±15.6)	33.7 (±10.8)	39.4 (±15.4)	41.9 (±15.4)	0.4 (±0.6)

* The drainage class for all plots within a cluster was identical to the mode.
** All drainage classes were different among plots that made up a cluster.

Table 2-22. Range and mode of soil drainage classes, and minimum, maximum, average, and standard deviation (in parentheses following values) of elevation for each cluster in the FE group (BTA = basin/dome swamp (*Taxodium ascendens*), BF = bottomland forest, HH = hydric hammock, MS = mangrove swamp, and MH = mesic hammock) in an urbanizing watershed in West Central Florida.

Soil	BTA (*n* = 3)	BF (*n* = 8)	HH (*n* = 3)	MS (*n* = 3)	MH (*n* = 4)
Range	N/A*	4-5	4-5	4-6	4-6
Mode	5	4	4	4	4
Elevation (feet)					
Min/Max	43.1/87.1	23.9/79.6	33.3/91.7	0.2/2.7	19.2/53.7
Average	58.2 (±25.1)	48.4 (±16.2)	70.9 (±32.6)	1.0 (±1.5)	34.4 (±15.9)

* The drainage class for all plots within a cluster was identical to the mode.

CHAPTER 4
CONCLUSION

Results from the first part of this study (chapter 2) corroborated what others have found in urban areas adjacent to water bodies in the Southeastern U.S. (Burton and Samuelson 2008, Burton et al. 2005, Lowenstein and Lowenstein 2005); introduced species richness and stem density increased and native species richness and stem densities decreased as anthropogenic disturbances were more frequent and intense. In addition, impervious surface area (ISA) was disproportionately greater in the most frequently and intensively anthropogenically managed group (inhibited/emergent; IE), where it was only present in trace amounts in the less intensively managed forested groups (FR and FE). Furthermore, results from the second part of this study (chapter 3) showed that vegetation in both forested groups aggregated into clusters that resembled natural plant communities. However, all plots in the remnant group (FR) were represented in natural community clusters, whereas 68% of the plots in the emergent (FE) group were represented as such, leaving 32% of the plots in the emergent group to be reclassified as altered land cover types. Additionally, the inhibited/emergent group (IE) had zero of its plots aggregate into clusters that resembled natural plant communities, thus all of its plots were reclassified into altered landcover types. Interestingly, reclassifying plots into altered landcover types only highlighted how heterogeneous vegetation was within these cover types.

This study also corroborated what Xian and Crane (2005) found in a study they conducted looking at the correlation between ISA and urbanization in the Tampa Bay Watershed, which was that urbanization is directly linked to a change in landcover and an increase in ISA in the Tampa Bay Watershed, all of which alter hydrological regimes

(Alberti 2008, Paul and Meyer 2008), and decrease water quality (Paul and Meyer 2008) and availability (Alberti 2008). While a lack of ISA in the forested groups suggests that the hydrological regime was less interrupted there, the presence of invasive species in these groups may pose a threat to vegetation dynamics in the long run, and thus the composition and structure of natural plant communities, since invasive species have the ability to outcompete native plant communities over time (FLEPPC 2009, Gordon 1998). Though hydrology is the most influential disturbance factor on soil properties and local elevation, and thus on the assemblage of vegetation in natural community types that occurred in this study (Mitsch and Gosselink 2000), it is clear that in the urban context, vegetation dynamics shift from being driven by natural disturbance regimes (e.g. hydrology, fire) to being driven by anthropogenic disturbances (maintained grass, altered landcover, introduced species), as selection pressures change from involving a multitude of abiotic and biotic interactions (ecological) to being directed by human preferences (Schomer et al. 1990).

Although the plant communities that occurred in this study may seemingly act as individual entities, they are in fact interconnected and function as one large system through their exchange of water, nutrients, and species (Mitsch and Gosselink 2000). Since plant communities adjacent to water bodies are integral to watershed functionality (Sprague et al. 2006), management of the Tampa Bay Watershed needs to take a landscape approach at the watershed scale (FDEP 2008, Duryea and Hermansen 2002) if it is going to continue to provide clean and available water to all life dependant on it in the face of urbanization. Because the human element is a reality in the Tampa Bay Watershed and population growth is imminent, management also needs to consider strategies that minimize human impacts on natural plant communities that are important for watershed functionality (Alberti 2005). For example, a study conducted by Sprague et al. (2006) in the Chesapeake Bay Watershed in the Northeastern U.S. recommended that at least 70% of the watershed was buffered by at least 100 feet of forest land along riparian areas for maximum watershed benefits. Though this study used a 50 foot buffer around water bodies to select plots for analyses, 68% of them aggregated into clusters that resembled natural community types, suggesting there is still potential to protect a good portion of forested areas adjacent to water bodies in the Tampa Bay Watershed that remain relatively intact. However, management would likely be needed to monitor and control for invasive species, thereby preventing their establishment and thus their potential to displace native species and natural plant communities over time.

APPENDIX A
RELATIVE FREQUENCY AND COVER, IMPORTANCE, AND AVERAGE STRUCTURAL METRICS OF SPECIES IN THE TREE AND SHRUB STRATA FOR COMMUNITY CLUSTERS IN THE FORESTED REMNANT (FR) GROUP IN AN URBANIZING WATERSHED IN WEST CENTRAL FLORIDA.

Table A-1.Relative frequency (*f*), relative cover (CVR), importance value (IV), and average structural metrics (diameter at breast height (DBH), height (HT), basal area/acre (BA/acre), trees per acre (TPA)), and standard deviations (SD) (in parentheses next to average values; values without SD's had a SD of zero) of species in the tree strata for community clusters in the forested remnant (FR) group in an urbanizing watershed in West Central Florida.

		Tree Stratum						
		Relative			Average			
Community	**Species**	***f***	**CVR**	**IV**	**DBH**	**HT**	**BA/Acre**	**TPA**
Alluvial Forest	*Acer rubrum*	0.13	0.16	14.84	5.0 ±(2.4)	31.7 ±(4.9)	13.2 ±(11.1)	36.0 ±(27.1)
	Carya aquatica	0.01	0.05	3.33	15.2	82.5	5.1 ±(11.3)	4.0 ±(9.0)
	Cephalanthus occidentalis	0.09	0.05	6.76	1.6 ±(0.2)	12.9 ±(0.8)	0.9 ±(1.2)	24.0 ±(37.9)
	Fraxinus spp.	0.48	0.47	47.27	4.2 ±(2.1)	23.3 ±(8.5)	107.5 ±(68.8)	128.0 ±(106.2)
	Nyssa sylvatica	0.01	0.02	1.98	27.0	90.5	16.0 ±(35.7)	4.0 ±(9.0)
	Quercus laurifolia	0.06	0.07	6.59	6.3 ±(2.2)	25.6 ±(7.2)	9.2 ±(10.2)	16.0 ±(5.5)
	Salix caroliniana	0.07	0.04	5.83	2.4 ±(0.7)	15.4 ±(1.4)	1.2 ±(1.9)	20.0 ±(30.9)
	Taxodium distichum	0.07	0.09	8.22	18.9 ±(11.9)	49.0 ±(1.2)	69.0 ±(125.6)	20.0 ±(25.5)
	Ulmus americana	0.06	0.04	5.18	9.1 ±(4.9)	33.3 ±(10.7)	4.5 ±(4.1)	16.0 ±(25.1)
Basin/Dome Swamp (*Nyssa sylvatica*)	*Acer rubrum*	0.23	0.24	23.69	6.6 ±(0.7)	37.3 ±(4.1)	51.7 ±(3.0)	115.0 ±(49.5)
	Cephalanthus occidentalis	0.01	0.00	0.57	2.0	18.0	0.2 ±(0.2)	5.0 ±(7.1)
	Ilex cassine	0.16	0.08	11.88	2.8 ±(0.1)	21.4 ±(4.8)	5.7 ±(1.1)	80.0 ±(28.3)
	Magnolia virginiana	0.06	0.12	8.90	7.7 ±(4.9)	49.8 ±(24.4)	32.7 ±(43.4)	30.0 ±(14.2)
	Myrica cerifera	0.05	0.01	3.11	1.6 ±(0.4)	14.9 ±(1.3)	0.6 ±(0.6)	25.0 ±(21.3)
	Nyssa sylvatica	0.38	0.48	43.20	10.8 ±(3.7)	52.7 ±(10.1)	122.1 ±(34.6)	190.0 ±(212.2)
	Persea palustris	0.05	0.03	3.80	5.4	30.6	5.9 ±(8.3)	25.0 ±(35.4)
	Quercus laurifolia	0.04	0.03	3.52	5.0	30.0	3.4 ±(4.7)	20.0 ±(28.3)
	Taxodium distichum	0.01	0.02	1.31	21.1	70.0	12.2 ±(17.2)	5.0 ±(7.1)
Basin/Dome Swamp (*Taxodium ascendens*)	*Acer rubrum*	0.04	0.04	3.82	2.9 ±(0.2)	24.8 ±(5.8)	1.4 ±(1.6)	22.0 ±(22.9)
	Cephalanthus occidentalis	0.00	0.01	0.43	1.7	9.0	0.1 ±(0.3)	2.0 ±(4.5)
	Cornus florida	0.00	0.00	0.26	3.7	25.0	0.2 ±(0.4)	2.0 ±(4.5)
	Ilex cassine	0.05	0.14	9.57	3.8 ±(0.1)	26.9 ±(2.2)	3.7 ±(6.9)	30.0 ±(52)
	Liquidambar styraciflua	0.06	0.02	4.27	3.3	29.5	2.6 ±(5.7)	36.0 ±(80.5)
	Lyonia lucida	0.00	0.00	0.23	1.1	11.0	0.1 ±(0.1)	2.0 ±(4.5)
	Magnolia virginiana	0.00	0.01	0.70	7.0	40.0	0.6 ±(1.2)	2.0 ±(4.5)
	Myrica cerifera	0.09	0.09	8.89	1.6 ±(0.2)	12.1 ±(3.5)	2.2 ±(2.4)	50.0 ±(48.5)
	Nyssa sylvatica	0.02	0.07	4.56	6.1	48.4	7.2 ±(15.9)	12.0 ±(26.9)
	Persea borbonia	0.08	0.08	7.70	2.5 ±(0.2)	21.3 ±(3.0)	2.3 ±(3.1)	44.0 ±(61.9)
	Persea palustris	0.00	0.00	0.22	11.1	12.0	1.4 ±(3.1)	2.0 ±(4.5)

Table A1. Continued

		Tree Stratum						
		Relative			Average			
Community	**Species**	***f***	**CVR**	**IV**	**DBH**	**HT**	**BA/Acre**	**TPA**
Basin /Dome Swamp	*Prunus caroliniana*	0.02	0.03	2.46	5.9	36.8	2.2 ±(4.8)	10.0 ±(22.4)
(*Taxodium ascendens*)	*Quercus laurifolia*	0.04	0.06	5.18	4.2 ±(1.2)	29.0 ±(1.7)	3.3 ±(3.8)	22.0 ±(20.5)
	Quercus nigra	0.02	0.02	1.88	2.2 ±(0.3)	19.0 ±(3.3)	0.5 ±(0.7)	12.0 ±(16.5)
	Salix caroliniana	0.01	0.01	0.93	2.7	20.0	0.3 ±(0.7)	6.0 ±(13.5)
	*Sapium sebiferum**	0.02	0.01	1.14	1.5	12.8	0.2 ±(0.3)	10.0 ±(22.4)
	Taxodium ascendens	0.51	0.42	46.42	8.0 ±(2.7)	41.6 ±(11.5)	116.0 ±(61.3)	290.0 ±(148.5)
	Taxodium distichum	0.02	0.01	1.33	3.9 ±(1.9)	23.9 ±(12.6)	2.4 ±(5.0)	12.5 ±(25.0)
Bottomland Forest	*Acer rubrum*	0.10	0.10	10.16	7.1 ±(3.2)	39.7 ±(13.8)	21.4 ±(30.0)	46.5 ±(43.3)
	Carya aquatica	0.01	0.00	0.63	2.4	24.6	0.2 ±(0.5)	3.6 ±(13.4)
	Carpinus caroliniana	0.03	0.02	2.42	2.9 ±(0.7)	19.9 ±(3.5)	0.7 ±(1.4)	7.9 ±(20.9)
	Carya glabra	0.03	0.05	4.14	12 ±(2.1)	68.3 ±(10.8)	14.9 ±(39.3)	14.3 ±(37.2)
	Celtis laevigata	0.04	0.02	3.12	2.3 ±(1.0)	20.8 ±(1.4)	1.3 ±(4.5)	17.2 ±(58.5)
	Crataegus marshallii	0.01	0.00	0.45	1.6 ±(0.1)	21.5 ±(5.0)	0.1 ±(0.2)	2.9 ±(8.3)
	Fraxinus spp.	0.03	0.02	2.84	4.7 ±(2.8)	25.4 ±(8.2)	11.3 ±(35.1)	13.6 ±(25.0)
	Gleditsia spp.	0.01	0.01	0.96	7.3 ±(5.1)	34.9 ±(19.2)	2.7 ±(6.7)	5.0 ±(11.0)
	Ilex cassine	0.01	0.00	0.41	3.0 ±(0.5)	21.4 ±(5.6)	0.2 ±(0.4)	2.2 ±(4.3)
	Ilex spp.º	0.00	0.00	0.18	6.3	25.0	0.4 ±(1.2)	0.8 ±(2.7)
	Liquidambar styraciflua	0.10	0.08	9.07	12.5 ±(7.4)	51.9 ±(20.2)	21.7 ±(24.2)	40.0 ±(80.3)
	Myrica cerifera	0.00	0.00	0.14	3.2	15.0	0.1 ±(0.2)	0.8 ±(2.7)
	Nyssa sylvatica	0.03	0.03	2.89	9.4 ±(6.2)	50.0 ±(26.6)	12.1 ±(35.7)	10.8 ±(21.3)
	Persea borbonia	0.00	0.00	0.29	8.9	47.5	0.9 ±(3.2)	1.5 ±(5.4)
	Persea palustris	0.00	0.00	0.11	3.4	20.0	0.1 ±(0.2)	0.8 ±(2.7)
	*Peltophorum pterocarpum***	0.03	0.03	3.09	3.1	28.5	1.3 ±(4.8)	14.3 ±(53.5)
	Pinus elliottii	0.00	0.00	0.20	15.5	80.0	1 ±(3.6)	0.8 ±(2.7)
	Quercus hemisphaerica	0.00	0.00	0.16	6.1	38.0	0.2 ±(0.6)	0.8 ±(2.7)
	Quercus laurifolia	0.21	0.38	29.27	13.3 ±(6.6)	46.1 ±(15.9)	70.0±(49.0)	87.2 ±(94.1)
	Quercus nigra	0.00	0.00	0.09	6.5	25.0	0.2 ±(0.7)	0.8 ±(2.7)
	Quercus virginiana	0.00	0.01	0.50	18.0	60.0	1.3 ±(4.8)	0.8 ±(2.7)
	Sabal palmetto	0.06	0.05	5.62	12.0 ±(3.1)	25.0 ±(7.9)	17.0 ±(26.8)	25.8 ±(39.8)
	Taxodium ascendens	0.06	0.05	5.69	15.7 ±(2.6)	75.5 ±(7.7)	36.3±(84.1)	26.5 ±(63.1)
	Taxodium distichum	0.10	0.05	7.38	7.5 ±(3)	44.9 ±(16.1)	23.0 ±(38.8)	40.0 ±(57.2)
	Ulmus americana	0.11	0.07	9.08	5.7 ±(3.1)	31.7 ±(8.9)	10.4 ±(14.7)	44.3 ±(49.3)
	Viburnum obovatum	0.02	0.01	1.12	1.7 ±(0.3)	17.8 ±(2.5)	0.2 ±(0.6)	6.5 ±(18.7)
Floodplain Swamp	*Acer rubrum*	0.05	0.07	6.05	10.0 ±(6.0)	46.6 ±(16.9)	15.3 ±(26.9)	16.7 ±(17.4)
	Carya aquatica	0.00	0.00	0.41	10.2	45.0	0.7 ±(1.9)	1.2 ±(3.4)
	Carpinus caroliniana	0.01	0.02	1.69	4.4 ±(0.7)	27.3 ±(6.8)	0.5 ±(0.7)	4.5 ±(7.3)
	Carya glabra	0.00	0.01	0.77	7.7	50.0	0.8 ±(2.2)	1.2 ±(3.4)
	Fraxinus spp.	0.02	0.03	2.55	5.3 ±(3.1)	27.4 ±(9.1)	11.5 ±(33.9)	5.6 ±(13.4)
	Gleditsia spp.	0.00	0.00	0.24	1.1	11.0	0.1 ±(0.1)	1.2 ±(3.4)
	Ilex cassine	0.03	0.01	2.13	3.3 ±(1.7)	19.4 ±(3.4)	1.1 ±(2.9)	8.9 ±(17)

Table A-1. Continued

		Tree Stratum						
		Relative			Average			
Community	Species	*f*	CVR	IV	DBH	HT	BA/Acre	TPA
Floodplain Swamp	*Magnolia virginiana*	0.01	0.00	0.48	4.7	26.5	0.4 ±(1.2)	2.3 ±(6.7)
	Myrica cerifera	0.01	0.01	0.89	1.7	13.0	0.2 ±(0.6)	3.4 ±(10.0)
	Nyssa sylvatica	0.06	0.09	7.30	10.6 ±(5.7)	58.7 ±(30.3)	18.3 ±(35.4)	17.8 ±(26.9)
	Persea palustris	0.01	0.01	1.05	5.6	26.5	1.1 ±(3.3)	4.5 ±(13.4)
	Prunus caroliniana	0.01	0.01	0.67	7.8	35.0	0.8 ±(2.3)	2.3 ±(6.7)
	Quercus spp.	0.00	0.00	0.25	9.6	20.0	0.6 ±(1.7)	1.2 ±(3.4)
	Quercus laurifolia	0.09	0.11	10.19	8.0 ±(3.5)	41.9 ±(16.2)	12.7 ±(12.9)	28.9 ±(30.2)
	Quercus nigra	0.03	0.07	5.02	11.5 ±(3.0)	46.5 ±(13.0)	6.7 ±(10.9)	7.8 ±(11.0)
	Taxodium ascendens	0.03	0.07	4.70	15.5 ±(8.5)	69.8 ±(28.0)	19.5 ±(56.7)	7.8 ±(19.9)
	Taxodium distichum	0.55	0.35	45.03	14.9 ±(7.1)	65.3 ±(17.0)	160.7 ±(79.0)	166.7 ±(155.2)
	Ulmus americana	0.08	0.14	10.59	7.4 ±(3.9)	38.1 ±(22.2)	10.7 ±(15.1)	23.4 ±(28.8)
Hydric Hammock	*Acer rubrum*	0.00	0.00	0.19	2.6	30.0	0.1 ±(0.2)	1.3 ±(3.6)
	Callicarpa americana	0.00	0.00	0.19	1.3	15.0	0.1 ±(0.1)	1.3 ±(3.6)
	Carpinus caroliniana	0.30	0.29	29.57	4.1 ±(2.2)	24.5 ±(5.8)	11.6 ±(6.2)	148.8 ±(118.3)
	Carya glabra	0.01	0.03	1.93	11.6 ±(6.6)	52.8 ±(16.0)	4.7 ±(7.3)	6.3 ±(7.5)
	Celtis laevigata	0.01	0.02	1.46	4.2 ±(2.5)	37.0 ±(13.9)	0.8 ±(1.6)	6.3 ±(9.2)
	*Citrus aurantium***	0.01	0.01	0.70	3.8 ±(2.5)	26.3 ±(12.4)	0.3 ±(0.6)	3.8 ±(7.5)
	Fagus grandifolia	0.01	0.01	0.65	2.2 ±(1.1)	16.8 ±(8.2)	0.2 ±(0.4)	3.8 ±(7.5)
	Ilex cassine	0.00	0.00	0.36	8.3	50.0	0.5 ±(1.4)	1.3 ±(3.6)
	Liquidambar styraciflua	0.16	0.12	14.37	4.2 ±(2.1)	27.6 ±(8.9)	17.2 ±(16.6)	80.0 ±(58.6)
	Magnolia grandiflora	0.00	0.00	0.31	9.5	55.0	0.7 ±(1.8)	1.3 ±(3.6)
	Magnolia virginiana	0.05	0.03	3.98	4.7 ±(3.9)	30.5 ±(11.0)	3.9 ±(7.1)	26.3 ±(62.6)
	Morus rubra	0.01	0.02	1.18	12.7 ±(11.1)	45.0 ±(28.3)	3.1 ±(8.1)	2.5 ±(4.7)
	Nyssa sylvatica	0.00	0.00	0.27	7.9	58.0	0.5 ±(1.3)	1.3 ±(3.6)
	Quercus hemisphaerica	0.01	0.00	0.36	16.2 ±(18.6)	38.0 ±(24.1)	6.0 ±(16.6)	2.5 ±(4.7)
	Quercus laurifolia	0.02	0.05	3.51	9.0 ±(6.9)	42.0 ±(21.3)	12.0 ±(19.0)	11.3 ±(13.6)
	Quercus nigra	0.06	0.08	6.70	9.6 ±(10.6)	32.1 ±(19.4)	19.3 ±(31.1)	27.5 ±(35.0)
	Quercus virginiana	0.02	0.09	5.65	15.3 ±(8.1)	43.9 ±(14.1)	20.8 ±(30.8)	11.3 ±(17.3)
	Sabal palmetto	0.30	0.25	27.24	10.5 ±(1.6)	38.1 ±(9.4)	91.1 ±(43.2)	145.0 ±(65.3)
	Taxodium distichum	0.00	0.00	0.22	8.7	85.0	0.6 ±(1.5)	1.3 ±(3.6)
	Ulmus americana	0.01	0.01	0.97	4.4	38.8	0.9 ±(2.3)	5.0 ±(14.2)
	Viburnum obovatum	0.00	0.00	0.19	2.3	18.0	0.1 ±(0.2)	1.3 ±(3.6)
Mangrove Swamp	*Avicennia germinans*	0.32	0.48	39.78	3.2	19.4	17.6 ±(30.4)	183.4 ±(317.6)
	Rhizophora mangle	0.68	0.52	60.22	1.9 ±(0.2)	18.1 ±(2.8)	13.1 ±(11.4)	396.7 ±(479.9)

* Species invasive to Florida.

** Species introduced to Florida.

^{0} Native/introduced status cannot be determined.

Table A-2. Relative frequency (*f*), relative cover (CVR), importance value (IV), average height (HT), and standard deviations (SD) (in parentheses next to average values; values without SD's had a SD of zero) of species in the shrub strata for community clusters in the forested remnant (FR) group in an urbanizing watershed in West Central Florida.

		Shrub Stratum			
		Relative			**Average**
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Alluvial Forest	*Acer rubrum*	0.08	0.02	5.28	8.0
	Cephalanthus occidentalis	0.33	0.75	54.31	6.9 ±(2.2)
	Fraxinus spp.	0.17	0.08	12.22	5.5 ±(3.6)
	Quercus laurifolia	0.08	0.02	5.28	5.0
	Salix caroliniana	0.08	0.02	5.28	6.0
	Taxodium distichum	0.17	0.06	11.25	7.3 ±(2.5)
	Ulmus americana	0.08	0.04	6.39	11.0
Basin/Dome Swamp (*Nyssa sylvatica*)	*Acer rubrum*	0.13	0.09	10.80	6.0
	Cephalanthus occidentalis	0.13	0.32	22.16	6.0
	Gordonia lasianthus	0.13	0.03	7.84	6.0
	Itea virginica	0.13	0.03	7.61	6.0
	Lyonia lucida	0.13	0.36	24.43	5.5
	Myrica cerifera	0.13	0.09	10.80	7.5
	Persea borbonia	0.13	0.05	8.52	6.0
	Sambucus nigra	0.13	0.03	7.84	6.0
Basin/Dome Swamp (*Taxodium ascendens*)	*Acer rubrum*	0.08	0.04	5.66	7.0 ±(4.3)
	Baccharis halimifolia	0.08	0.07	7.31	7.3 ±(3.9)
	Cephalanthus occidentalis	0.19	0.19	18.99	5.6 ±(1.2)
	*Ludwigia peruviana**	0.08	0.35	21.40	4.8 ±(0.4)
	Lyonia lucida	0.08	0.10	8.96	4.8 ±(1.8)
	Myrica cerifera	0.19	0.19	19.05	5.1 ±(1.4)
	Persea borbonia	0.04	0.01	2.66	3.0
	Quercus nigra	0.04	0.00	2.04	3.0
	Salix caroliniana	0.04	0.01	2.60	7.0
	Sambucus nigra	0.04	0.01	2.66	5.0
	*Sapium sebiferum**	0.04	0.01	2.38	5.0
	*Schinus terebinthifolius**	0.04	0.00	2.04	4.0
	Taxodium ascendens	0.04	0.01	2.21	8.0
	Taxodium distichum	0.04	0.00	2.04	4.0
Bottomland Forest	*Acer rubrum*	0.08	0.02	4.89	8.0 ±(3.6)
	Baccharis halimifolia	0.02	0.00	1.03	4.0
	Callicarpa americana	0.02	0.05	3.56	6.0
	Carya aquatica	0.02	0.01	1.41	3.0

Table A-2. Continued

		Shrub Stratum			
		Relative			Average
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Bottomland Forest	*Carya glabra*	0.02	0.01	1.30	7.0
	Celtis laevigata	0.02	0.00	1.09	8.0
	*Citrus aurantium***	0.02	0.01	1.41	14.0
	*Cinnamomum camphora**	0.02	0.01	1.41	3.5
	Crataegus spp.	0.02	0.00	1.09	6.0
	Crataegus marshallii	0.02	0.00	1.09	6.0
	Fraxinus spp.	0.02	0.01	1.41	3.0
	Gleditsia spp.	0.06	0.01	3.67	3.2 ±(1.8)
	Itea virginica	0.02	0.06	4.18	5.0
	Liquidambar styraciflua	0.08	0.02	4.73	3.5 ±(2.2)
	Lyonia lucida	0.02	0.10	6.01	5.0
	Myrica cerifera	0.06	0.02	3.94	5.4 ±(2.4)
	Persea borbonia	0.02	0.01	1.25	5.0
	Persea palustris	0.02	0.01	1.30	9.0
	*Peltophorum pterocarpum***	0.02	0.01	1.41	5.0
	Prunus caroliniana	0.02	0.01	1.41	2.5
	Prunus serotina	0.02	0.03	2.70	2.5
	Quercus laurifolia	0.02	0.00	1.20	4.0
	Sabal minor	0.06	0.16	11.01	4.7 ±(2.1)
	Sabal palmetto	0.22	0.33	27.29	8.0 ±(4.5)
	*Sapium sebiferum**	0.02	0.01	1.41	3.5
	Serenoa repens	0.02	0.08	5.01	3.0
	Ulmus americana	0.04	0.01	2.39	6.0 ±(1.5)
	Viburnum obovatum	0.02	0.01	1.41	5.0
Floodplain Swamp	*Acer rubrum*	0.11	0.03	7.16	6.8 ±(4.6)
	Baccharis halimifolia	0.06	0.02	3.98	3.0
	Callicarpa americana	0.06	0.01	3.38	3.0
	Cephalanthus occidentalis	0.11	0.09	9.96	4.3 ±(1.1)
	Fraxinus spp.	0.06	0.04	4.78	6.0
	Itea virginica	0.11	0.11	11.16	5.8 ±(1.8)
	*Ludwigia peruviana**	0.06	0.29	17.18	5.0
	Lyonia lucida	0.06	0.10	7.58	5.0
	Myrica cerifera	0.06	0.02	3.98	4.0
	Quercus laurifolia	0.28	0.18	22.69	7.2 ±(3.2)
	Sabal palmetto	0.06	0.11	8.18	6.0

Table A-2. Continued

		Shrub Stratum			
		Relative			Average
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Hydric Hammock	*Acer rubrum*				
	Callicarpa americana	0.16	0.07	11.63	4.9 ±(1.7)
	Carpinus caroliniana	0.05	0.01	3.30	7.5 ±(3.6)
	Celtis laevigata	0.03	0.01	1.64	6.0
	Ilex cassine	0.03	0.01	1.72	3.0
	Liquidambar styraciflua	0.11	0.03	6.58	3.8 ±(1.1)
	Magnolia virginiana	0.03	0.02	2.12	4.0
	Myrica cerifera	0.03	0.01	1.72	10.0
	Persea borbonia	0.05	0.02	3.41	4.0 ±(2.9)
	Quercus hemisphaerica	0.03	0.01	1.69	2.0
	Quercus laurifolia	0.03	0.01	1.72	6.0
	Quercus nigra	0.05	0.01	3.17	4.3 ±(0.4)
	Sabal minor	0.03	0.01	1.58	2.5
	Sabal palmetto	0.21	0.65	43.05	7.7 ±(3.1)
	Serenoa repens	0.13	0.14	13.35	3.7 ±(1.0)
	Taxodium distichum	0.03	0.01	1.72	10.0
	Vaccinium arboreum	0.03	0.01	1.58	1.0
Mangrove Swamp	*Avicennia germinans*	0.33	0.08	20.83	3.8 ±(1.8)
	Borrichia frutescens	0.17	0.29	22.92	3.5
	Rhizophora mangle	0.50	0.63	56.25	8.4 ±(6.2)

* Species invasive to Florida.
** Species introduced to Florida.

APPENDIX B
RELATIVE FREQUENCY AND COVER, IMPORTANCE, AND AVERAGE STRUCTURAL METRICS OF SPECIES IN THE TREE AND SHRUB STRATA FOR COMMUNITY CLUSTERS IN THE FORESTED EMERGENT (FE) GROUP IN AN URBANIZING WATERSHED IN WEST CENTRAL FLORIDA.

Table B-1. Relative frequency (*f*), relative cover (CVR), importance value (IV), and average structural metrics (diameter at breast height (DBH), height (HT), basal area/acre (BA/acre), trees per acre (TPA)), and standard deviations (SD) (in parentheses next to average values; values without SD's had a SD of zero) of species in the tree strata for community clusters in the forested emergent (FE) group in an urbanizing watershed in West Central Florida.

		Tree Stratum						
		Relative			Average			
Community	**Species**	***f***	**CVR**	**IV**	**DBH**	**HT**	**BA/Acre**	**TPA**
Basin/Dome Swamp (*Taxodium ascendens*)	*Ilex cassine*	0.05	0.05	5.29	2.5 ±(0.9)	17.8 ±(3.9)	1.6 ±(1.5)	36.7 ±(35.2)
	Magnolia virginiana	0.15	0.30	22.45	5.6 ±(0.8)	29.7 ±(5.5)	35.1 ±(14.5)	103.4 ±(28.9)
	Myrica cerifera	0.08	0.06	7.08	1.8 ±(0.5)	12.6 ±(0.8)	1.1 ±(1.7)	53.4 ±(83.9)
	Persea borbonia	0.11	0.19	15.03	5.9	33.3	17.1 ±(29.5)	73.4 ±(127.1)
	Persea palustris	0.01	0.02	1.58	3.9 ±(0.8)	28.0 ±(2.9)	1.1 ±(1.4)	10.0 ±(10.0)
	Quercus laurifolia	0.02	0.02	2.36	2.5	17.2	0.7 ±(1.2)	16.7 ±(28.9)
	Quercus nigra	0.01	0.02	1.81	3.1 ±(0.4)	16.8 ±(0.4)	0.6 ±(0.6)	10.0 ±(10.0)
	Taxodium ascendens	0.55	0.34	44.41	6.0	33.3 ±(4.1)	77.7 ±(74.1)	370.0 ±(442.4)
Bottomland Forest	*Acer rubrum*	0.02	0.04	3.32	3.6 ±(1.8)	30.7 ±(9.8)	2.2 ±(5.2)	10.0 ±(15.2)
	Crataegus marshallii	0.00	0.00	0.24	1.9	12.0	0.1 ±(0.2)	1.3 ±(3.6)
	Diospyros virginiana	0.05	0.02	3.41	4.6	22.1	3.5 ±(9.9)	20.0 ±(56.6)
	Fraxinus spp.	0.00	0.00	0.22	15.0	15.0	1.6 ±(4.4)	1.3 ±(3.6)
	Ilex cassine	0.09	0.08	8.29	2.8 ±(0.6)	18.8 ±(1.1)	2.1 ±(4.4)	36.3 ±(90.8)
	Ilex vomitoria	0.00	0.00	0.17	2.0	15.0	0.1 ±(0.1)	1.3 ±(3.6)
	Liquidambar styraciflua	0.01	0.00	0.45	4.0	30.0	0.3 ±(0.8)	2.5 ±(7.1)
	Lyonia lucida	0.02	0.01	1.87	1.5	14.2	0.2 ±(0.6)	10.0 ±(28.3)
	Myrica cerifera	0.22	0.11	16.85	1.4 ±(0.3)	11.2 ±(3.3)	3.5 ±(8.1)	92.5 ±(185.4)
	Nyssa sylvatica	0.10	0.13	11.47	8.6 ±(3.4)	52.1 ±(11.3)	15.3 ±(38.3)	42.5 ±(112.4)
	Persea borbonia	0.04	0.06	4.79	6.6 ±(4.7)	28.2 ±(12.1)	5.3 ±(7.6)	15.0±(24)

Table B-1. Continued

		Tree Stratum						
		Relative			Average			
Community	**Species**	***f***	**CVR**	**IV**	**DBH**	**HT**	**BA/Acre**	**TPA**
Bottomland Forest	*Pinus elliottii*	0.00	0.00	0.15	12.0	18.0	1.0 ±(2.8)	1.3±(3.6)
	Pinus palustris	0.00	0.01	0.49	7.4	30.0	0.4 ±(1.1)	1.3 ±(3.6)
	Quercus laurifolia	0.16	0.33	24.64	6.6 ±(3.8)	32.6 ±(12.0)	33.1 ±(42.1)	66.3 ±(40.4)
	Quercus virginiana	0.01	0.00	0.34	1.1	14.0	0.1 ±(0.1)	2.5 ±(7.1)
	Sabal palmetto	0.02	0.04	3.03	12.8	25.3	8.0 ±(22.5)	8.8 ±(24.8)
	Salix caroliniana	0.00	0.00	0.15	1.2	10.0	0.1 ±(0.1)	1.3 ±(3.6)
	*Sapium sebiferum**	0.05	0.04	4.50	3.4	25.5	1.7 ±(4.6)	21.3 ±(60.2)
	Taxodium distichum	0.15	0.07	11.07	6.2 ±(4.3)	35.9 ±(14.6)	21.8 ±(55.6)	62.5 ±(157.1)
	Ulmus americana	0.04	0.05	4.55	3.9	26.6	1.5 ±(4.3)	15.0 ±(42.5)
Hydric Hammock	*Cinnamomum camphora**	0.02	0.02	2.13	4.3	30.0	1.1 ±(1.8)	3.4 ±(5.8)
	Liquidambar styraciflua	0.34	0.14	23.88	3.4	24.9	4.7 ±(8.1)	60.0 ±(104.0)
	Pinus elliottii	0.04	0.15	9.31	21.1	67.0	16.2 ±(28.0)	6.7 ±(11.6)
	Pinus palustris	0.02	0.00	0.94	8.0	30.0	1.2 ±(2.1)	3.4 ±(5.8)
	Quercus laurifolia	0.17	0.07	11.83	4.9 ±(1.0)	25.1 ±(8.8)	4.4 ±(2.9)	30.0 ±(20.0)
	Quercus nigra	0.06	0.03	4.58	6.6	41.7	2.4 ±(4.1)	10.0 ±(17.4)
	Quercus virginiana	0.25	0.51	37.57	18.8 ±(5.9)	40.8 ±(8.4)	65.2 ±(38.6)	43.4 ±(41.7)
	Sabal palmetto	0.09	0.08	8.81	12.4	22.2	14.7 ±(25.3)	16.7 ±(28.9)
	Taxodium distichum	0.02	0.00	0.94	8.4	30.0	1.3 ±(2.3)	3.4 ±(5.8)
Mangrove Swamp	*Avicennia germinans*	0.97	0.94	95.37	1.9 ±(0.5)	14.5 ±(3.0)	40.4 ±(21)	1170.0 ±(624.9)
	Baccharis halimifolia	0.00	0.00	0.25	1.1	11.0	0.1 ±(0.1)	3.4 ±(5.8)
	Prunus serotina	0.00	0.00	0.20	1.2	12.0	0.1 ±(0.1)	3.4 ±(5.8)
	Quercus geminata	0.00	0.01	0.42	1.7	12.0	0.3 ±(0.4)	3.4 ±(5.8)
	Quercus virginiana	0.01	0.04	2.59	5.4	16.8	5.2 ±(8.9)	13.4 ±(23.1)
	Rhizophora mangle	0.01	0.00	0.49	1.4	18.0	0.1 ±(0.2)	6.7 ±(11.6)
	*Schinus terebinthifolius**	0.00	0.01	0.42	1.4	18.0	0.2 ±(0.3)	3.4 ±(5.8)
	Yucca filamentosa	0.00	0.00	0.25	3.0	9.0	0.2 ±(0.3)	3.4 ±(5.8)

Table B-1. Continued

		Tree Stratum						
		Relative			Average			
Community	Species	*f*	CVR	IV	DBH	HT	BA/Acre	TPA
Mesic Hammock	*Acer rubrum*	0.01	0.01	1.34	8.6	35.0	2.0 ±(4.0)	5.0 ±(10.0)
	Diospyros virginiana	0.01	0.00	0.41	1.2	15.0	0.1 ±(0.1)	2.5 ±(5.0)
	Ilex cassine	0.02	0.02	1.89	5.0	26.4	2.3 ±(4.5)	7.5 ±(15.0)
	Liquidambar styraciflua	0.03	0.03	2.68	5.3 ±(4.7)	29.4 ±(22.2)	1.2 ±(1.9)	10.0 ±(14.2)
	Persea palustris	0.03	0.01	2.04	9.2	35.5	4.8 ±(9.5)	10.0 ±(20.0)
	Pinus elliottii	0.01	0.03	1.83	18.0	65.0	4.5 ±(8.9)	2.5 ±(5.0)
	Prunus caroliniana	0.01	0.00	0.89	2.5	20.0	0.2 ±(0.4)	5.0 ±(10.0)
	Quercus geminata	0.06	0.08	6.72	6.3	37.2	4.8 ±(9.5)	20.0 ±(40.0)
	Quercus hemisphaerica	0.14	0.31	22.47	15.3 ±(17.0)	37.7 ±(21.2)	62.9 ±(100.8)	47.5 ±(40.4)
	Quercus laurifolia	0.03	0.04	3.20	9.0	45.8	5.9 ±(11.7)	10.0 ±(20.0)
	Quercus nigra	0.20	0.33	26.55	9.2 ±(3.9)	39.0 ±(5.5)	26.0 ±(30.0)	70.0 ±(87.6)
	Sabal palmetto	0.01	0.01	1.20	8.0	15.0	1.8 ±(2.1)	5.0 ±(5.8)
	Taxodium ascendens	0.25	0.03	13.99	6.8	43.1	25.7 ±(51.3)	87.5 ±(175.0)
	Taxodium distichum	0.03	0.01	1.76	2.2	17.8	0.3 ±(0.6)	10.0 ±(20.0)
	Vaccinium arboreum	0.06	0.05	5.17	2.1	14.5	0.9 ±(1.8)	20.0 ±(40.0)
	Vaccinium corymbosum	0.09	0.04	6.78	2.0	15.3	0.8 ±(1.6)	32.5 ±(65.0)
	Viburnum obovatum	0.01	0.01	1.06	1.8	20.0	0.2 ±(0.4)	5.0 ±(10.0)

* Species invasive to Florida.

Table B-2. Relative frequency (*f*), relative cover (CVR), importance value (IV), average height (HT), and standard deviations (SD) (in parentheses next to average values; values without SD's had a SD of zero) of species in the shrub strata for community clusters in the forested emergent (FE) group in an urbanizing watershed in West Central Florida.

		Shrub Stratum			
		Relative			Average
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Alluvial Forest	*Acer rubrum*	0.08	0.02	5.28	8.0
	Cephalanthus occidentalis	0.33	0.75	54.31	6.9 ±(2.2)
	Fraxinus spp.	0.17	0.08	12.22	5.5 ±(3.6)
	Quercus laurifolia	0.08	0.02	5.28	5.0
	Salix caroliniana	0.08	0.02	5.28	6.0
	Taxodium distichum	0.17	0.06	11.25	7.3 ±(2.5)
	Ulmus americana	0.08	0.04	6.39	11.0
Basin/Dome Swamp (*Nyssa sylvatica*)	*Acer rubrum*	0.13	0.09	10.80	6.0
	Cephalanthus occidentalis	0.13	0.32	22.16	6.0
	Gordonia lasianthus	0.13	0.03	7.84	6.0
	Itea virginica	0.13	0.03	7.61	6.0
	Lyonia lucida	0.13	0.36	24.43	5.5
	Myrica cerifera	0.13	0.09	10.80	7.5
	Persea borbonia	0.13	0.05	8.52	6.0
	Sambucus nigra	0.13	0.03	7.84	6.0
Basin/Dome Swamp (*Taxodium ascendens*)	*Acer rubrum*	0.08	0.04	5.66	7.0 ±(4.3)
	Baccharis halimifolia	0.08	0.07	7.31	7.3 ±(3.9)
	Cephalanthus occidentalis	0.19	0.19	18.99	5.6 ±(1.2)
	*Ludwigia peruviana**	0.08	0.35	21.40	4.8 ±(0.4)
	Lyonia lucida	0.08	0.10	8.96	4.8 ±(1.8)
	Myrica cerifera	0.19	0.19	19.05	5.1 ±(1.4)
	Persea borbonia	0.04	0.01	2.66	3.0
	Quercus nigra	0.04	0.00	2.04	3.0
	Salix caroliniana	0.04	0.01	2.60	7.0
	Sambucus nigra	0.04	0.01	2.66	5.0
	*Sapium sebiferum**	0.04	0.01	2.38	5.0
	*Schinus terebinthifolius**	0.04	0.00	2.04	4.0

Table B-2. Continued

		Shrub Stratum			
		Relative			Average
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Basin/Dome Swamp (*Taxodium ascendens*)	*Taxodium ascendens*	0.04	0.01	2.21	8.0
	Taxodium distichum	0.04	0.00	2.04	4.0
Bottomland Forest	*Acer rubrum*	0.08	0.02	4.89	8.0 ±(3.6)
	Baccharis halimifolia	0.02	0.00	1.03	4.0
	Callicarpa americana	0.02	0.05	3.56	6.0
	Carya aquatica	0.02	0.01	1.41	3.0
	Carya glabra	0.02	0.01	1.30	7.0
	Celtis laevigata	0.02	0.00	1.09	8.0
	*Citrus aurantium***	0.02	0.01	1.41	14.0
	*Cinnamomum camphora**	0.02	0.01	1.41	3.5
	Crataegus spp.	0.02	0.00	1.09	6.0
	Crataegus marshallii	0.02	0.00	1.09	6.0
	Fraxinus spp.	0.02	0.01	1.41	3.0
	Gleditsia spp.	0.06	0.01	3.67	3.2 ±(1.8)
	Itea virginica	0.02	0.06	4.18	5.0
	Liquidambar styraciflua	0.08	0.02	4.73	3.5 ±(2.2)
	Lyonia lucida	0.02	0.10	6.01	5.0
	Myrica cerifera	0.06	0.02	3.94	5.4 ±(2.4)
	Persea borbonia	0.02	0.01	1.25	5.0
	Persea palustris	0.02	0.01	1.30	9.0
	*Peltophorum pterocarpum***	0.02	0.01	1.41	5.0
	Prunus caroliniana	0.02	0.01	1.41	2.5
	Prunus serotina	0.02	0.03	2.70	2.5
	Quercus laurifolia	0.02	0.00	1.20	4.0
	Sabal minor	0.06	0.16	11.01	4.7 ±(2.1)
	Sabal palmetto	0.22	0.33	27.29	8.0 ±(4.5)
	*Sapium sebiferum**	0.02	0.01	1.41	3.5
	Serenoa repens	0.02	0.08	5.01	3.0
	Ulmus americana	0.04	0.01	2.39	6.0 ±(1.5)

Table B-2. Continued

		Shrub Stratum			
		Relative			Average
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Bottomland Forest	*Viburnum obovatum*	0.02	0.01	1.41	5.0
Floodplain Swamp	*Acer rubrum*	0.11	0.03	7.16	6.8 ±(4.6)
	Baccharis halimifolia	0.06	0.02	3.98	3.0
	Callicarpa americana	0.06	0.01	3.38	3.0
	Cephalanthus occidentalis	0.11	0.09	9.96	4.3 ±(1.1)
	Fraxinus spp.	0.06	0.04	4.78	6.0
	Itea virginica	0.11	0.11	11.16	5.8 ±(1.8)
	*Ludwigia peruviana**	0.06	0.29	17.18	5.0
	Lyonia lucida	0.06	0.10	7.58	5.0
	Myrica cerifera	0.06	0.02	3.98	4.0
	Quercus laurifolia	0.28	0.18	22.69	7.2 ±(3.2)
	Sabal palmetto	0.06	0.11	8.18	6.0
Hydric Hammock	*Callicarpa americana*	0.16	0.07	11.63	4.9 ±(1.7)
	Carpinus caroliniana	0.05	0.01	3.30	7.5 ±(3.6)
	Celtis laevigata	0.03	0.01	1.64	6.0
	Ilex cassine	0.03	0.01	1.72	3.0
	Liquidambar styraciflua	0.11	0.03	6.58	3.8 ±(1.1)
	Magnolia virginiana	0.03	0.02	2.12	4.0
	Myrica cerifera	0.03	0.01	1.72	10.0
	Persea borbonia	0.05	0.02	3.41	4.0 ±(2.9)
	Quercus hemisphaerica	0.03	0.01	1.69	2.0
	Quercus laurifolia	0.03	0.01	1.72	6.0
	Quercus nigra	0.05	0.01	3.17	4.3 ±(0.4)
	Sabal minor	0.03	0.01	1.58	2.5
	Sabal palmetto	0.21	0.65	43.05	7.7 ±(3.1)
	Serenoa repens	0.13	0.14	13.35	3.7 ±(1.0)
	Taxodium distichum	0.03	0.01	1.72	10.0
	Vaccinium arboreum	0.03	0.01	1.58	1.0

Table B-2. Continued

		Shrub Stratum			
		Relative			Average
Community	**Species**	***f***	**CVR**	**IV**	**HT**
Mangrove Swamp	*Avicennia germinans*	0.33	0.08	20.83	3.8 ±(1.8)
	Borrichia frutescens	0.17	0.29	22.92	3.5
	Rhizophora mangle	0.50	0.63	56.25	8.4 ±(6.2)

* Species invasive to Florida.
** Species introduced to Florida.

LIST OF REFERENCES

Alberti, M. (2008) *Advances in Urban Ecology: Integrating Humans and Ecological Processes in Urban Ecosystems*. Springer Science + Business Media, LLC., New York, NY, USA.

Alberti, M. (2005) The effects of urban patterns on ecosystem function. *International Regional Science Review* **28**, 168-192.

Ball, M. C. (1980) Patterns of secondary succession in a mangrove forest of southern Florida. *Oecologia* **44**(2), 226-235.

Bradley, G. A., Ed. (1995) *Urban Forest Landscapes*. University of Washington Press, Seattle, WA, USA.

Bridges, E. L. and Reese, G. A. (1996) Upper Lakes Basin watershed natural resource inventory. Natural Resource Inventory of Save our River Lands. Final Report for Work Order #1, C-6973.

Burton, M. L. and Samuelson, L. J. (2008) Influence of urbanization on riparian forest diversity and structure in the Georgia Piedmont, US. *Plant Ecology* **195**(1), 99-115.

Burton, M. L., Samuelson, L. J., and Pan, S. (2005) Riparian woody plant diversity and forest structure along an urban-rural gradient. *Urban Ecosystems* **8**(1), 93-106.

Carlton, J. M. (1977) A survey of selected coastal vegetation communities in Florida. Florida Marine Research Publications. Number 30.

Cavender-Bares, J., Kitjima, K., and Bazzaz, F. A. (2004) Multiple trait associations in relation to habitat differentiation among 17 Floridian oak species. *Ecological Monographs* **74**(4), 635-662.

Cordell, H. K. and Macie, E. A. (2002) Population and Demographic Trends. In *Human Influences on Forest Ecosystems: The Southern Wildland-Urban Interface Assessment* (Macie, E. A. and Hermansen, L. A., eds.), pp. 11-34. US Dept. of Agriculture. Forest Service. Gen. Tech. Rep. SRS-55.

Covington, J. W. (1961) The armed occupation act of 1842. *The Florida Historical Quarterly* **40**(1), 41-52.

Darst, M. R. and Light, H. M. (2008) Drier forest composition associated with hydrological change in the Apalachicola River floodplain, Florida. U.S. Geological Survey, Scientific Investigations. Report 2008-5062.

Duryea, M. L. and Hermansen, L. A. (2002) Challenges to Forest Resource Management and Conservation. In *Human Influences on Forest Ecosystems: The Southern Wildland-Urban Interface Assessment* (Macie, E. A. and Hermansen, L. A., eds.), pp. 93-110. US Dept. of Agriculture. Forest Service. Gen. Tech. Rep. SRS-55.

Ewel, K. C. (1990) Swamps. In *Ecosystems of Florida* (Myers, R. L. and Ewel, J. J., eds.), pp. 281-323. University of Central Florida Press, Orlando, FL, USA.

Florida Department of Environmental Protection, FDEP. (2008) Integrated water quality assessment for Florida: 2008 305(b) report and 303(d) list update. Dept. of Environmental Assessment and Restoration, Bureau of Watershed Management.

Florida Department of Environmental Protection, FDEP. (2005) Water quality assessment report: Tampa Bay tributaries. Division of Water Resource Management, Southwest District, Basin 2.

Florida Department of Environmental Protection, FDEP. (2003) Water quality assessment report: Tampa Bay. Division of Water Resource Management, Southwest District, Basin 1.

Florida Exotic Pest Plant Council, FLEPPC. (2009) *2009 invasive plant list*. Retrieved September 28, 2010 from http://www.fleppc.org/list/list.htm

Florida Natural Areas Inventory, FNAI. (2010) Guide to the natural communities of Florida: 2010 edition. Florida Natural Areas Inventory.

Florida Nursery, Growers, and Landscape Association, FNGLA. (2010) *The FNGLA plant and product locator*. Retrieved January 12, 2011 from http://www.fngla.org/search/searching/locator.asp

Fowlkes, M. D., Michael, J. L., Crisman, T. L., and Prenger, J. P. (2003) Effects of the herbicide imazapyr on benthic macroinvertebrates in a logged pond cypress dome. *Environmental Toxicology and Chemistry* **22**(4), 900-907.

Godfrey, R. K. (1988) *Trees, Shrubs, and Woody Vines of Northern Florida and Adjacent Georgia and Alabama*. University of Georgia Press, Athens, GA, USA.

Gordon, D. R. (1998) Effects of invasive, non-indigenous plants species on ecosystem processes: Lessons from Florida. *Ecological Applications* **8**(4), 975-989.

Gotelli, N. J. and Ellison, A. M. (2004) *A Primer of Ecological Statistics*. Sinauer Associates, Inc., Sunderland, MA, USA.

Grimm, N. B., Foster, D., Groffman, P., Grove, J. M., Hopkinson, C. S., Nadelhoffer, K. J., Pataki, D. E., and Peters, D. P. (2008) The changing landscape: Ecosystem responses to urbanization and pollution across climatic and societal gradients. *Frontiers in Ecology and the Environment* **6**(5), 264-271.

Grove, J. M., Troy, A. R., O'Niel-Dunne, J. P. M., Burch Jr., W. R., Cadenasso, M. L., and Pickett, S. T. A. (2006) Characterization of households and its implications for the vegetation of urban ecosystems. *Ecosystems* **9**(4), 578-597.

Gunderson, L. H. (1984) Regeneration of Cypress in Logged and Burned Strands at Corkscrew Swamp Sanctuary, Florida. In *Cypress Swamps* (Ewel, K. C. and Odum, H. T., eds.), pp. 349-357. University Press of Florida, Gainesville, FL, USA.

Gunderson, L. H. (1977) Regeneration of cypress, Taxodium distichum and Taxodium ascendens, in logged and burned cypress strands at Corkscrew Swamp Sanctuary, Florida*.* Unpublished Masters, University of Florida, Gainesville, FL.

Haag, K. H. and Lee, T. M. (2010) Hydrology and ecology of freshwater wetlands in Central Florida: A primer. U.S. Geological Survey. Circular 1342.

Kachigan, S. K. (1991) *Multivariate Statistical Analysis* (2nd ed.). Radius Press, New York, NY, USA.

Kowarik, I. (2008) On the Role of Alien Species in Urban Flora and Vegetation. In *Urban Ecology: An International Perspective on the Interaction Between Humans and Nature* (Marzluff, J. M., Shulenberger, E., Endlicher, W., Alberti, M., Bradley, G., Ryan, C., Simon, U., and ZumBrunnen, C., eds.), pp. 321-338. Springer Science+Business Media, LLC., New York, NY, USA.

Kowarik, I. (1990) Some Responses of Flora and Vegetation to Urbanization in Central Europe. In *Urban Ecology: Plants and Plant Communities in Urban Environments* (Sukopp, H. and Hejny, S., eds.), pp. 45-74. SPB Academic Publishing, The Hague, Netherlands.

Kuenzler, E. J. (1974) Mangrove Swamp Systems. In *Coastal Ecological Systems of the United States* (H. T. Odum, B. J. Copeland, and E. A. McMahon, eds.), pp. 347-371. The Conservation Foundation, Washington, DC, USA.

Langland, K. A. and Burks, K. C., eds. (1998) *Identification and Biology of Non-Native Plants in Florida's Natural Areas*. University of Florida Press, Gainesville, FL, USA.

Light, H. M., Darst, M. R., Lewis, L. J., and Howell, D. A. (2002) Hydrology, vegetation, and soils of riverine and tidal floodplain forests of the lower Suwannee River, Florida, and potential impacts of flow reductions. U.S. Geological Survey. Professional Paper 1656 A.

Loewenstein, N. J. and Loewenstein, E. F. (2005) Non-native plants in the understory of riparian forests across a land use gradient in the Southeast. *Urban Ecosystems* **8**, 79-91.

McCune, B. and Grace, J. B. (2002) *Analysis of Ecological Communities*. MjM Software Design, Gleneden Beach, OR, USA.

Marois, K. C. and Ewel, K. C. (1983) Natural and management-related variation in cypress domes. *Forest Science* **29**(3), 627-640.

Mitsch, W. J. and Gosselink, J. G. (2000) *Wetlands, Third Edition*. John Wiley and Sons, Inc., New York, NY, USA.

Monk, C. D. and Brown, T. W. (1965) Ecological consideration of cypress heads in North Central Florida. *American Midland Naturalist* **74**(1), 126-140.

Myers, R. L. and Ewel, J. J. (Eds.). (1990) *Ecosystems of Florida*. University of Central Florida Press, Orlando, FL, USA.

Oliver, C. D. and Larson, B. C. (1996) *Forest Stand Dynamics*. John Wiley and Sons, Inc., New York, NY, USA.

Odum, W. E. and McIvor, C. C. (1990) Mangroves. In *Ecosystems of Florida* (Myers, R. L. and Ewel, J. J., eds.), pp. 517-548. University of Central Florida Press, Orlando, FL, USA.

Odum, W. E., McIvor, C. C. and Smith III, T. J. (1982) Ecology of the mangroves of south Florida: A community profile. US Fish and Wildlife Service. Office of Biological Services. FWS/OBS-81/24.

Olmsted, I. C. and Loope, L. L. (1984) Plant Communities of Everglades National Park. In *Environments of South Florida: Present and Past, Memoir II*. (Gleason, P. J., ed.), pp. 167-184. Miami Geological Society, Coral Gables, FL, USA.

Owen, W. (2002) The history of native plant communities in the South. In *Southern forest resource assessment* (Wear, D. N. and Greis, J. G., eds.), pp. 47-61. U.S. Dept. of Agriculture. Forest Service. Southern Research Station Gen. Tech. Rep. SRS-53.

Paul, M. J. and Meyer, J. L. (2008) Streams in the Urban Landscape. In *Urban Ecology: An International Perspective on the Interaction Between Humans and Nature* (Marzluff, J. M., Shulenberger, E., Endlicher, W., Alberti, M., Bradley, G., Ryan, C., Simon, U., and ZumBrunnen, C., eds.), pp. 207-232. Springer Science + Business Media, LLC. New York, NY, USA.

Pearce, F. (2006) *When the Rivers Run Dry: Water - The Defining Crisis of the Twenty-First Century*. Beacon Press, Boston, MA, USA.

Platt, W. J. and Schwartz, M. W. (1990) Temperate Hardwood Forests. In *Ecosystems of Florida* (Myers, R. L. and Ewel, J. J., eds.), pp. 194-229. University of Central Florida, Orlando, FL, USA.

Pool, D. J., Snedaker, S. C., and Lugo, A. E. (1977) Structure of mangrove forests in Florida, Puerto Rico, Mexico, and Costa Rica. *Biotropica* **9**(3), 195-212.

Schneider, R. L. and Sharitz, R. R. (1986) Seed bank dynamics in a southeastern riverine swamp. *American Journal of Botany* **73**(7), 1022-1030.

Schomer, N. S., Drew, R. D., and Johnson, P. (1990) Vegetation communities (habitats). In *An ecological characterization of the Tampa Bay Watershed* (Wolf, S. H. and Drew, R. D., eds.), pp. 134-215. US Fish and Wildlife Service. Biological Report 90(20).

Sharitz, R. R. and Mitsch W. J. (1993) Southern Floodplain Forests. In *Biodiversity of the Southeastern United States: Lowland Terrestrial Communities* (Martin, W. H., Boyce, S. G., and Echternacht, A. C., eds.), pp. 310-372. John Wiley and Sons Inc., New York, NY, USA.

Sharpe, D. M., Stearns, F., Leitner, L. A., and Dorney, J. R. (1986) Fate of natural vegetation during urban development of rural landscapes in southeastern Wisconsin. *Urban* Ecology **9**(3-4), 267-287.

Soil Survey Division Staff. (1993) *Soil survey manual*. U.S. Dept. of Agriculture. Soil Conservation Service. Handbook 18.

Southeast Regional Climate Change Center, SERCC. (2007) *Historical climate summaries for Florida*. Retrieved September 1, 2010 from http://www.sercc.com/index.php.

Sprague, E., Burke, D., Claggett, S., and Todd, A., eds. (2006) The state of Chesapeake forests. U.S. Dept. of Agriculture. Forest Service. Northeast Area.

Teas, H. J. (1979) Silviculture with Saline Water. In *Biosaline Concept: An Approach to the Utilization of Underexploited Resources* (Hollaender, A., ed.), pp. 117-162. Plenum Publishing Corporation, New York, NY, USA.

U.S. Census Bureau. (2010) *State and county quick facts*. Retrieved October 6, 2010 from http://quickfacts.census.gov/qfd/states/12000.html

U.S. Department of Agriculture Forest Service. (2006) *i-Tree software suite v1.0: Tools for assessing and managing community forests*. Retrieved January 5, 2007 from http://www.itreetools.org.

U.S. Department of Agriculture, Natural Resources Conservation Service, USDA/NRCS. (2010) *Plants database*. Retrieved February 10, 2010 from http://plants.usda.gov/java/.

U.S. Department of Agriculture, Natural Resources Conservation Service, USDA/NRCS. (2009) *National Soil Survey handbook, title 430-VI*. Retrieved June 10, 2009 from http://soils.usda.gov/technical/handbook/.

U.S. Department of Agriculture, Natural Resources Conservation Service, USDA/NRCS. (2007) *Soil Survey Geographic (SSURGO) database for Pasco County, Florida*. Retrieved June 1, 2009 from http://soildatamart.nrcs.usda.gov .

U.S. Department of Agriculture, Natural Resources Conservation Service, USDA/NRCS. (2006) *Soil Survey Geographic (SSURGO) database for Hillsborough County, Florida*. Retrieved May 31, 201129, 2009 from http://soildatamart.nrcs.usda.gov .

U.S. Department of Agriculture, USDA. (1989) *Soil Survey of Hillsborough County, Florida*. U.S. Dept. of Agriculture. Soil Conservation Service. Washington, DC, USA.

U.S. Fish and Wildlife Service, USFWS. (1999) South Florida multi-species recovery plan. U.S. Fish and Wildlife Service.

U.S. Geological Survey, USGS. (2009) *National elevation dataset*. Retrieved June 17, 2009 from http://ned.usgs.gov/.

University of Florida, UF. (2009a) *Center for aquatic and invasive plants*. Retrieved October 5, 2010 from http://plants.ifas.ufl.edu/.

University of Florida, UF. (2009b) *Florida forests trees: Slash pine (Pinus elliottii)*. Retrieved April 4, 2011 from http://www.sfrc.ufl.edu/4h/Slash_pine/slaspine.htm.

Vince, S. W., Humphrey, S. R. and Simons, R. W. (1989) The ecology of hydric hammocks: A community profile. US Fish and Wildlife Service. Biological Report 85(7.26).

Vitousek, P. M., Mooney, H. A., Lubchenco, J., and Melillo, J. M. (2008) Human Domination of Earth's Ecosystems. In *Urban Ecology: An International Perspective on the Interaction Between Humans and Nature* (Marzluff, J. M., Shulenberger, E., Endlicher, W., Alberti M., Bradley, G., Ryan, C., Simon, U., and ZumBrunnen, C., eds.), pp. 3-14. Springer Science + Business Media, LLC, New York, NY, USA.

Walker, J. S., Grimm, N. B., Briggs, J. M., Gries, C., and Dugan, L. (2009) Effects of urbanization on plant species diversity in central Arizona. *Frontiers in Ecology* **7**(9), 465-470.

Wharton, C. H., Kitchens, W. M., Pendleton, E. C., and Sipe, T. W. (1982) The ecology of bottomland hardwood swamps of the southeast: A community profile. US Fish and Wildlife Service. Biological Service Program. FWS/OBS-81/37.

Williams, W. T., Lambert, J. M., and Lance, G. N. (1966) Multivariate methods in plant ecology: V. Similarity analysis and information-analysis. *Journal of Ecology* **54**(2): 427-445.

Wishart, D. (1969) An algorithm for hierarchical classifications. *Biometrics* **25**(1), 165-170.

Xian, G. and Crane, M. (2005) Assessments of urban growth in the Tampa Bay watershed using remote sensing data. *Remote Sensing of Environment* **97**(2)**,** 203-215.

Zipperer, W. C. (2002a) Species composition and structure of regenerated and remnant forest patches within an urban landscape. *Urban Ecosystems* **6**(4), 271-290.

Zipperer, W. C. (2002b) Urban Influences on Forests. In *Human Influences on Forest Ecosystems: The Southern Wildland-Urban Interface Assessment* (Macie, E. A. and Hermansen, L. A., eds.), pp. 73-88. U.S. Dept. of Agriculture. Forest Service. Gen. Tech. Rep. SRS-55.

Zwick, P. D. and Carr, M. H. (2006) Florida 2060: A population distribution scenario for the state of Florida*.* GeoPlan Center, University of Florida.

BIOGRAPHICAL SKETCH

Ms. Friedman earned her high school diploma from Cooper City High School in Cooper City, Florida in 1994. With no aspirations to attend college, she did the minimum necessary to graduate. About a year after graduation, Ms. Friedman realized that academia was in fact the best route for her to take and began to apply herself at the local community college. Many remedial courses and a pivotal math tutorer later, she graduated Cum Laude with her Associate of Arts degree from Broward Community College in spring of 2001. Ms. Friedman continued to pursue her academic endeavors at the University of Florida's (UF) College of Agricultural and Life Sciences (CALS), where she graduated Cum Laude once again, but this time with a Bachelor of Science degree from the Department of Wildlife Ecology and Conservation in fall of 2003. Ms. Friedman also earned a minor in Forest Resources and Conservation from the School of Forest Resources and Conservation (SFRC) because she felt this would provide her with a more well-rounded background. After graduation, Ms. Friedman aspired to earn a master's degree but felt that it was necessary to gain experience in her chosen field before deciding on an area of focus. After 5 years working on various projects ranging from avian population ecology to urban forest ecosystems, Ms. Friedman was ready to pursue her master's degree. In fall of 2008 she returned to CALS as a distance student in the SFRC. In August of 2011 Ms. Friedman willo earn her Master of Science degree and looks forward to embarking on the next chapter in her life.