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A Comparison of Ecological Conditions and Relationships in an Altered Wetland and an Unaltered Wetland

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A Comparison of Ecological Conditions and Relationships in an Altered Wetland

and an Unaltered Wetland

by

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Table of Contents

List of Tables iii

List of Figures iv

Abstract vi

Chapter One: Introduction 1
- Research Strategy 5
  - Thesis Statement 5
  - Research Purpose 6
  - Research Questions 7
- Research Objectives 8
  - Background Information 9
  - Wetland Restoration and Hydrology 9
  - Wetland Hydrology and Wildlife Utilization 13
  - Wetland Hydrology and Vegetation Response 15

Chapter Two: Study Area 21
- Location 21
  - Physiography 24
- Historical Information 28
- Site Information 42

Chapter Three: Methodology 47
- Information Sources 47
- Methods 47
  - Rainfall 48
  - Monitoring 49
  - Hydrology 49
  - Vegetation 53
  - Birds 57
  - Analysis 58

Chapter Four: Results 61
- Hydrology 61
- Vegetation 65
- Birds 72
  - Swamp Birds 73

Marsh Birds 74

Chapter Five: Discussion 77
Hydrology 79
Vegetation 89
Habitat Utilization 98
Swamp Birds 98
Marsh Birds 99

Chapter Six: Conclusions 105

List of References 111

Appendix A: Water Level Monitoring Locations 114

Appendix B: Vegetation Monitorin Form 116

Appendix C: Vegetation Species Lists 118

Appendix D: Vegetation Monitoring Locations 122

Appendix E: Vegetation Groundcover Graphs 124

Appendix F: Avian Species Lists 135

Appendix G: Avian Monitoring Points 138

Appendix H: Site Photographs 140

Appendix I: Institutional Animal Care and Use Committee (IACUC) Permit 148

Appendix J: Florida Department of Environmental Protections Research Permit 150

List of Tables

Table 1A. Summary Statistics for Vegetation in Individual Quadrats (Transects 1 and 2) 67

Table 1B. Summary Statistics for Vegetation in Individual Quadrats (Transects 1 and 2) 68

Table 2. A comparison of similarity of of groundcover vegetation in each pair of monitoring transects 69

Table 3. Numbers of different species of each indicator type in each monitoring transect 71

Table 4. A comparison of avian utilization in the swamp and the marsh 78

Table 5. State and Federal Listed Avian Species Identified at the Colt Creek Study Site 103

.

List of Figures

Figure 1. The location of Colt Creek State Park in the west central Florida Peninsula 4

Figure 2. Colt Creek State Park Vicinity Map 22

Figure 3. Colt Creek State Park Reference Map 23

Figure 4. Regional mean rainfall and temperatures recorded at Dade City, FL 24

Figure 5. 2010 aerial photograph with LiDAR 1-foot contours 25

Figure 6. USGS 1:24,000 Quadrangle Map of the lower reach of Colt Creek 27

Figure 7. Study area and adjacent sections of Colt Creek (1941) 29

Figure 8. 1951 aerial photograph showing distinct trails or roads north and south of Colt Creek 31

Figure 9. 1952 aerial photograph which shows the newly excavated bypass ditch that crosses Colt Creek in an approximately north-south orientation (perpendicular to stream flow) 32

Figure 10. 1957 aerial photograph 34

Figure 11. 1968 aerial photograph 35

Figure 12. Circa 1975 aerial photograph 37

Figure 13. 1984 aerial photograph (false color infrared) 38

Figure 14. 1999 aerial photograph (false color infrared) 40

Figure 15. 2010 aerial photograph 41

Figure 16. Topsoil in marsh 43

Figure 17. Subsurface clayey soil in marsh 44

Figure 18. Clayey soil 3 feet to 5 feet below ground surface in marsh........ 45

Figure 19. Rainfall at Colt Creek State Park during the monitoring period from January 2, 2010 to January 15, 2011 62

Figure 20. Colt Creek hydrology from January 2010 to January 2011........ 63

Figure 21. Site hydrology with adjacent staff gage levels for comparison........ 65

Figure 22. A comparison of the distribution of vegetation species in each monitoring transect by percentage of each wetland indicator category........ 70

Figure 23. A comparison of the distribution of vegetation species in each monitoring transect by the number of species within each wetland indicator category 71

Figure 24. Changes in bird abundance in the Colt Creek swamp during the monitoring period........ 73

Figure 25. Weekly bird species numbers in the Colt Creek swamp........ 74

Figure 26. Weekly bird counts in the Colt Creek marsh........ 75

Figure 27. Weekly bird species numbers in the Colt Creek marsh 76

Figure 28. A comparison of 2010 rainfall at Colt Creek with historic mean rainfall in the region 79

Figure 29. Summary of the site hydrology 86

Figure 30. Monitor well hydrograph with the key hydrologic differences between the undrained (upstream) swamp and the drained (downstream) marsh identified........ 87

Figure 31. A comparison of bird abundance in the marsh with water levels 100

Figure 32. A comparison of bird abundances in the swamp and in the marsh........ 101

Abstract

The purpose of the study is to identify and quantify the hydrologic and ecologic differences between two adjacent sections of Colt Creek; one section unaltered and one section altered by clearing and drainage. These differences were measured by monitoring water levels, groundcover vegetation in each of the two areas, and monitoring numbers and species of birds utilizing the two areas. Surface water levels were measured in three locations: in the historic Colt Creek flow way, in the ditch draining the creek, and in an adjacent wetland strand. In addition, a shallow monitor well in the creek was used to measure groundwater levels when the creek was dry. The intent of avian monitoring was to use birds as a relatively easily observable surrogate for wildlife habitat utilization in general. Groundcover vegetation species and approximate percent cover data were recorded at several locations in both wetlands. Data collection occurred from January 2010 to January 2011.

The results indicate that the hydrology, vegetation, and avian utilization of the two adjacent areas were substantially different. Specifically, the hydroperiod during the monitoring period was seven weeks shorter in duration in the downstream area than in the upstream unaltered area. In addition, the presence of flowing water, i.e., stream flow, through the downstream area was approximately 18 weeks less than the upstream area. Vegetation species composition, diversity, and percent cover also differed in the two areas. A total of 39 groundcover species were identified in

the two sites. Seven (7) additional plants were identified to genus. Twenty one species (74.9 %) of all plants identified were common to both areas. Sixteen species (41.0 %) were found only in the unaltered site and 10 species (25.6 %) were found only in the altered site. Species richness was greater in the unaltered site while percent cover was less, i.e., more bare ground / plant litter. Relative percent cover by wetland species in the unaltered site was 11.8 percent greater than in the altered site. Finally, avian utilization was greater in the altered area, as 484 individual birds and 27 species were identified in the altered site compared to 138 individual birds and 13 different species identified in the unaltered area.

Chapter One: Introduction

For any wetland habitat, the fundamental component is hydrology. If that component is altered, the other components of the system will also change over some period of time. If the hydrology is restored, the other components can subsequently be restored or allowed to restore themselves. As each component returns to the system, wetland functions are usually restored, as well. Within this reach of Colt Creek, a portion of the historic flow has bypassed the natural flow way via a ditch excavated through the stream and adjacent associated flood plain.

The vegetation structure of the stream and flood plain, which is determined to a great degree by the hydrology, is a second component of a wetland. The vegetation in the undrained portion of Colt Creek, upstream of the bypass ditch appears to be intact and fully functional. The wetland in the drained section of the creek downstream from the ditch, in addition to being hydrologically altered, has been cleared of almost all trees and shrubs, and converted to an improved pasture.

A third component of a wetland habitat is wildlife utilization. Wildlife use of a habitat, to a great degree, is determined by the vegetative structure and composition. Therefore, wildlife could perhaps be considered the third tier of this

particular hierarchy, although all three components probably relate in a more complex fashion than the simple linear model outlined here.

This thesis has attempted to quantify and relate these three components within a short section of Colt Creek and portions of the adjacent flood plain. Specifically, this study consists of measuring these three components of hydrology, vegetation, and habitat use in the unaltered creek and floodplain upstream of the bypass ditch, and also in the altered creek and floodplain downstream of the ditch. With those data, the two areas are described and compared to each other in order to try to understand the differences in the two sections of the creek and, ultimately, to understand the effect those differences have on the third component: habitat use.

Colt Creek is one of seven relatively small tributary drainages to the upper reaches of the Withlacoochee River in west central Florida. As was common practice until late in the 20th Century, much of the Colt Creek flow was channelized to increase drainage in order to facilitate agriculture within the basin, primarily to improve pasture for cattle grazing. This study site consists of two adjacent, but now very different parts of what was historically a continuous forested wetland strand. The downstream portion of the creek has been hydrologically altered by the agricultural ditching, and structurally altered by clearing and conversion to pasture. Now that these sections of Colt Creek are within a state park, agricultural activities are being replaced by passive recreation, habitat restoration, and natural systems management.

In an article located on the internet site for the conservation organization American Rivers (Meyer et al, 2007), the authors state that headwater wetlands and streams “exert critical influences on the character and quality of downstream waters” and “the health and productivity of rivers and lakes depend upon intact small streams and wetlands.” Colt Creek is a relatively minor tributary located in the upper basin / watershed of the Withlacoochee River in central Florida (Figure 1). Although not a “headwater” stream in the strictest sense of being the source or beginning of the Withlacoochee River, it is a component of the upper portion of the river watershed that undoubtedly has an effect on the entire river to some extent. Therefore, alterations to Colt Creek would affect the downstream river.

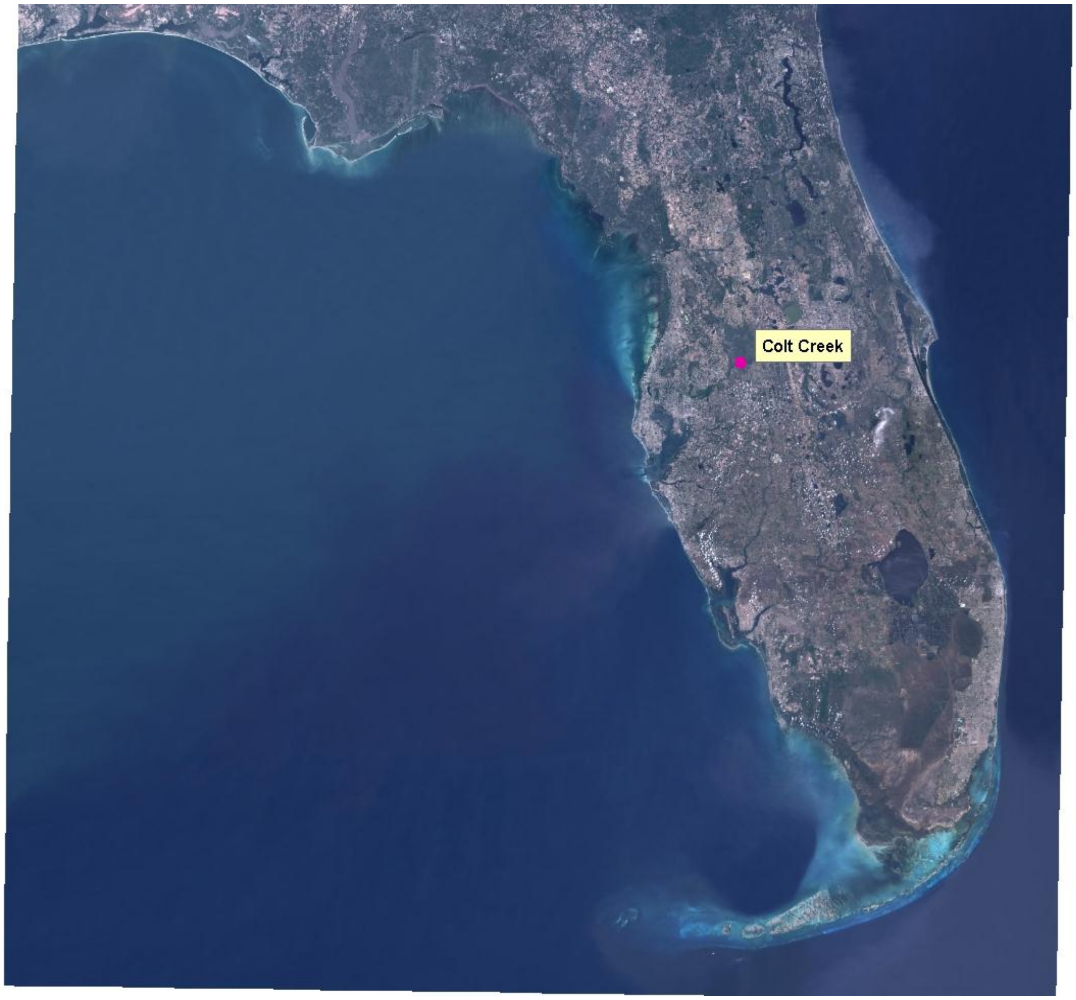

Figure 1. Colt Creek State Park is located in the west central area of the Florida peninsula.

According to Naiman et al (2005), alterations of riparian systems fall into four broad categories: flow regulation, pollution, climate change, and land use change. The alterations, or disturbances, that have occurred at Colt Creek include at least two of these categories: flow regulation and land use change; specifically, rerouting the historic flow path and clearing a portion of the flow way and flood plain, and planting exotic grasses, i.e., Bahia (*Paspalum notatum)* and Bermudagrass (*Cynodon dactylon*) for pasture. Although a detailed description of the historic system does not exist, the previous condition can be at interpreted

to some degree from historic aerial photography, and comparison with nearby, relatively intact systems. Essentially, the historic condition of Colt Creek as a structurally and functionally complex and diverse native wetland habitat has, in this part of the creek, been simplified to a single stratum (groundcover) of one or two dominant (exotic) species, with a reduced hydroperiod. In addition, although the canopy structure immediately upstream of the improved pasture area appears to be mostly intact, the channelization higher in the basin likely had some effect on the functions of this area, as well. This anthropogenic disturbance of channelization can result in lowering of the water table, desiccation and change in community composition, e.g., loss of wetland species and recruitment of more upland species, and possibly a decline in biodiversity (Naiman et al, 2005). In general, the overall effect of flow regulation is to impose equilibrium conditions on a non-equilibrium community (Naiman et al, 2005).

Research Strategy

Thesis statement

Differences in hydrology and vegetation between an altered wetland and a relatively unaltered wetland result in differences in wetland functions, such as wildlife utilization. Habitat functions provided by a forested wetland strand are significantly different from habitat functions provided by a wetland which has been altered by drainage and clearing.

Research Purpose

The rationale and justification for this research is based on several sources. The American Rivers publication cited previously describes the importance of headwater wetlands and streams such as Colt Creek, the functions they provide, and the historic and on-going impacts to these valuable hydrologic and ecologic systems. The authors state that headwater streams constitute 80% of all stream systems in the United States. Those headwaters provide many functions, including protecting water quality, maintaining water supplies, providing flood control, trapping excess sediments, sustaining downstream ecosystems, and maintaining riparian biological diversity (Meyer et al, 2007). Considering the importance of protecting existing systems and restoring degraded systems, understanding the processes of these systems and the changes that occur when they are altered and then restored would seem to be a worthwhile endeavor, if not an ecologically critical one. The understanding gained could potentially be applied in planning and implementing similar restoration activities.

Additionally, in the book <u>Riperia: ecology, conservation, and management of streamside communities</u> (Naiman et al, 2005), the authors state the need and importance for research on riparian systems, and monitoring of restored systems.

Finally, in the approved Colt Creek State Park Unit Management Plan, the Florida Department of Environmental Protection, Division of Recreation and Parks, states that two of the goals and objectives for the park's natural resources are to: 1) Hydrologically restore Colt Creek and, 2) Monitor and evaluate

hydrological restoration efforts. The plan also identified water level monitoring and bird surveys as two parameters needing research at the park.

Research Questions

The fundamental question for this research is: Are there significant functional differences between a relatively unaltered forested wetland strand and one which has been drained and cleared, and is wildlife utilization a reasonable indicator?

Within this over-arching question are the following sub-questions:

1. What are the differences in the hydrologic regime between the unaltered and altered wetlands, i.e., hydroperiod, depth of inundation / seasonal high water level and extent of inundation (floodplain)?
2. What are the differences in vegetative structure, i.e., species composition, relative composition of wetland, upland, and transitional species?
3. How does wildlife utilization differ? Will there be a statistically significant correlation between wildlife utilization, i.e., avian abundance and species composition or richness, and differences in vegetation between the unaltered and altered wetlands? Will there be a statistically significant correlation between wildlife utilization and differences in hydrology between the unaltered and altered wetlands?

Research Objectives

Meeting the following objectives will provide the basis for this study and provide the information to address the research questions:

1. Quantify the hydrologic differences in the two areas of Colt Creek.
    a. Estimate the percentage of the total flow that bypasses the historic flow way.
        i. Estimate the current water elevation fluctuations, stage duration and extent in both the historic flow way and compare with similar estimations immediately upstream in the unaltered flow way.
2. Quantify vegetative differences in the two areas of Colt Creek.
    a. Estimate existing groundcover (species composition and percent cover) in the historic flow way and compare with the groundcover in the area immediately upstream in the unaltered flow way;
    b. Estimate species richness in each wetland
3. Quantify wildlife utilization of the two areas of Colt Creek.
    a. Estimate current total avian abundance and species richness observed in the historic flow way and in the unaltered flow way; and
    b. Compare avian abundance and species richness in the two wetlands.

Background Information

Wetland Restoration and Hydrology

Naiman et al (2005) state that reestablishing more natural hydrologic regimes is the most effective means to successful restoration of “riparia”. The authors also point out that total restoration, i.e., to an original pristine condition, is rarely possible. This is due to the fact that the original condition frequently cannot be determined and / or land use changes in the basin make total restoration usually impractical or infeasible. The authors list ten hydrologic characteristics they consider fundamental to stream integrity, but emphasize one as key, that being frequent or regular flow variability. In contrast to many other stream and wetland alterations, it appears that most of the source water is still flowing through the Colt Creek Basin, i.e., no apparent diversions, dams/reservoirs, extensive ground water pumping, etc. In addition, although ditched throughout the basin, the flow path distance may not be significantly shortened, e.g., the Kissimmee River channelization, although the rate of flow through the basin has likely increased due to the ditching. One of the primary changes to Colt Creek has been to take a percentage of the high flows and much, or perhaps even all of the low flows and converting the natural broad, shallow flow to a deeper and narrower channel (ditch). In addition, in some areas of the basin those same high flows / low flows have been re-routed around the wetlands that were the natural flow path. This has likely altered what has been called the flood pulse. Junk et al (1989) propose that this flood pulse, which periodically connects a stream channel to its floodplain, is the primary

factor influencing biota in a stream-floodplain system. Generally, low order streams with relatively small upstream watersheds (such as Colt Creek) flood irregularly, frequently, and peak quickly, .i.e., “flashy”, based on local precipitation (Junk et al, 1989). The authors describe the fluctuating edge of periodic floods as a “moving littoral” area which they call the aquatic-terrestrial transition zone (ATTZ). This moving zone is an area of higher ecologic stress / disturbance relative to the more or less permanently inundated aquatic zone and the adjacent uplands beyond the floodplain. The greater habitat diversity found in floodplains due to the periodic disturbance of the flood pulse may provide for greater species diversity (Junk et al, 1989). If the ditching of Colt Creek has reduced the normal flood pulse, which is very possible if not likely, then this suggests that species diversity should increase with hydrologic restoration.

Similarly, Poff et al (1997) state that the natural flow regime is of primary importance to stream integrity and that the flow regime consists of five critical flow components: magnitude, frequency, duration, timing, and rate of change. Even without empirical data it is intuitive that some or all five of these components have probably been altered at Colt Creek. Consequently, this alteration has drained wetlands in the basin, which reduces base flow during dry periods and increases downstream flooding (Poff et al, 1997). The drainage work in Colt Creek has likely also reduced or altered the function of the flood plain in the basin. Prior to ditching, the flood plain likely consisted of all the wetlands along the creek flow way and for greater, less frequent floods, e.g., 10-year, 25-year, etc., the flood plain likely extended beyond the wetlands into

adjacent uplands. Lowland streams such as Colt Creek are very susceptible to "channel-floodplain linkages" (Poff et al, 1997) so the ditches likely reduced the magnitude and frequency of floodplain inundation. The natural flow regime is inherently variable and complete restoration of natural ecological processes requires restoration of the five components of the flow regime.

One study by Hammersmark et al (2008), was on the hydrological effects of a stream restoration and is similar in some respects to the Colt Creek study. The authors state three conclusions from their study relative to hydrology of the riparian system. First, the stream channel restoration increased ground water tables lowered by prior channelization and the subsequent incision that results from erosion in the channel. Second, stream restoration resulted in increased frequency of floodplain inundation and decreased magnitude of flood peaks, due to the increased flood storage. Third, there was a decrease in annual runoff and stream base flow. The authors also state that although direct comparison of pre- and post-restoration hydrologic data can be informative, they warned that climatic variability from year to year can cause this data to be misleading. That will need to be a consideration with the Colt Creek study as this past winter (2009 – 2010) apparently was a moderate El Nino, resulting in above average rainfall preceding and during data collection. It should also be noted that the Hammersmark study utilized extensive filling of most of the incised channel in order to restore flow to the historic natural channel. The Colt Creek hydrologic restoration will utilize a single control structure to restore flow to the historic path. However, there are key differences in the two sites relative to this. One difference is the lengths of

the restored areas: approximately 3500 meters in the Hammersmark study compared to approximately 400 meters at Colt Creek. A second significant difference is topographic fall: approximately 8.0 meters of fall in elevation at the Hammersmark site compared to a fall of less than 1.0 meter at the Colt Creek site. Presumably due to the length and elevation changes, the Hammersmark study site utilized four piezometers approximately evenly spaced along the 3500 meter site. Considering the lack of significant longitudinal (flow path) elevation change at the Colt Creek site, a single monitor well installed near the edge of the low flow channel should be sufficient.

At least some of the results of the Hammersmark study can reasonably be expected to also occur at Colt Creek, to some extent. An increase in the magnitude (depth) and frequency of floodplain inundation is the most likely result expected from this restoration. Also, it seems reasonable that there would be some increase in surficial aquifer / water table elevations with the blocking of flow in the bypass ditch. However, the largest (deepest and widest) segment of the bypass ditch is about 300 feet south of the monitor well and some research would need to be done to see if the ditch significantly influences ground water elevations at that distance, (i.e., what is the reach of the drawdown contours of the ditch?). Finally, a similar reduction in runoff and base flow through the basin is a reasonable expectation with the Colt Creek restoration. Also, increased evapotranspiration (ET) was responsible for approximately half of the decrease in total annual runoff in the Hammersmark study. Although changes in ET will not

be quantified at Colt Creek, an increase in ET is expected due to changes in the flow path and flow characteristics.

Wetland Hydrology and Wildlife Utilization

As a common goal for stream and wetland restoration is also habitat restoration, it seemed important that a measure of wildlife presence be incorporated into the Colt Creek evaluation. Birds were selected as the indicator group due to the relative ease of visual assessment and the researcher's familiarity with many of the bird species typically associated with wetlands. The "point count" technique described in the Tucson Bird Count – Park Monitoring Instructions (www.TUCSONBIRDS.org) was used to estimate bird utilization of the site.

Point count is an efficient and accepted method to estimate the numbers of birds observed in a particular habitat area (Betts et al, 2005). In the Betts paper, the authors' objective was to determine which of the most commonly used summary statistics of point count data were used in recent studies and how frequently they were used. In addition, as the point count method is only a measure of a bird's presence, the authors' wanted to see which summary statistics best correlated with other specific measures of bird reproductive activity; reproductive activity being a better indicator of habitat quality. The four most commonly used summary statistics, in descending order of usage, were 1) mean abundance, 2) presence / absence, 3) maximum abundance, and 4) frequency. Based on a meta-analysis of 10 ornithological journals over a 10-year

period, i.e., 100 journal years from 1992 to 2002, mean abundance was the most commonly used statistic, by far. Furthermore, they concluded that mean abundance and frequency were generally the best indicators of reproductive activity, although not for all bird species. The authors also found that point count was often unsuccessful at predicting reproductive activity in forest birds. This is applicable to the Colt Creek study in that the point count method was used to estimate bird numbers utilizing the study site, with the intent that changes in the number of birds and relative diversity of bird species would be an indicator of habitat quality. However, because the summary statistics cannot be universally applied to indicate habitat quality, i.e., not for all bird species and not necessarily for species observed within the forested portion of the site, the Colt Creek survey results will have to be qualified with these caveats.

In their research, Klein et al (2007), included changes in bird abundance and species diversity (along with 16 other parameters) as one measure, or indicator, of the degree of habitat restoration. These 17 indicators, although obviously more diverse and encompassing than the parameters used for the Colt Creek research, can be divided into the same three basic criteria of hydrology, vegetation, and habitat use. Relative to habitat use, their results showed a statistically significant increase in numbers of birds, and a significant positive correlation between numbers of bird species and number of years post-restoration. In addition to suggesting that changes in bird numbers appear to be a reasonable metric for evaluating the effects of habitat restoration, the authors discuss several other important factors that should be considered when

evaluating the Colt Creek restoration. Although an appropriate control site is preferable, e.g., a similarly altered site that is not restored, the authors suggest establishing performance criteria for each parameter being monitored as a surrogate for reference / control sites for comparing restoration results. Performance criteria should be sensitive to the restoration actions, include both physical and biological components, and specify trends and / or quantitative ranges rather than precise targets. The authors also included what they call an "ecological significance" test which is comparing the direction and magnitude of changes, regardless of whether or not the results are statistically significant. They state that small sample size and /or the inherent variability of natural systems may prevent statistically significant measurements of change.

Wetland Hydrology and Vegetation Response

A third indicator of the effects of wetland hydrologic alteration is changes in vegetation species and location in the landscape (zonation). Loheide and Gorelick (2007) studied these vegetation changes relative to changes in surficial ground water (water table) elevations caused by the degree (depth) of stream channel incision. Their study compared ground water flow (direction) and levels to vegetation zonation in montane meadows for three different stream condition scenarios: pristine streams, degraded streams (i.e., incised), and restored streams. The degraded stream scenario was further refined to include slightly degraded (channel incised 1 m), moderately degraded (incised 2 m), and severely degraded (incised 4 m). The authors used a numerical model that

coupled ground water elevation and flow with two vegetation types; wet/mesic vegetation and dry/xeric vegetation, and compared the model with monitoring data of ground water levels and vegetation zonation, both before channel blocking and after. The results of both the model and the empirical information showed that the depth to near-surface ground water is greatest immediately adjacent to an incised stream and the magnitude of that ground water drawdown is directly and strongly related to the depth of the incised stream. As would be expected, the vegetation shifted accordingly, with the mesic vegetation dominant in the areas with a higher mean water table and xeric vegetation dominating in areas with a lower mean water table.

A similar relationship between ditch depth and vegetation may exist at the Colt Creek site. Cross-sectional measurements of the bypass ditch (width and depth) from the point where Colt Creek flows into the ditch, downstream to the point where the location of the new control structure was installed, indicate that the width remains approximately 15 feet for that section of the ditch, but the depth (below natural ground elevation) increases from approximately 16 inches to approximately 42 inches (adjacent to the study site). However, the hydrologic monitoring of Colt Creek site is focused on changes in surface water elevation. Only one monitor well is proposed and that was used to measure water levels in the original flow way when the flow way dried up. Therefore, although a vegetation zonation may be observed that is comparable to the sites studied by Loheide and Gorelich, the water table elevations and gradient throughout the site can only be assumed without a more extensive monitoring network.

Loheide and Gorelich also state that the vegetative recovery, i.e., the shift from xeric back to mesic occurs quickly, often by the end of the first growing season following plugging of the incised channel. However, the authors do not report how long the streams were incised so it is not known what effect, if any, length of time of disturbance has on vegetation recovery.

Hammersmark et al (September 2009) studied the relationship between plant communities and water table fluctuations in a hydrologically restored riparian meadow. Bear Creek (California) is an intermittent stream and was hydrologically restored by channel blocks (“pond and plug”) seven years prior to their study. Rather than evaluate single plant species relative to water table elevations, the authors identified four plant communities consisting of multiple species associations with each community. The authors then determined the range of water table fluctuation characteristic of each plant community. Based on the range of water table fluctuation associated with each community, the four communities fell into one of three groups: xeric, mesic, or hydric. The water table depth (below ground level) was greatest (deepest) for xeric, shallowest for hydric and intermediate for the two groups classified as mesic.

In addition to the community / water table correlations observed, the authors make two additional points that should be considered for the Colt Creek study. They note that it was assumed, and is usually valid, that hydrology is the primary factor determining herbaceous community distributions in wetlands. But they also state there are other factors that can influence these distributions. Perhaps even more critical, the authors point out that short monitoring periods

such as the 12-month period proposed for the Colt Creek study, may produce misleading results due to inter-annual climatic variation. This was mentioned by the same authors in another article discussed previously. This possibility, particularly as it relates to post-hydrologic restoration monitoring at Colt Creek, is a significant concern.

In a companion article of the same study site, Hammersmark et al (2009) compared the distribution of pre- and post-restoration vegetation communities relative to pre- and post-restoration water tables. Using a hydrologic model along with post-restoration quantitative vegetation monitoring across the site, the authors developed a "habitat-suitability" model. This allowed them to reconstruct the pre-restoration vegetation communities and provided a tool for planning and implementing restoration at other sites. A critical component of the study was to determine the water table depth and range during the growing season. This proved to be a strong predictor of vegetation community distribution. The methodology developed provides a "practical, quantifiable, and science-based method" for predicting changes in vegetation cover associated with stream and meadow restoration. The authors state that it was assumed that water table depth is the dominant factor controlling vegetation distribution. This is also the assumption for the Colt Creek restoration. However, the authors mention that heavy grazing also contributed to the site degradation. This may be a confounding factor at Colt Creek as grazing and cutting hay has occurred for decades at the site and haying adjacent to the study site was discontinued only around the end of 2009.

A study by Helfield et al (2007) is somewhat more applicable to the Colt Creek study than the studies discussed previously, in that the Helfield research involved the restoration of streams and the effect changes in surface water flow regimes have on riparian vegetation. Specifically, this paper discusses comparisons of riparian vegetation between channelized streams and restored streams. The methodology consisted primarily of data obtained from vegetation surveys using 1- meter square quadrats located along transects positioned perpendicular to the streams. Their hypothesis was that restored streams would experience more frequent disturbance due to frequent flooding which would increase vegetation species diversity, i.e., species richness, evenness, and percent cover. Their hypothesis was confirmed by the results with statistically significant greater species richness and evenness. Of particular interest was a discussion of the possible mechanisms for these changes. They hypothesized that the vegetation changes were due to an increase in hydrologic and hydraulic disturbance resulting from the restoration, i.e., Connell's intermediate disturbance hypothesis. In addition, the authors emphasized the specific role of increased competition as perhaps the most important factor influencing the species changes observed in the study. It is important to note that this study was done in a boreal region (northern Sweden) and the authors point out that in more temperate locations the results will likely be different, including the possible spreading of exotic species, which are for the most part absent from their study sites. Although it is not unreasonable that exotic species may be spread by hydrologic restoration, in contrast, Naiman et al (2005) state that restoration of a

more natural hydrologic regime may favor native species adapted to natural fluctuations.

Finally, Klein et al (2007) point out several caveats that should be considered when assessing the results of ecological restoration and are applicable to the Colt Creek project. One should be cautious to not assume that the observed changes were necessarily caused by the restoration activities. One should also consider the effects of interactions and combinations of components of the system in evaluating restoration results. The authors also state that long-term, i.e., multi-year, monitoring pre- and post-restoration is necessary to accurately assess results, and it is unrealistic to expect measurable change in parameters that have high variability from year to year and a slow response time to changes. Hammersmark et al (2009) also state the same problem with short-term monitoring. This is acknowledged as a significant short-coming with the Colt Creek assessment. Ideally, two or more years of pre-restoration monitoring should be conducted followed by several years of post-restoration monitoring. As this is not practical for this study, it is hoped that the data collected will at least provide a measure of the direction and magnitude of change sufficient to indicate “ecologically significant” results if not statistical significance (Klein et al, 2007) and / or perhaps provide a baseline for future studies.

Chapter Two: Study Area

Location

The proposed study site is within Colt Creek State Park and consists of two adjacent wetlands in the lower section of Colt Creek, in northwest Polk County, Florida. The creek and state park are within the southern extent of the physiographic region known as the Green Swamp (Figure 2 -Vicinity Map and Figure 3 – Reference Map). The Green Swamp region encompasses approximately 560,000 acres within five counties in west-central Florida (Southwest Florida Water Management District, 2011). In addition to Polk County, the Green Swamp extends into Pasco, Hernando, Sumter, and Lake Counties.

This site was selected primarily for one reason, that being the proposed restoration of the creek. One of the management goals of the Florida Division of Recreation and Parks for this park is habitat restoration, including restoring Colt Creek. The water management district, in cooperation with the state park, has created a plan to restore Colt Creek as a part of the water management district's mitigation plan for the Florida Department of Transportation (SWFWMD FDOT Mitigation Plan – Project SW 84). The first phase of the two-phase restoration consists of restoring historic flow to the natural creek channel.

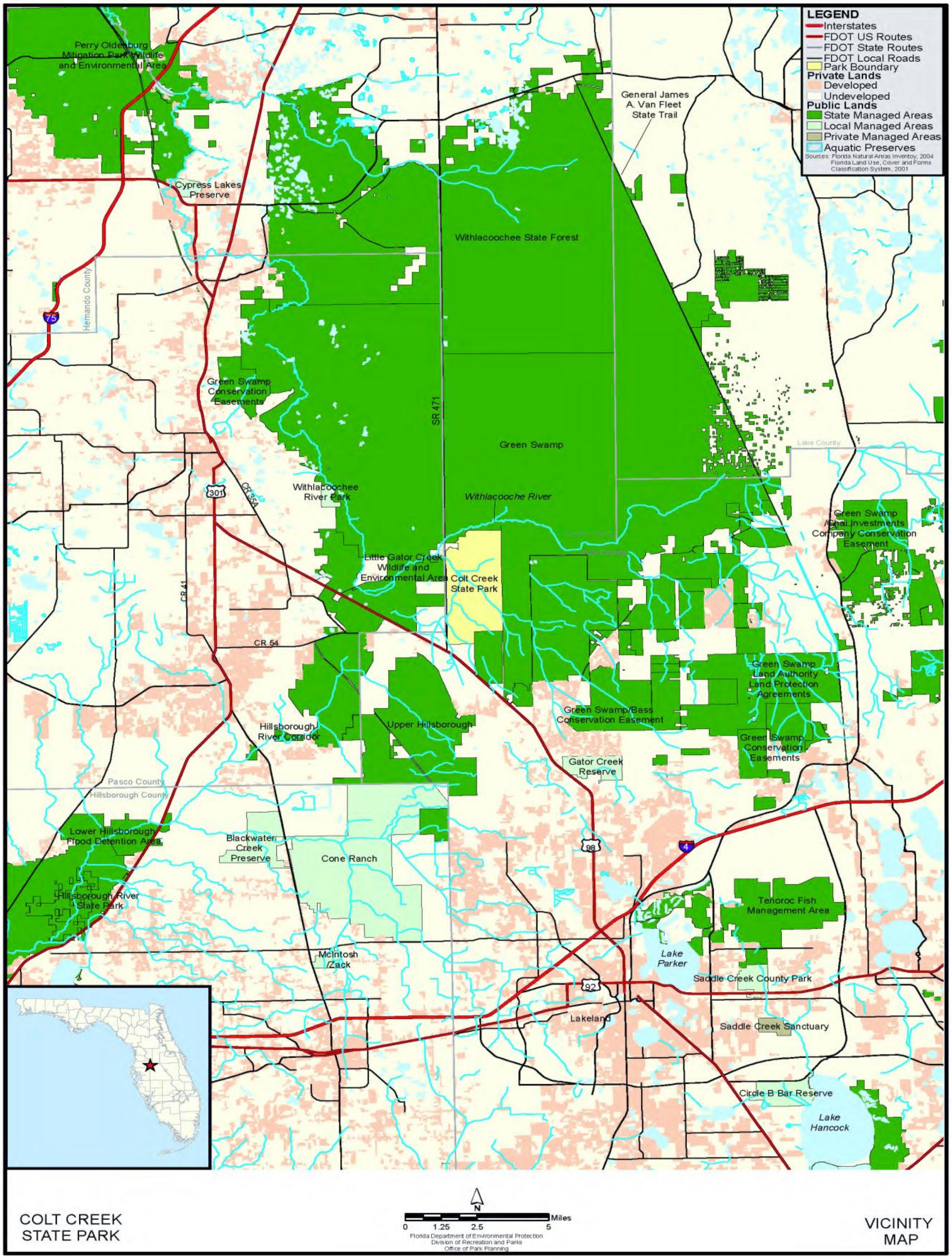

Figure 2. Colt Creek State Park Vicinity Map (Florida Department of Environmental Protection, Division of Recreation and Parks. 2007. Colt Creek State Park Unit Management Plan)

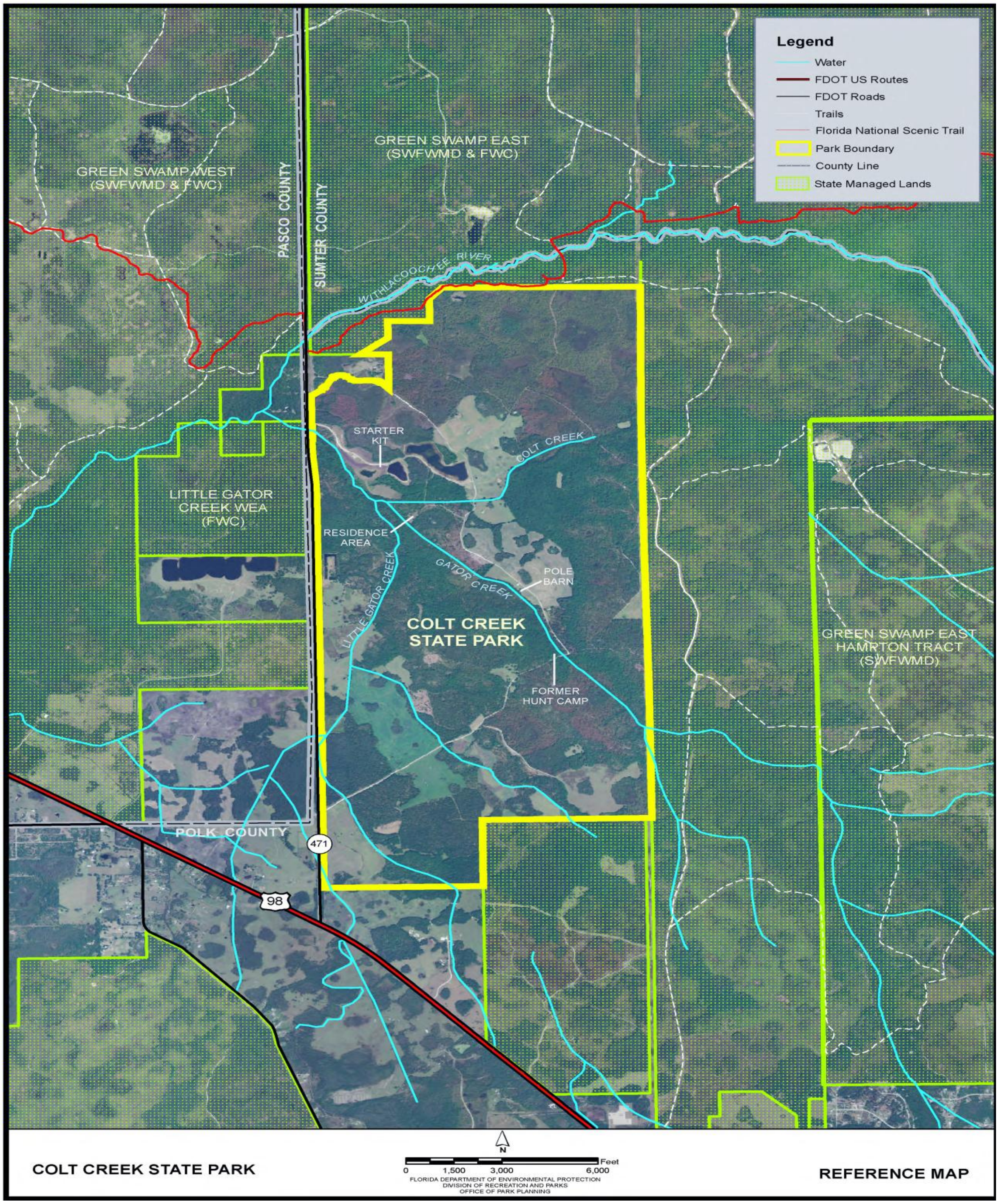

Figure 3. Colt Creek State Park Reference map. Note the location of Colt Creek is the northern-most stream within the park boundary (yellow). (Florida Department of Environmental Protection, Division of Recreation and Parks. 2007. Colt Creek State Park Unit Management Plan)

Physiography

Located in south-central Florida at approximately 28 degrees North latitude, the climate is subtropical with mild, relatively dry winters, and hot, humid, and wet summers. Mean annual high temperature is 84.0 °F, mean annual low temperature is 61.0 °F, with mean annual rainfall of 51.32 inches (Figure 4.).

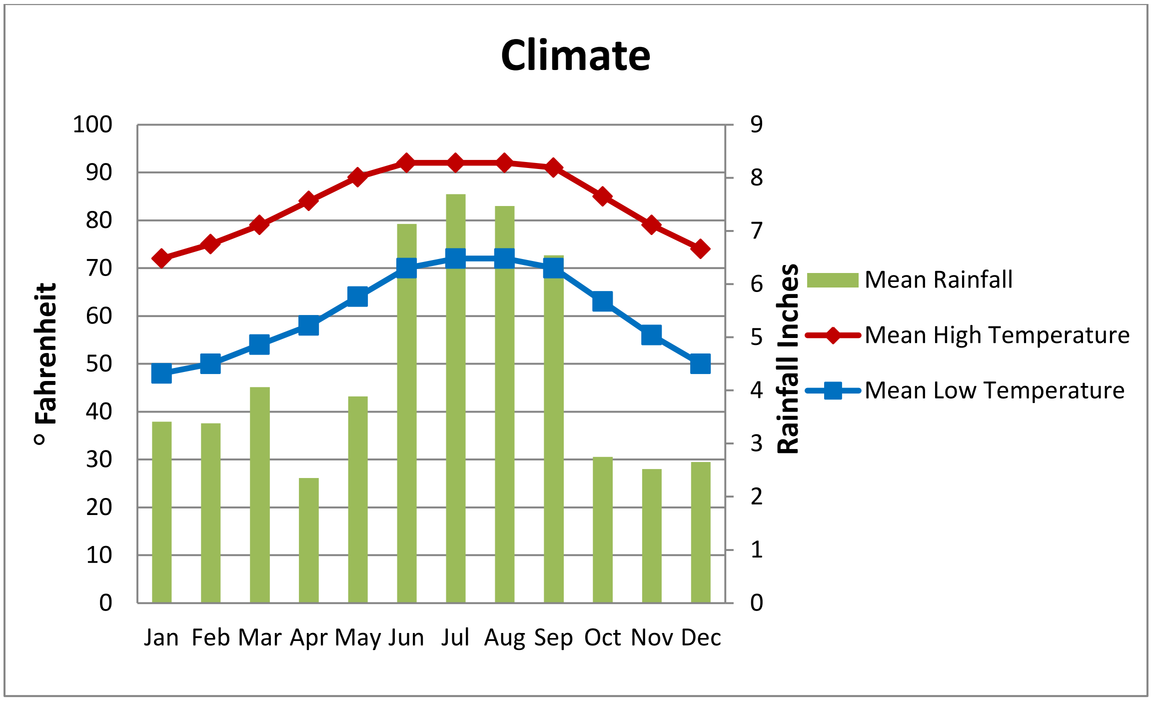

Figure 4. Regional mean rainfall and temperatures recorded at Dade City, FL (http//www.weather.com)

The Colt Creek basin is elongated and approximately ten miles long from the top, or upstream end of the basin, downstream to where Colt Creek flows into Little Gator Creek. Topographic change within the 10-mile length of the basin is very gradual; averaging approximately 0.07%, or 3.5 feet of elevation change per linear mile. The elevation at the highest point of the basin is approximately 125 feet NGVD 29, and the lowest elevation is approximately 90 feet NGVD 29, at the

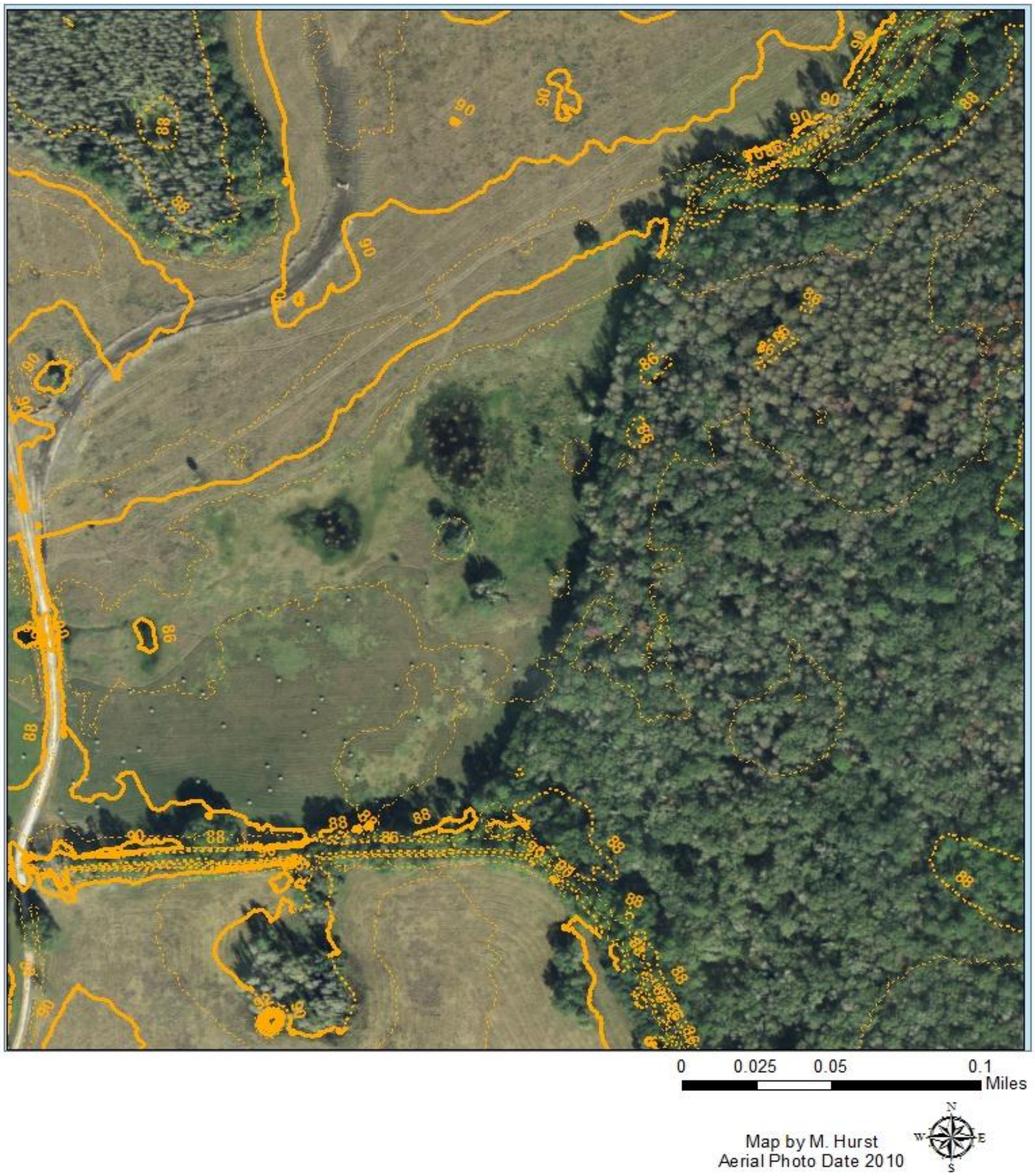

Figure 5. 2010 aerial photograph with LiDAR 1-foot contours. The historic Colt Creek flow way is from upper right diagonally through the photo. The bypass ditch is located just inside the tree line near the center of the photo, turns left (west) and follows the line of trees near the bottom of the photo.

confluence with Little Gator Creek. The topographic gradient is generally from southeast to northwest (Figures 5. and 6.). The section of Colt Creek within the study site has approximately 1 foot of topographic fall along the approximately 1300 linear feet of creek segment within the site, or a gradient of approximately 0.08 percent.

Based on the topography of the flow way and an inspection of the creek upstream of the bypass ditch, it appears that Colt Creek is not now, nor ever was a “creek” in the sense of having a defined channel, but it is a series of forested strand swamps that are connected and flow seasonally. The stream flow is probably not perennial but likely flows in response to sufficient rainfall within the basin. Colt Creek is a tributary of Gator Creek, which is joined immediately downstream from the Colt Creek / Gator Creek confluence by another small tributary, Little Gator Creek. The combined flow, called Gator Creek, flows northwest approximately one mile and joins the Withlacoochee River.

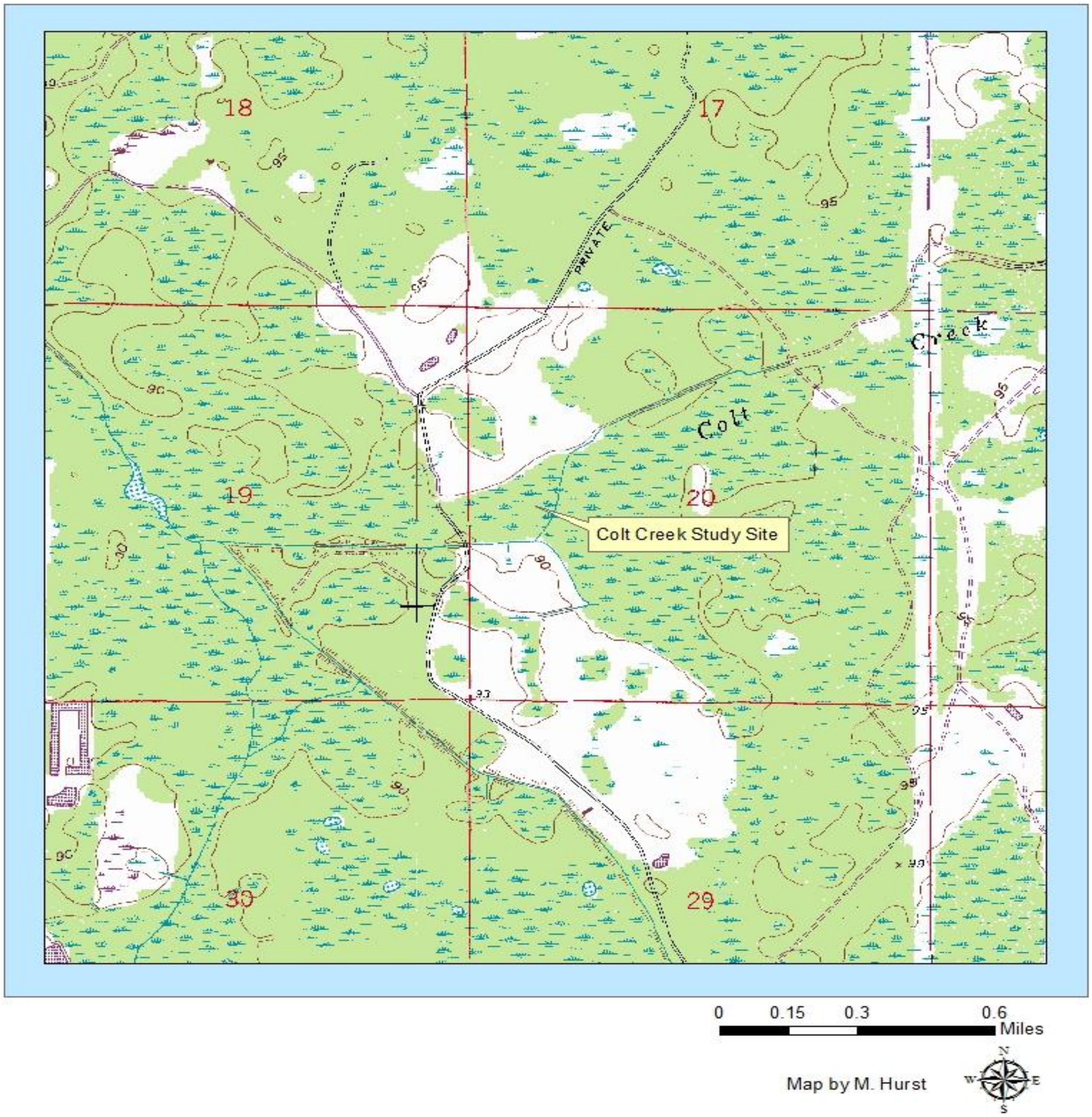

Figure 6. USGS 1:24,000 Quadrangle map of the lower reach of Colt Creek. West of the study site Colt Creek and Little Gator Creek flow into Gator Creek (Section 19). Note that the contours on this map are based on the National Geodetic Vertical Datum of 1929. All other elevations reported elsewhere in this study are North American Vertical Datum 1988 (NAVD 88).

The Colt Creek drainage basin is 4,722 hectares (ha) in size (18.32 square miles), which is approximately 1.5 percent of the entire Withlacoochee River basin. Most of the Colt Creek basin, including the study site, was privately owned and operated primarily as a cattle ranch until 2006, but has been

purchased by the State of Florida and the portion that includes the study site is now managed as Colt Creek State Park. Most of the land surrounding Colt Creek State Park is also public land owned and managed by either the Southwest Florida Water Management District or the Florida Fish and Wildlife Conservation Commission. However, historic aerial photography shows the extensive improved pasture and drainage alterations from the prior agricultural activities.

Historical Information

Prior to 1950, the Colt Creek basin apparently was little changed from the natural, relatively undisturbed condition, i.e., little or no changes such as drainage or clearing. Historic aerial photography shows that as late as 1941, Colt Creek and the adjacent uplands appear to be in pristine, unaltered condition (Figure 7). In the 1941 photograph, the study area of Colt Creek that is currently cleared and converted to pasture appears to be identical to the adjacent areas upstream and downstream of the site. There is no apparent difference in the tree canopy signature in the photograph. There are no apparent land use changes in the uplands adjacent to Colt Creek or in any part of the photograph area. The only indication of use is several faint trails visible in the north part of the photograph that may be unimproved roads or trails. It appears that two of these trails cross Colt Creek at the approximate locations where the bypass ditch and downstream farm road crossed the swamp.

Aerial Photography: Florida

Page 1 of 1

Aerial Photography: Florida

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Figure 7. Study area and adjacent sections of Colt Creek (1941). Colt Creek is the forested strand entering the photo top right (northeast), running west and exiting on the left side of the photo (west). The portion of the swamp that was later cleared and converted to pasture is in the center immediately west of the large swamp. With the exception of a few faint trails near the top (north) of the photo, all wetlands and interspersed uplands appear to be unaltered. Stream flow is right to left (east to west).

In the next available photograph, taken in 1951, some of the trails seen in the 1941 photograph are more distinct and the Colt Creek crossing appears more distinct, as well (Figure 8). This suggests these trails were being used more and the trail crossing Colt Creek appears to have been sufficient for vehicle use. In addition, many of the trees in the uplands north and south of the creek were removed and some areas of the uplands appear to be disturbed. These upland areas were likely mesic flatwoods and the trees were probably longleaf pine (*Pinus palutris*) or slash pine (*Pinus elliottii*) (Florida Department of Environmental Protection, 2007). Other than the single narrow crossing, Colt Creek appears to be intact and unchanged.

Beginning sometime in 1951 or 1952, the natural drainage of Colt Creek was altered by a series of ditches excavated to drain the land in order to facilitate agricultural activities such as grazing (Overstreet, 2004), particularly during the summer wet season when surficial groundwater levels are high, and the swamps are flooded and water levels are at or above seasonal high levels. As can be seen in the 1952 aerial photograph, the ditches that drain Colt Creek and adjacent Gator Creek were excavated, documenting that the drainage of this area has been occurring for 58 to 60 years (Figure 9.). The ditches appear to be relatively new as the adjacent spoil piles and disturbed areas are clear of any observable vegetation cover. The trail / road crossing of Colt Creek appears to still be in place, but no crossing of the new ditch is apparent where the trail intersects the ditch. No other changes to the Colt Creek swamp are apparent in the photograph.

Aerial Photography: Florida Page 1 of 1

Aerial Photography: Florida

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Figure 8. 1951 aerial photograph showing distinct trails or roads north and south of Colt Creek. The creek appears to be intact except for the single north-south crossing seen in the left (west) half of the photograph.

Aerial Photography: Florida Page 1 of 1

Aerial Photography: Florida

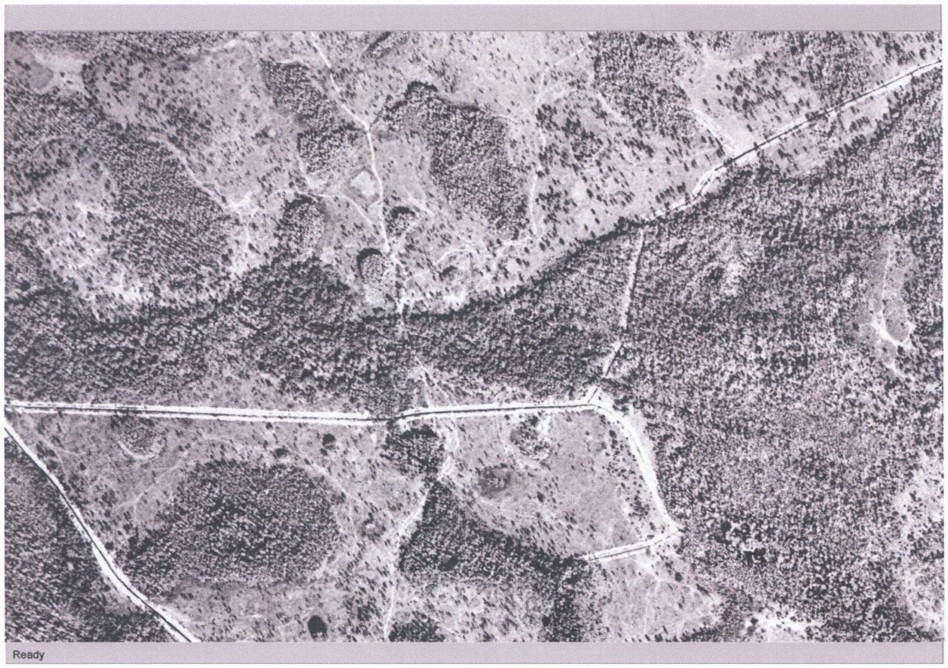

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Figure 9. 1952 aerial photograph which shows the newly excavated bypass ditch that crosses Colt Creek in an approximately north-south orientation (perpendicular to stream flow). The Colt Creek ditch merges with a second ditch immediately south of the swamp and extends west to the Gator Creek drainage ditch seen crossing the bottom left (southwest) corner of the photograph.

The 1957 aerial photograph shows that fill material, e.g., dirt, was placed on a section of the trail crossing Colt Creek which was widened and is clearly an unpaved road (Figure 10.). In addition, two changes related to the swamp crossing improvements are apparent. The most significant change is the upland area adjacent to the south side of the swamp appears to be completely cleared. From the photograph signature, it appears there is little or no vegetation, suggesting the area was recently disked. The other noticeable change is a crossing of some type placed in the bypass ditch which would have restored vehicle / equipment access to the areas south of the ditch. There are no apparent changes to the canopy of the Colt Creek swamp downstream from the bypass ditch.

By 1968 the cleared area identified in the 1957 photograph, and much of the other pine flatwoods / uplands south of the creek have been converted to improved pasture (Figure 11.). The groundcover seen in the 1968 photograph is probably bahia grass (*Paspalum notatum*), as that is the current dominant groundcover in these areas. In addition, a small area of the Colt Creek swamp / floodplain adjacent to the road crossing was cleared and it appears that additional fill material was placed in this area. The bypass ditch crossing Colt Creek has become somewhat obscured as the canopy has partly recovered. Otherwise, the remainder of the Colt Creek swamp canopy appears to still be intact despite the drainage that had been occurring for 16 or 17 years.

Aerial Photography: Florida Page 1 of 1

Aerial Photography: Florida

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Figure 10. 1957 aerial photograph. The trail crossing Colt Creek has been enlarged and is now clearly a road. In addition, the first area to be converted to improved pasture is seen as a cleared area immediately south of the swamp.

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Figure 11. 1968 aerial photograph. Large areas of uplands south of Colt Creek have been converted to improved pasture.

The exact year the next aerial photograph was taken is unknown other than sometime between 1970 and 1979 (Figure 12.). This photograph shows that the improved pastures were being maintained. It appears that the pasture adjacent to the south side of the Colt Creek swamp had been recently disked, as the photographic signature is distinctly lighter colored. However, the most important change relative to this study is apparent in the Colt Creek swamp between the bypass ditch and the road crossing. The thinning of the canopy is clearly evident for the first time since the drainage ditches were excavated approximately 20 years prior. The thinning canopy is likely due to logging of cypress (*Taxodium* spp.) and perhaps some pine (Florida Department of Environmental Protection, 2007). That the thinning canopy is restricted to the area downstream of the bypass ditch suggests the logging may have been facilitated by the reduced hydrology / hydroperiod in the Colt Creek swamp. The bypass ditch within the Colt Creek swamp is almost indiscernible in this photograph. This is due to the fact that large trees have revegetated the spoil piles adjacent to the ditch, as was observed during the monitoring for this study. Clearly, little or no ditch maintenance has been done since the ditch was originally excavated, which is atypical for most agricultural operations. The reason for this lack of maintenance is unknown.

In the 1984 aerial photograph, the section of the logged swamp between the bypass ditch and the road crossing appears to be completely cleared of all trees and the floodplain and adjacent uplands north and south of the swamp has been converted to improved pasture; the condition it is in currently (Figure 13.).

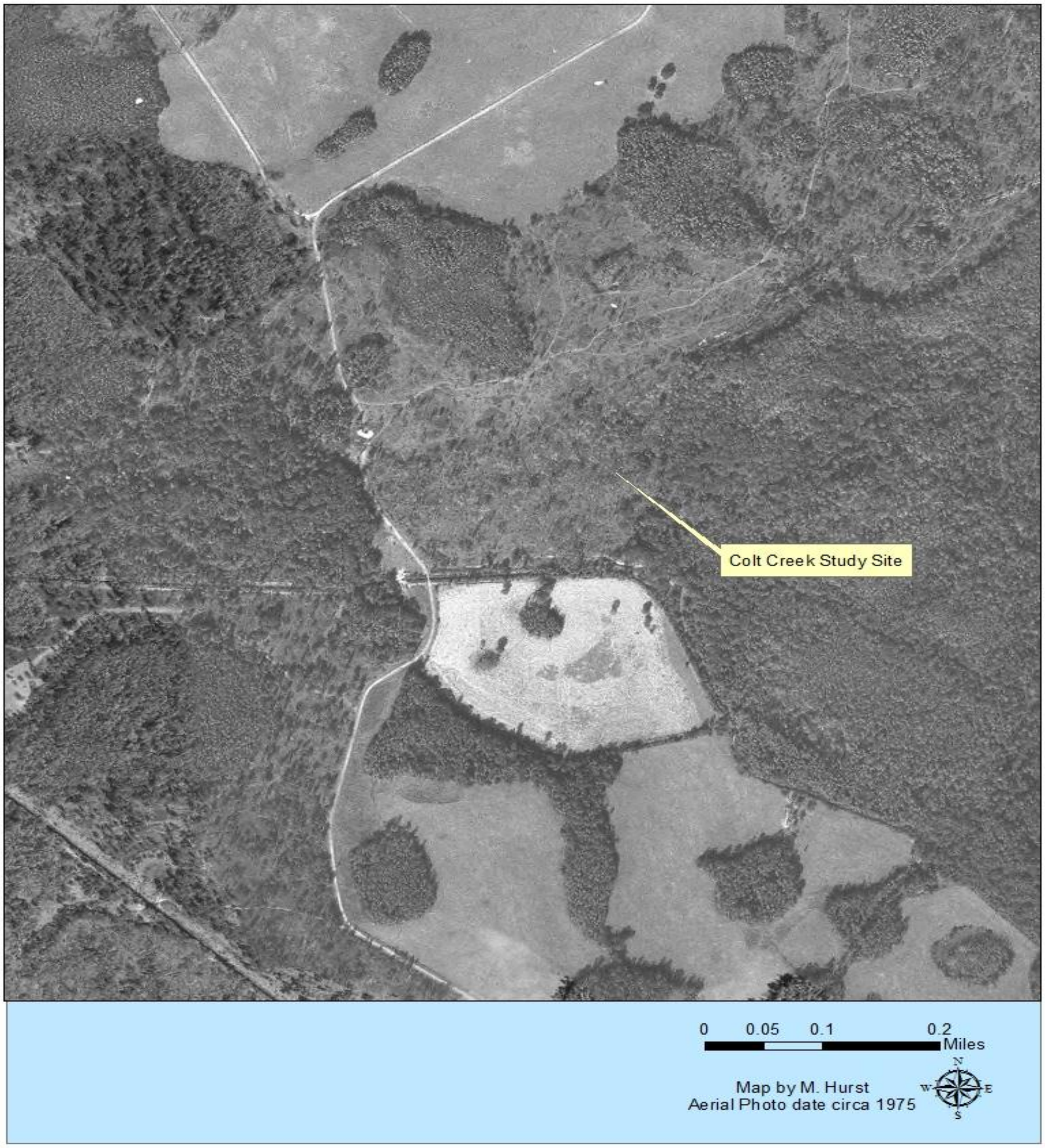

Figure 12. Circa 1975 aerial photograph. The most notable change during this time period is the canopy thinning occurring downstream from the Colt Creek bypass ditch.

Apparently the photograph was taken during a wet winter as the cleared creek flow way appears to be wet. This is not surprising as the winter of 2009-2010 was also wet and the historic creek flow way had standing or flowing water much of the time when monitoring for this project began in 2010.

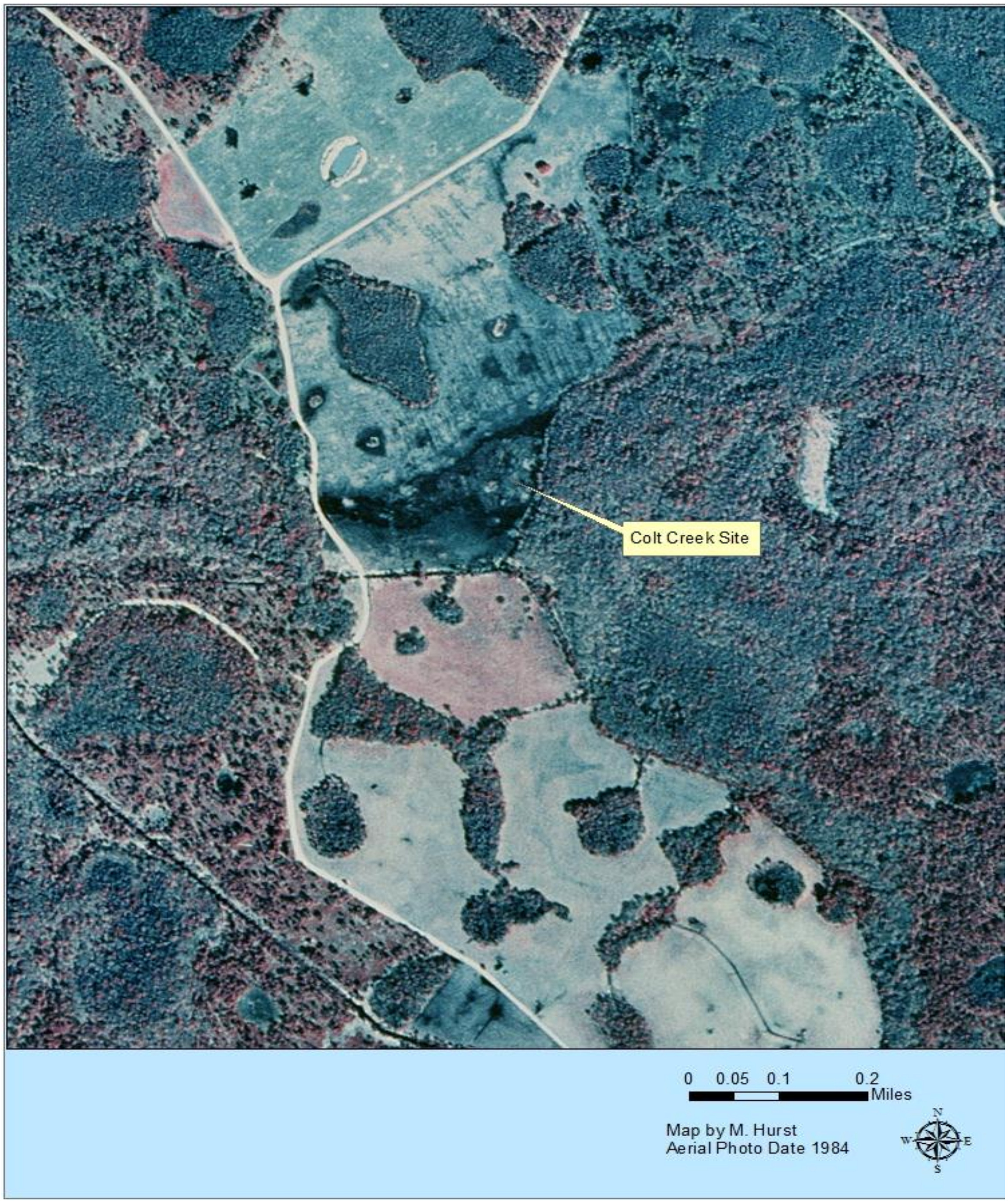

Figure 13. 1984 aerial photograph (false color infrared). The cleared Colt Creek swamp is evident in this photograph. The darker signature in the historic flow way between the bypass ditch and the roadway on the west side appears to be surface water. The configuration of the dark signature follows the lowest topographic elevation (87.0' NAVD) of the flow way.

The last two aerial photographs, 1999 and 2010, show that the site has changed little in the 26 years since 1984, other than the pit lakes northwest of Colt Creek created as a result of limerock mining. In 1999 the land was still privately owned and managed as a ranch. By 2010 the property was public land and being managed as a state park, although the restoration of Colt Creek had not begun, so there is little difference in the two photographs. As evident in the two photographs, it appears that the winter of 1999 was very dry, as much of the historic Colt Creek flow way and floodplain is indistinguishable from the upland pasture, i.e., bahia grass. (Aerial photography is typically done in winter, e.g., January when humidity and cloud cover are generally less than other times of the year). It appears that the winter of 2010 was a little wetter as standing water can be seen in several of lowest elevation pools in the historic flow way. However, the pasture grass is still clearly evident in much of the flow way, indicating that the conversion of the swamp to improved pasture was at least partially successful.

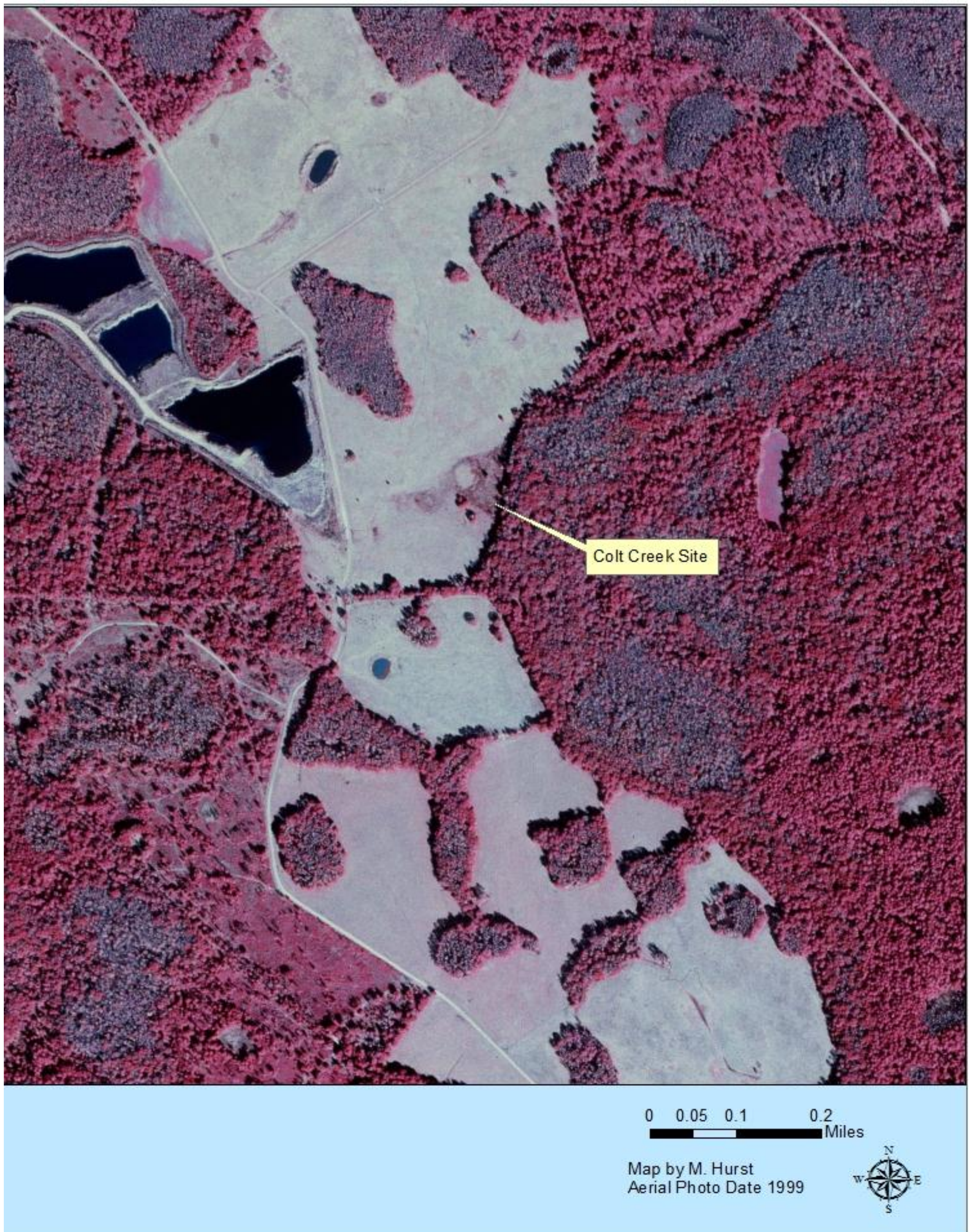

Figure 14. 1999 aerial photograph (false color infrared). Much of the historic Colt Creek flow way is indistinguishable from the adjacent upland pasture during the dry winter of 1999. The similar photographic signature in the upland pasture and much of the historic flow way is very likely bahia grass.

Figure 15. 2010 aerial photograph. Although now known as Colt Creek State Park, the restoration of the creek had not begun at this time and the site is little changed from 1984.

Site Information

Using the stream classification system of A.N. Strahler (1952), Colt Creek is classified as a “0” (zero) order stream, the lowest classification order, since it is at the “top” of the basin and does not have a defined channel. There are no named streams that flow into the creek, only drainage ditches and other swamps. The study site is located near the downstream end of the Colt Creek basin; approximately 2,500 feet upstream of the confluence of Colt Creek and Gator Creek.

The soils in this portion of Colt Creek are mapped by the United States Department of Agriculture - Natural Resources Conservation Service (NRCS 1990) as Felda fine sand, frequently flooded (#82). The following is the NRCS description of this soil unit:

> *Within this series, Felda fine sand, Felda fine sand/frequently flooded, and Felda fine sand/digressional are found at this unit. Slopes range from 0 to 1 percent. This series consists of very deep, poorly drained and very poorly drained, moderately permeable soils in drainage ways, sloughs and depressions, and on flood plains and low flats. They formed in stratified, unconsolidated marine sands and clays. Near the type location, the mean annual temperature is about 72 degrees F., and the mean annual precipitation is about 55 inches. Indicative native vegetation: cypress, wax myrtle, pond pine, slash pine, cabbage palm, pineland three awn, and various grasses, vines, and shrubs.*

During installation of the monitor well, a 2-inch diameter bucket auger was used to bore the hole. The topsoil, approximately six inches thick, was primarily sand, but also included some organics and a small amount of clay (Figure 16.).


Figure 16. Topsoil in marsh.

Immediately below the topsoil and continuing to the bottom of the boring at approximately five feet, the soil had some sand but was very clayey (Figures 17. and 18.)


Figure 17. Subsurface clayey soil in marsh.

Figure18. Clayey soil 3 feet to 5 feet below ground surface in marsh.

Although the extent of the vegetation monitoring is precisely defined by the transect locations, the boundaries of the study area are not exact due primarily to the fact that the avian monitoring includes all birds observed flying near the creek, and in the floodplain and uplands adjacent to the creek. Therefore, the study area does not have exact boundaries but is approximately 10 ha. (25 acres) in total area, including approximately 3.2 ha. of marsh (8 acres) and 2.8 ha. of swamp (7 acres). It generally encompasses the entire marsh from the existing roadway that crosses the marsh near the west end of the site, upstream into the swamp where the swamp transects are located, plus a portion

of the uplands adjacent to the marsh, and a portion of the swamp surrounding the vegetation monitoring locations.

Prior to conversion to pasture, the marsh appears to have been a broad, shallow swamp or strand. Based on interpretation of the historic aerial photography, the upstream swamp is very likely similar to what the adjacent marsh looked like prior to alteration. In order to convert the downstream area to a relatively dry pasture, the bypass ditch was excavated through the swamp, which diverts much of the flow past the adjacent downstream marsh and directly to Gator Creek. The area upstream of the marsh / pasture is a vegetatively-intact forested area that is part of the historic wetland strand. It appears that the bypassed marsh now inundates less frequently than it did historically. Much of the flow that historically was probably shallow sheet flow through the swamp on a seasonal basis is now conveyed by the ditch; which still overflows the ditch and floods the marsh / pasture but apparently on a less frequent basis.

In October 2010, the Florida Department of Environmental Protection, Division of Recreation and Parks, installed a manually operable structure in the ditch as part of their habitat restoration plan for the park. This structure will block all or much of the bypass ditch flow and force water back through the historic path. In addition, the culverts under the pre-existing road (which now serves as a main park access) were replaced with a series of 12 culverts that were installed so as to more closely mimic the historic creek flow.

Chapter Three: Methodology

This chapter summarizes the sources of information, the methods used to conduct the study, and the data organization. The discussion will focus primarily on the data collection, and processing the raw data for analysis.

Information Sources

This study was based almost entirely on data collected at the Colt Creek site during the study period. Weather data was obtained from two sources. Daily rainfall and daily temperatures were recorded at the park and provided by the park staff. The historic mean monthly rainfall and temperatures for the area were obtained from the internet (http://www.weather.com/) for Dade City, FL, the closest location to the study site, approximately 10 miles northwest of the park. Survey elevations used for benchmarks to vertically locate the monitor well, and to measure water levels in Colt Creek and the bypass ditch were obtained from certified surveys provided by the park.

Methods

The purpose of this study is to compare an intact, unaltered wetland with an adjacent wetland that has been altered hydrologically and vegetatively. The

bypass ditch that was excavated through the wetland strand runs along the north side of the intact swamp (north of the study area), curves south and cuts across the strand approximately perpendicular to the stream flow path, and then turns west and runs approximately parallel to the south side of the historic flow way (Figure 9). The hydrologic impact of this ditch orientation appears to be primarily to the downstream / marsh section of the creek. Although the original / historic condition of the strand upstream of the study area was not investigated in detail for this study, the system appears to be vegetatively and hydrologically intact and fully functional, with no readily apparent anthropogenic changes or impairments. This assessment is based on several pedestrian excursions through portions of the upstream area at various times of the year.

Rainfall

Daily rainfall amounts were totaled for each period of time between monitoring events, usually seven days, and “assigned” to the monitoring event that occurred at the end of the week. The purpose for this was to be able to associate recorded surface water or ground water levels with the rainfall amount recorded since the prior monitoring event. Consequently, rainfall amounts are reported in 49 subtotals beginning the week prior to the initial monitoring event on January 2, 2010, through the week prior to the final event on January 15, 2011.

Monitoring

Monitoring frequency and monitoring parameters were selected in an effort to understand the wetlands to the greatest extent practicable for a study of this scope. The three parameters selected for monitoring were water levels, groundcover vegetation cover, and bird abundance and species richness. Water level monitoring and bird counts were conducted approximately weekly. The weekly monitoring interval for water levels and birds was selected in order to balance the need for as much data as possible with the practicality of traveling to the site and physically taking the measurements and counts.

Typically, vegetation monitoring for most purposes is done quarterly or every six months for a period of years. However, due to the one year span of this study and also in an effort to make the vegetation monitoring more sensitive to detecting any vegetation shifts that might be due to changes in hydrology and / or seasonal changes, a monthly monitoring frequency was selected.

Data collection for water levels and birds began January 2010 and concluded January 2011. Vegetation monitoring did not begin until March 2010 and concluded in January 2011. This delay in vegetation monitoring was due, to some extent, to the additional logistics of setting up the monitoring network and the assumption that there would be little vegetative growth in January and February and therefore, little change in species or percent cover.

Hydrology

Water levels were measured weekly at four locations (Appendix A.). As this study focused on surface water levels in the wetlands, three of the

monitoring stations were for the purpose of measuring surface water levels. One surface water monitoring location was in the bypass ditch at a culvert located immediately south of the historic flow way. A second monitoring location was at the existing culvert in the historic flow way at the west end of the study site. The fourth water level monitoring location was an existing staff gauge located in a wetland strand south of, and adjacent to Colt Creek. This gauge was monitored only for comparison to the Colt Creek levels and also to some extent as a general reference for data QA/QC, as it is adjacent to Colt Creek, i.e., approximately parallel, and not upstream or downstream of the study area. However, although the gauge scale appears to be relative to ground elevation in the area, based on LiDAR ground elevations, the datum for the gauge and the accuracy with which it was installed is unknown, so it was used as a relative reference only.

Water level elevations recorded at the two existing culverts (bypass and historic) were determined by measuring the water levels relative to the upstream invert elevations of the culverts. These culvert invert elevations were obtained from certified surveys and park construction drawings (Kimley-Horn and Associates, Jacksonville, FL). Water levels at the two culverts were measured by simply lowering a wooden rod into the water until it contacted the invert of the culvert, i.e., the lowest point in the pipe opening, and the height of the water mark on the rod was measured with a standard metal tape measure. The exact low point of the invert of the culvert opening was visually estimated.

The fourth monitoring point was a shallow (approximately five feet below land surface), 1-inch diameter PVC monitor well installed near the south edge of one of the depressions within the historic flow way (Appendix A). The ground elevation at the monitor well was determined by survey to be 86.6 feet NAVD88. Surveying was done with a laser level (Spectra-Physics Laserplane 500) using the known elevation of the culvert located in the historic flow way as a survey benchmark. The bottom of the well was 4'9" below ground surface at an elevation of 81.8 feet NAVD88. As the lowest ground elevation in the study site (excluding the bypass ditch) is approximately 86 feet NAVD88, the intent was to locate the monitor well so as to be able to continue uninterrupted water level monitoring when the site dried out, which occurred several times and for extended periods. Well construction and installation followed EPA guidelines (U.S. EPA 1993), with the exception that the well was not grouted and sealed, as there seemed no need to exclude interaction with surface water since the intent was to measure the elevation of the water surface in the wetland wherever it was, not to measure a ground water elevation separate from a surface water elevation (Note however that the well was capped at all times when not being read). Water levels in the well were measured with the same technique as previously described for measuring water levels at the culverts. A wooden rod was lowered into the well and the height of the water mark measured by the tape. That distance (from rod tip to top of the watermark) could then be subtracted from the surveyed elevation of the top of the well to give the water level in feet NAVD. Note that per the EPA guidelines, care was taken to minimize the length

of rod that was submerged in the well so as to obtain a more accurate measurement by minimizing water displacement due to the measuring rod.

The purpose of these four monitoring points was to understand the overall site hydrology, but primarily to quantify the differences in hydrology between the altered and unaltered systems. A total of 50 weeks of water level measurements were recorded from January 2, 2011 to January 22, 2011. All water level elevations and field observation notes were recorded by hand in waterproof field notebooks during each event and later entered into an electronic spreadsheet (Microsoft Excel 2007). Note that the previously mentioned water control structure was installed in the bypass ditch the last week of October 2010, in preparation for blocking flow in the ditch and restoring the historic flow. However, water levels at the site were unaffected by the structure because the site was entirely dry (with the exception of one week) until January 22, 2011. Therefore, the final water levels recorded on January 22 (event #50) were not included in the study due to the hydrologic “alteration” caused by the structure.

As 1-foot LiDAR topography is available for the site, the extent and duration of site inundation was approximated from the water level data. For example, when the water level in the marsh was measured at elevation 88.0’ NAVD88, the extent of inundation at that elevation could be mapped and the area calculated with a Geographic Information System (GIS) program, such as ArcMap, using the 1-foot LiDAR layer on a digital ortho-photograph. For this study, the wetland hydroperiod and extent of inundation in the wetlands was approximated based on the recorded water levels at the site compared to

topography. Note that as the amount of rainfall recorded at the park during the monitoring period was near average for the area (as determined at Dade City, FL), the wetland hydroperiods and water levels, i.e., extent of inundation, that were observed at the site during 2010, can reasonably be expected to occur for an average rainfall year.

Vegetation

Vegetation monitoring was conducted in the Colt Creek wetlands in the herbaceous area (the marsh within the historic flow way) and the swamp (upstream of the bypass ditch within the relatively unaltered forested portion of the creek). Monitoring was conducted monthly from March 2010 to January 2011, for a total of eleven events. Four monitoring transects were located in the flow way; two in the marsh and two in the swamp (see Appendix D). The transects were numbered 1 through 4. The two marsh transects (Nos.1 and 2) were oriented perpendicular to the flow way and extended from what clearly appears to be the historic uplands on the north side of the creek, i.e., approximately elevation 88’ NAVD88, to what currently appears to be uplands on the south side of the creek, but may have historically been wetlands, i.e., approximately elevation 87’ NAVD88. Vegetation data was initially recorded in the same field notebook with water levels and bird data. However, later a standard spreadsheet was created for each quadrat which was found to be easier and more efficient (Appendix B).

The two swamp transects (Nos. 3 and 4) were located in the interior immediately south of the lowest / deepest area of the swamp. Based on GPS determinations and LiDAR maps, one of the transects was located partly below the 87' contour and partly above 87'. The second swamp transect is also located partly below the 87' contour and partly at 87'. The locations for the transects were originally determined by visual inspection with the intent of being representative of the swamp interior. In order to monitor the same area at every event, each end of the transects was identified by a section of 3/4 inch diameter PVC pipe driven into the ground. These transect end marker pipes stood approximately four feet above ground and were flagged or painted for easy visibility.

Quantitative monitoring along each transect was done at 40-foot intervals from transect end to transect end. For the same reason as physically identifying the end of each transect, each 40-foot interval within the transects was marked with a short section of ¾ inch PVC pipe driven into the ground. These points extended one foot to 18 inches above ground and were also flagged or painted for easy visibility. Transect 1 contained seven monitoring locations, Transect 2 contained eight, and Transects 3 and 4 each had six. This resulted in 15 sampling locations along the two marsh transects and 12 locations along the two swamp transects. The difference in number of monitoring locations is due to the fact that the marsh transects were longer in order to cover the current width of the marsh.

A one meter square area, i.e., quadrat, was monitored at each of the 27 points located at the 40-foot intervals along the transects. This was accomplished by using a square meter frame constructed of ½ inch diameter PVC pipe. Six strands (3x3) of thin-gage metal wire stretched across the frame divided the square meter into 16 equal squares. Each of the sixteen squares was approximately 6% of the quadrat. This subdividing of the quadrat enabled easier and more accurate estimation of percent cover of vegetation within the quadrat. In order to consistently monitor the same plot at each event, the meter square quadrat was always placed in the same location relative to the PVC monitoring point identification pipe.

Within each quadrat, groundcover vegetation species, including tree seedlings, were listed and the percent cover of each species within the quadrat was estimated. Percent cover within each quadrat was estimated in units of five percent. Species present but with less than 5% cover were recorded as “trace”. Samples of unknown species were collected and identified later. Identification of unknown plants was usually determined using the Florida Department of Environmental Protection’s (FDEP) “Florida Wetland Plants” identification manual (Tobe et al, 1998) or on the U.S. Department of Agriculture internet site (http//plants.usda.gov).

The intent of the vegetation monitoring was to determine the percent cover of wetland plants relative to the percent cover of upland plants in the marsh and the swamp. As the marsh hydrology had presumably been altered by the bypass ditch and the vegetation also affected by the agricultural activities, the goal was

to quantity the degree of remnant wetland function in the marsh as reflected by the vegetation. In order to do that, all species were identified relative to how they are listed in the Florida wetland delineation methodology (Chapter 62-340, Florida Administrative Code), i.e., “obligate”, “facultative wet”, “facultative”, “upland”, or not listed. The individual species name and percent cover of each were recorded for each meter-square quadrat along all four transect at each monthly event. Data from each quadrat for each event that were classified as “obligate” or “facultative wet” were grouped as wetland species. Likewise, data for species classified as “facultative”, “upland”, or not listed in the methodology were grouped as upland species. Relative percent of wetland species to upland species was calculated by dividing the total cover of the wetland species by the total cover of all species, i.e., wetland and upland. The resulting relative percent cover was used to compare groundcover vegetation in the partially altered marsh with the intact swamp. As for the spatial extent of vegetation differences, differences in vegetation zonation in the marsh, particularly at / near the transect ends, i.e., at a higher elevation, provided additional information relative to functional differences. The vegetation data from the upstream swamp monitoring provide a reasonable control or reference for the marsh, as the stream flow and levels in the existing upstream swamp are assumed to not be greatly affected by the existing downstream drainage alterations, and there is no indication of significant alterations to the vegetation.

Birds

Bird monitoring was conducted weekly in conjunction with water level monitoring, i.e., the same day. The counts were conducted, for the most part, according to the point-count methodology described by Betts et al (2005), and the Tucson Bird Count Park Monitoring Instructions (2009).

Two monitoring points were selected. One point was located in the marsh and one point in the swamp, approximately 350 meters from the marsh point. The Tucson Bird Count instructions state that monitoring points should be about 250 meters apart in order to provide sufficient coverage while minimizing double counting individual birds. This study originally included a second marsh point, #2, between the first marsh point and the point located in the swamp, #3, but the data has not been included in the results and analyses in order to make an accurate comparison between the marsh and the swamp (Appendix G).

Per the methodology, all birds observed or heard (calls) during a 5-minute time span at each point were counted (abundance) and identified to species, when possible. In addition, all birds calling but not observed were also included, and identified to species, if known. Unidentified birds were counted and recorded as “unknown”, either by visual observation or by number of individual calls when possible. As the monitoring points in the herbaceous wetlands abut extensive improved pasture north and south of the marsh, birds counted at those two points were limited to individuals located within or in the uplands near the marsh flow way. Although somewhat subjective, the goal was to identify avian utilization of the wetlands, rather than utilization of uplands not immediately adjacent to the

wetlands, or birds flying past the wetlands. In the same way, as one monitoring point was in an extensive forested area, birds that were heard some distance away north or south of the swamp were presumed to be located in adjacent areas and not in the Colt Creek swamp, and therefore, were not counted.

Bird counts were done using binoculars (Brunton Echo 1025) and a common field guide (Peterson, 2002), and recorded in the same field notebook with water levels. The field notebooks were "Rite in the Rain All-Weather Transit No.303", obtained from Forestry Supplies. On rare occasions, a particular species was numerous and active, e.g., tree swallows, to the extent that an exact count could not be made. In those cases, the number of individuals was estimated.

Analysis

Once monitoring was completed and water levels, vegetation species and percent cover, and avian species and abundance were entered into a spreadsheet (Microsoft Excel 2007) and analyzed. The initial analyses consisted of data graphs of water levels, vegetation monitoring data, and avian counts to visually inspect for trends, both in individual parameters, e.g., water levels, vegetation, etc., and then in pairs to visually detect possible correlations.

Following data entry and graphical analysis, statistical analyses were done, beginning with summary statistics of the data for each of the three parameters, including mean, median, maximum, minimum, and standard

deviation. Both Excel 2007 and SPSS 19.0 were used to calculate summary statistics.

For further analysis, the vegetation data were sorted by grouping all identified species into the five wetland indicator categories, as defined by state rule. With this categorization, graphical and statistical analyses were done. The percent of each wetland category group for each monitoring quadrat was graphed relative to time so that shifts in vegetation during the course of the monitoring period could be seen. Also, using the same wetland indicator grouping, the mean relative percent occurrence of each group within each monitoring transect was calculated in order to approximate the difference in vegetation types, i.e., wetland or upland, occurring in the two wetlands.

In order to obtain a summary statistic that represented the amount of wetland vegetation along each transect, the sum of all weekly cover percentages of all obligate species plus the weekly sum of all facultative wet species cover for each transect was divided by the total percent cover of all identified species, i.e., obligate, facultative wet, facultative, facultative upland, and upland, recorded for the same transect. These four ratios, one for each transect, provide a single numerical approximation of the degree of "wetness" of each transect, as reflected by the groundcover species composition.

Additional analyses of the vegetation data included a calculation of the degree of similarity between each pair of vegetation transects using two standard indices, Jaccard and Sorensen (Dice), including, a calculation for statistical significance of similarity of the Sorensen (Dice) results. By calculating a

similarity index for each transect, a quantitative comparison of transect pairs could be made. Although any pair of transects can be compared, the primary purpose is to compare marsh transects to swamp transects. This was done by creating a list of all identified groundcover species found in each transect. From these four lists, all possible transect pairings were made (6) and the number of species common to each pair of transects was determined. Similarities could then be calculated from these numbers.

For the avian data, total abundances and the numbers of species, i.e., species richness, in the two areas were compared. Quantification of species diversity and evenness within each of the two wetlands was determined using the Shannon-Weaver diversity index. The Shannon-Weaver index, H, uses a summation of the percentage of each species within an assessment area multiplied by the natural log of that same species percentage. Index scores typical range from 1.5 to 3.5, with a higher score indicating greater diversity and evenness.

The intent of these analyses was to try to understand the existing conditions of the two wetlands as much as possible based on the data collected and subsequently use that information to quantify and describe how these two wetlands differ in each of these parameters. In addition to these comparisons, an additional statistical analysis was done as a means of detecting and quantifying correlations within the three parameters measured. To accomplish this, SPSS 19.0 was used for regression analyses to identify any significant correlations and quantify the strength of any observed correlations.

Chapter Four: Results

Although water level and bird monitoring was conducted weekly, there were four gaps in the weekly frequency. Those gaps occurred in January 2010 (2 weeks), June (2 weeks), September (1 week), and November (1 week) due to personal schedule conflicts. The following presents the results of the monitoring of the hydrology, vegetation, and avian utilization in the two wetlands.

Hydrology

Rainfall recorded at Colt Creek in 2010 totaled 52.68 inches. An additional 1.11 inches was recorded during the monitoring period that extended into 2011 (January 1 through January 14). Figure 19. depicts the recorded rainfall in inches grouped in weekly totals to correspond with the weekly water level monitoring.

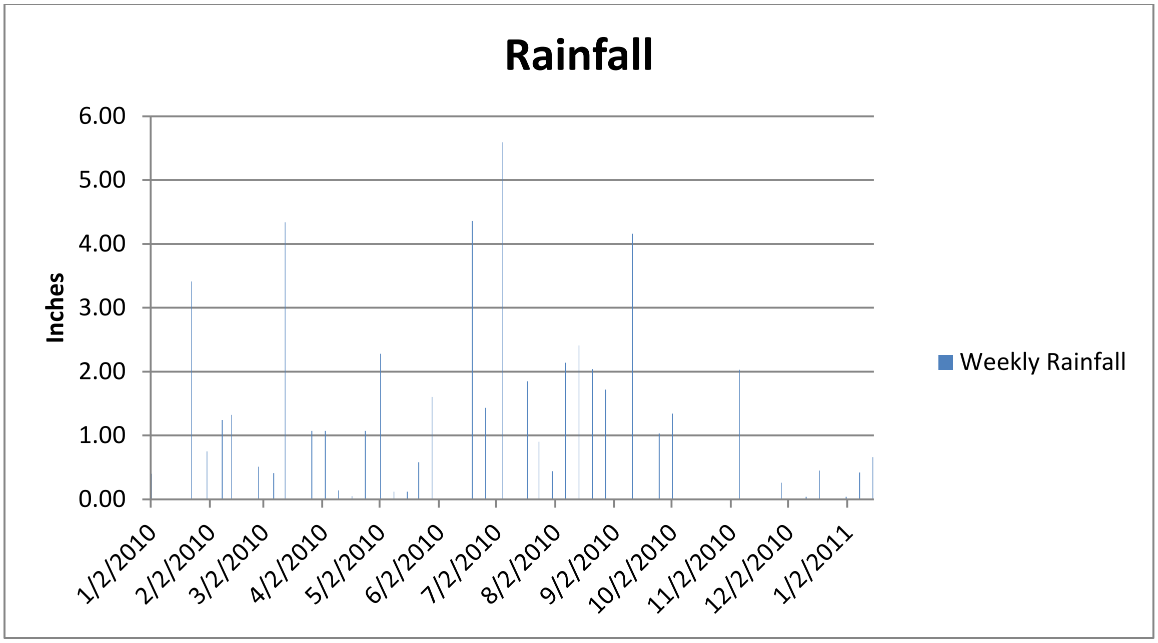

Figure 19. Rainfall at Colt Creek State Park during the monitoring period from January 2, 2010 to January 15, 2011.

During the monitoring period, the maximum water level elevation recorded at the site was 88.1' NAVD, recorded on March 13, 2010, at the monitor well. As the ground elevation at the well is 86.6' NAVD, a water level of 88.1 feet equates to a water depth of 1.5 feet at the monitor well and approximately 2 feet deep in the lowest part of the historic flow way. A similar high water elevation of 88.0' NAVD was recorded at the monitor well on August 28, 2010. The lowest water elevation recorded at the site was 83.7' NAVD on January 1, 2011, in the monitor well. This water level was 2.9 feet below ground elevation at the well and approximately 2.3 feet below the lowest part of the creek bed in the historic flow way. As might be expected, there was no surface water anywhere in the either the historic creek or the adjacent upstream swamp during that period. The water level fluctuation range in Colt Creek during the monitoring period was 4.4 feet

and the mean water elevation was 86.0 feet NAVD, as measured at the monitor well. The hydrograph of the water level data shows the approximately weekly water levels at three of the hydrologic monitoring stations and rainfall recorded at the park (Figure 20.). The two gaps (January 31, 2010 and March 13, 2010) in the levels measured at the bypass culvert were due simply to failure to measure or record the level that day. The lack of data after October 23rd at the bypass culvert location is due to the fact that there was no surface water at that location.

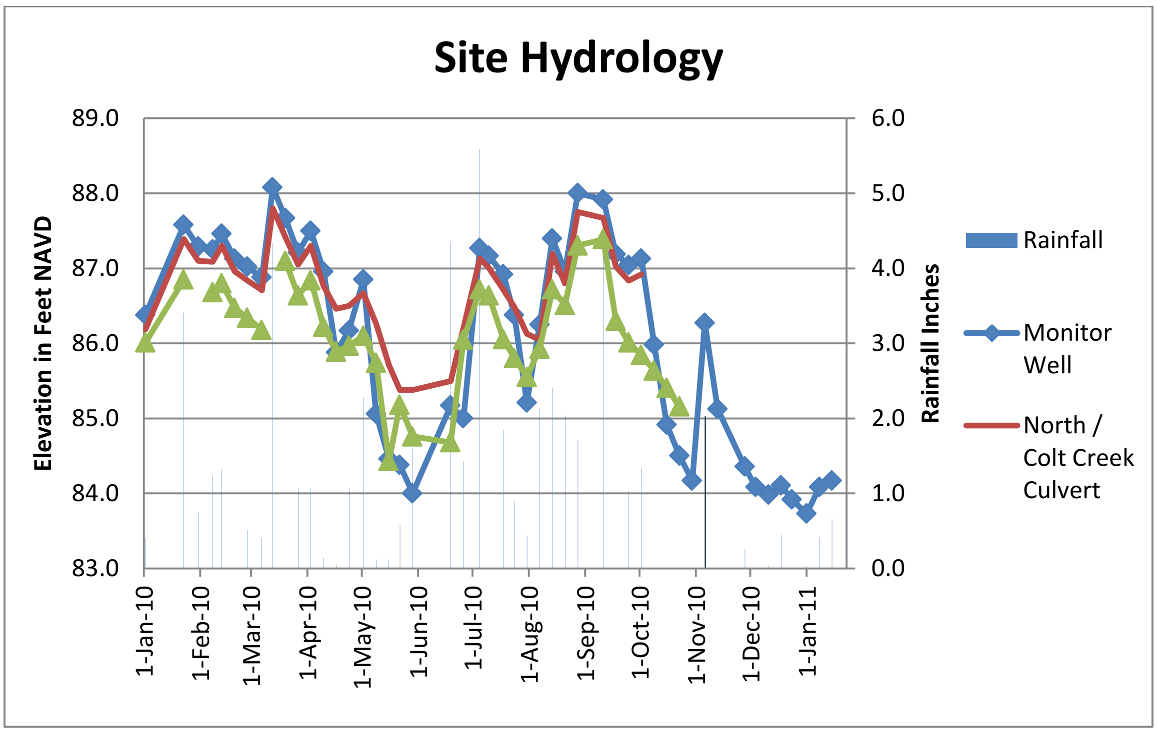

Figure 20. Colt Creek hydrology from January 2010 to January 2011.

Water levels in the bypass ditch, as measured at the culvert in the downstream (west) end of the ditch, ranged from a minimum of 84.4 feet, NAVD (not including when there was no water at that location) recorded on May 16, to a maximum level of 87.4 feet NAVD, recorded on September 11. There was no

measurable standing water in the ditch from October 30 through the end of the monitoring period on January 15, 2011. The range of water level fluctuation in the ditch was 3.0 feet and the mean water level elevation at that monitoring station was 86.1 feet NAVD.

In order to make a general comparison of the Colt Creek hydrology with another wetland strand, water levels were recorded at a staff gage located south of, and adjacent to Colt Creek. Water levels at the gage ranged from a maximum level of 88.8 feet NAVD, to completely dry. Figure 21. shows the staff gage data plotted with the water levels recorded at Colt Creek. The lowest measurable water level at the gage was 87.0 feet, which is approximately ground elevation at the gage (hence the flat graph line in June and July). The similarity in the pattern of water level fluctuation at the staff gage compared with Colt Creek water levels also provides a simple QA/QC check that the Colt Creek data are reasonable and reasonably accurate.

Water levels at the north culvert, located in the historic flow way at the west end of the site, generally fluctuated consistently with the water levels measured at the monitor well levels, as would be expected due to their proximity (Figure 20). However, there are a few discrepancies between the north culvert data and the monitor well data recorded in April and the end of July. These may be data errors with the measurements at the culvert, but appear to be errors with the monitor well data.

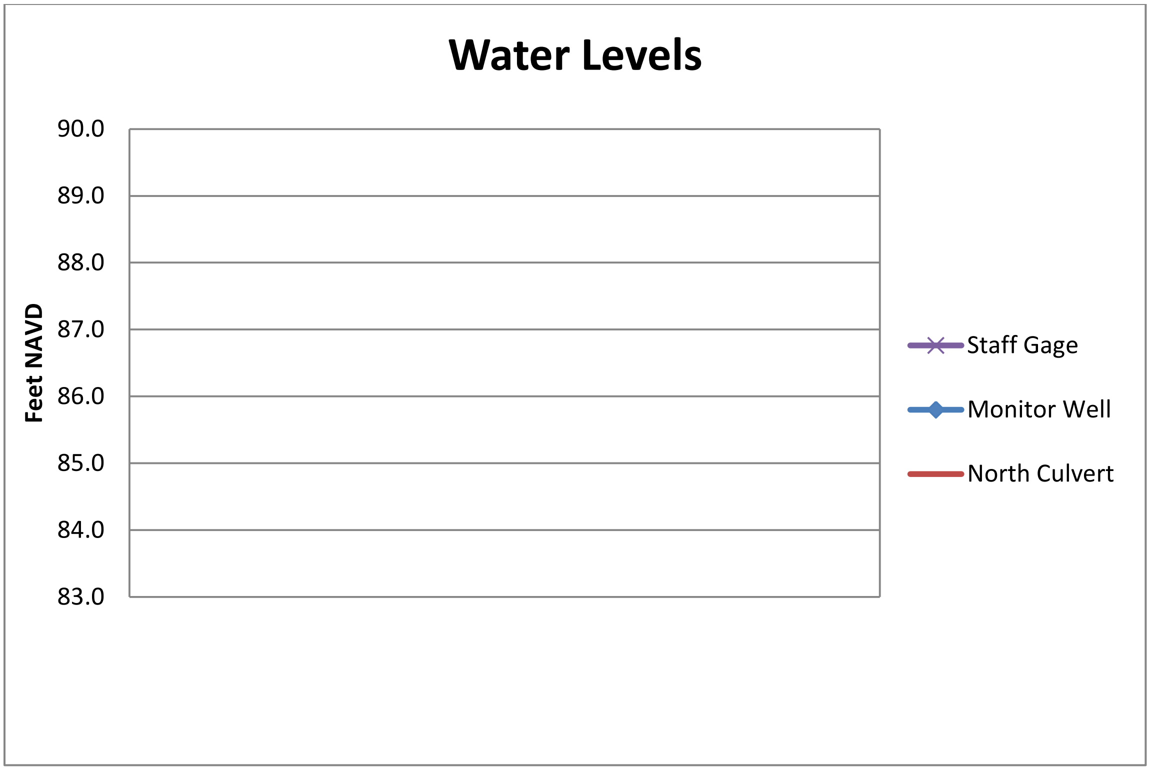

Figure 21. Site hydrology with adjacent staff gage levels for comparison.

Vegetation

Thirty-one different herbaceous species were identified. An additional eight plants were identified only to genus. Five plants were not identified. Plants that were not identified at least by genus were not included in the subsequent analyses. The eight plants that were only identified to genus were included in the analyses because all or most of the possible species within each genus had the same hydrologic indicator status and therefore identification of the exact species was not critical. Including them in the analysis based on an non-specific identification posed a reasonably small risk of error. The 39 identified plants consisted of 15 obligate species, 13 facultative wet species, 6 facultative species, 1 facultative upland species, and 4 upland / unlisted species. (See Appendix C

for the complete list of species, as well as species listed by quadrat and transect.) Summary statistics, i.e., mean, minimum, maximum, and median, were calculated for the percent cover in each of the 39 monitoring quadrats (Tables 1A and 1B). These statistics show the general vegetative composition of each quadrat relative to the percent of each wetland indicator category. The results vary for each transect but on a scale from most upland species to most wetland species, range from a mean of 99.2% upland species (Transect 2, Quadrat 8) to a mean of 97.2% wetland species (obligate and facultative wetland – Transect 2, Quadrat 3).

Two similarity indices, Jaccard and Sorenson (Dice), were calculated for each possible combination of transect pairs to confirm and quantify observed similarities in the field. Those results are listed in Table 2, below.

Table 1A. Summary Statistics for Vegetation in Individual Quadrats (Transects 1 and 2).

Transect 1	%	mean	max	min	median		Transect 2	%	mean	max	min	median
Quadrat 1	obl	6.8	15.0	3.0	5.0		Quadrat 1	obl	7.1	17.0		5.0
	facw	15.8	30.0	3.0	5.0			facw	10.9	30.0		6.0
	fac							fac				
	up	80.0	94.0	53.0	92.0			up	77.3	95.0	45.0	85.0
	bare							bare	3.4	17.0	0.0	0.0
Quadrat 2	obl	58.8	85.0	5.0	69.0		Quadrat 2	obl	53.7	85.0	8.0	62.0
	facw	20.1	36.0	10.0	20.0			facw	24.2	75.0	2.0	22.0
	fac							fac	7.5	19.0		4.0
	up	20.0	80.0	2.0	5.0			up	8.9	80.0		2.0
	bare	3.6	40.0	0.0	0.0			bare	5.4	50	0	0
Quadrat 3	obl	79.5	93.0	5.0	90.0		Quadrat 3	obl	85.5	95.0	60.0	90.0
	facw	8.7	20.0	5.0	6.0			facw	11.7	30.0	3.0	8.0
	fac	12.2	85.0	2.0	3.0			fac	0.0	0.0		
	up							up	0.9	4.0		
	bare	1.8	20.0	0.0	0.0			bare	0.6	5	0	0
Quadrat 4	obl	82.3	100.0	5.0	95.0		Quadrat 4	obl	91.3	97.0	85.0	91.0
	facw	2.5	5.0	0.0	3.0			facw	5.6	13.0	3.0	4.0
	fac	0.5	3.0	0.0	0.0			fac				
	up	9.3	92.0	0.0	0.0			up	1.7	4.0		2.0
	bare	5.4	60.0	0.0	0.0			bare	0.6	5	0	0
Quadrat 5	obl	72.1	92.0	5.0	83.0		Quadrat 5	obl	85.4	97.0	70.0	87.0
	facw	7.7	21.0	0.0	6.0			facw	8.3	19.0	3.0	5.0
	fac	3.7	9.0	0.0	3.0			fac	4.9	23.0		3.0
	up	10.1	90.0	0.0	3.0			up	1.1	10.0		
	bare	5.9	65.0	0.0	0.0			bare	0.4	5	0	0
Quadrat 6	obl	67.4	90.0	5.0	78.0		Quadrat 6	obl	73.2	93.0	15.0	81.0
	facw	5.8	12.0	2.0	5.0			facw	15.8	40.0	5.0	12.0
	fac	8.4	22.0	0.0	5.0			fac	1.8	10.0		
	up	18.5	85.0	0.0	4.0			up	7.5	75.0		
	bare							bare	0.4	5	0	0
Quadrat 7	obl	1.5	3.0	0.0	2.0		Quadrat 7	obl	10.1	25.0	2.0	8.0
	facw	2.7	5.0	0.0	3.0			facw	29.5	57.0	12.0	25.0
	fac							fac				
	up	94.3	100.0	90.0	94.0			up	59.1	75.0	18.0	68.0
	bare							bare				
							Quadrat 8	obl				
								facw	0.6	5.0		
								fac				
								up	99.2	100.0	93.0	100.0
								bare				

Table 1B. Summary Statistics for Vegetation in Individual Quadrats (Transects 3 and 4).

Transect 3	%	mean	max	min	median		Transect 4	%	mean	max	min	median
Quadrat 1	obl	15.3	20.0	10.0	15.0		Quadrat 1	obl	8.5	20.0	0.0	8.0
	facw	15.8	20.0	8.0	15.0			facw	21.1	37.0	10.0	20.0
	fac	2.8	5.0	0.0	3.0			fac	4.4	8.0	0.0	5.0
	up	2.0	2.0	2.0	2.0			up	0.5	2.0	0.0	0.0
	bare	65.4	75.0	55.0	65.0			bare	65.0	85.0	45.0	70.0
Quadrat 2	obl	18.4	25.0	15.0	18.0		Quadrat 2	obl	7.9	10.0	3.0	8.0
	facw	15.2	27.0	7.0	15.0			facw	18.6	30.0	10.0	15.0
	fac	3.0	3.0	3.0	3.0			fac	3.3	5.0	0.0	3.0
	up							up				
	bare	63.5	75.0	45.0	65.0			bare	69.3	85.0	50.0	70.0
Quadrat 3	obl	17.3	42.0	0.0	15.0		Quadrat 3	obl	1.9	3.0	0.0	3.0
	facw	13.4	17.0	10.0	15.0			facw	15.7	22.0	8.0	15.0
	fac	7.7	13.0	2.0	7.0			fac				
	up							up				
	bare	61.6	80.0	35.0	65.0			bare	82.4	92.0	75.0	82.0
Quadrat 4	obl	1.9	5.0	0.0	2.0		Quadrat 4	obl	54.0	77.0	30.0	52.0
	facw	20.4	28.0	13.0	20.0			facw	5.0	9.0	2.0	5.0
	fac	10.5	18.0	6.0	12.0			fac	1.5	3.0	0.0	2.0
	facu	3.5	5.0	3.0	3.0			up				
	bare	62.7	75.0	55.0	60.0			bare	39.7	65.0	20.0	42.0
Quadrat 5	obl	18.6	33.0	10.0	20.0		Quadrat 5	obl	11.0	15.0	5.0	12.0
	facw	8.4	10.0	5.0	10.0			facw	19.3	35.0	10.0	18.0
	fac	5.7	10.0	3.0	5.0			fac	6.4	13.0	0.0	5.0
	up							up				
	bare	67.3	80.0	55.0	65.0			bare	63.4	80.0	50.0	62.0
Quadrat 6	obl	2.9	7.0	0.0	5.0		Quadrat 6	obl	11.7	15.0	5.0	12.0
	facw	62.3	90.0	35.0	65.0			facw	16.6	20.0	10.0	15.0
	fac							fac				
	up							facu	19.4	25.0	10.0	75.0
	bare	34.5	60.0	10.0	25.0			bare	52.3	70.0	40.0	50.0

Table 2. A comparison of similarity of the groundcover vegetation in each pair of monitoring transects.

Jaccard Index			
	Transect 2	Transect 3	Transect 4
Transect 1	29.8	13.7	13.3
Transect 2		11.8	13.0
Transect 3			29.2
Sorensen (Dice) Index			
	Transect 2	Transect 3	Transect 4
Transect 1	**45.9**	24.1	23.5
Transect 2		21.1	23.1
Transect 3			**45.2**

Note that the Sorensen (Dice) similarities between Transects 1 and 2, and Transects 3 and 4 (**bolded**) are statistically significant.

Figures 22 and 23,below, provide graphical descriptions of species composition in each transect relative to wetland indicator categories. Figure 22 presents the data by percentage of each indicator category within each transect. Figure 23 presents the same data but with the numbers of different species within each indicator category. Table 3 is a tabular description of the data presented in Figure 23. A statistical analysis of vegetation species diversity was not done, as the number of individuals of each species necessary for that analysis was not a component of the vegetation monitoring protocol.

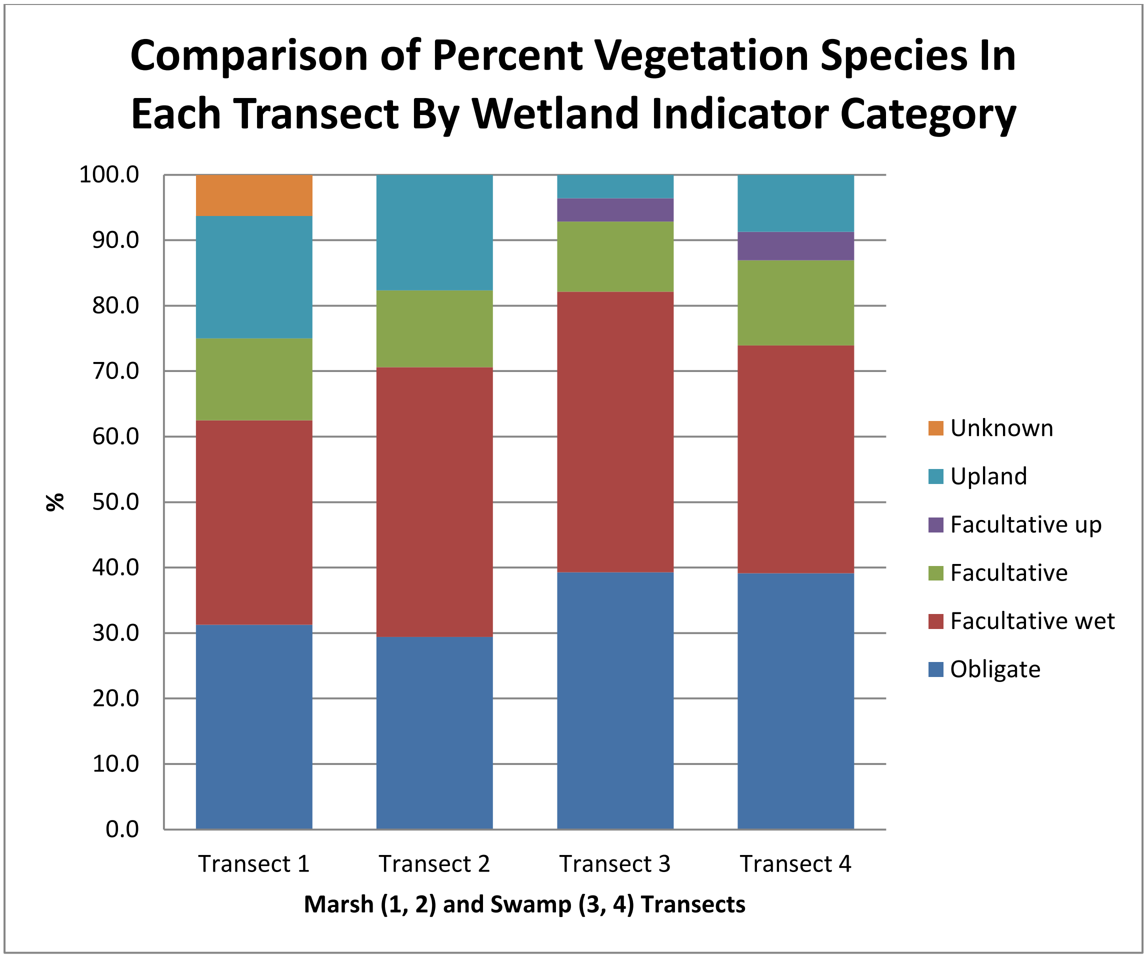

Figure 22. A comparison of the distribution of vegetation species in each monitoring transect by percentage of each wetland indicator category.

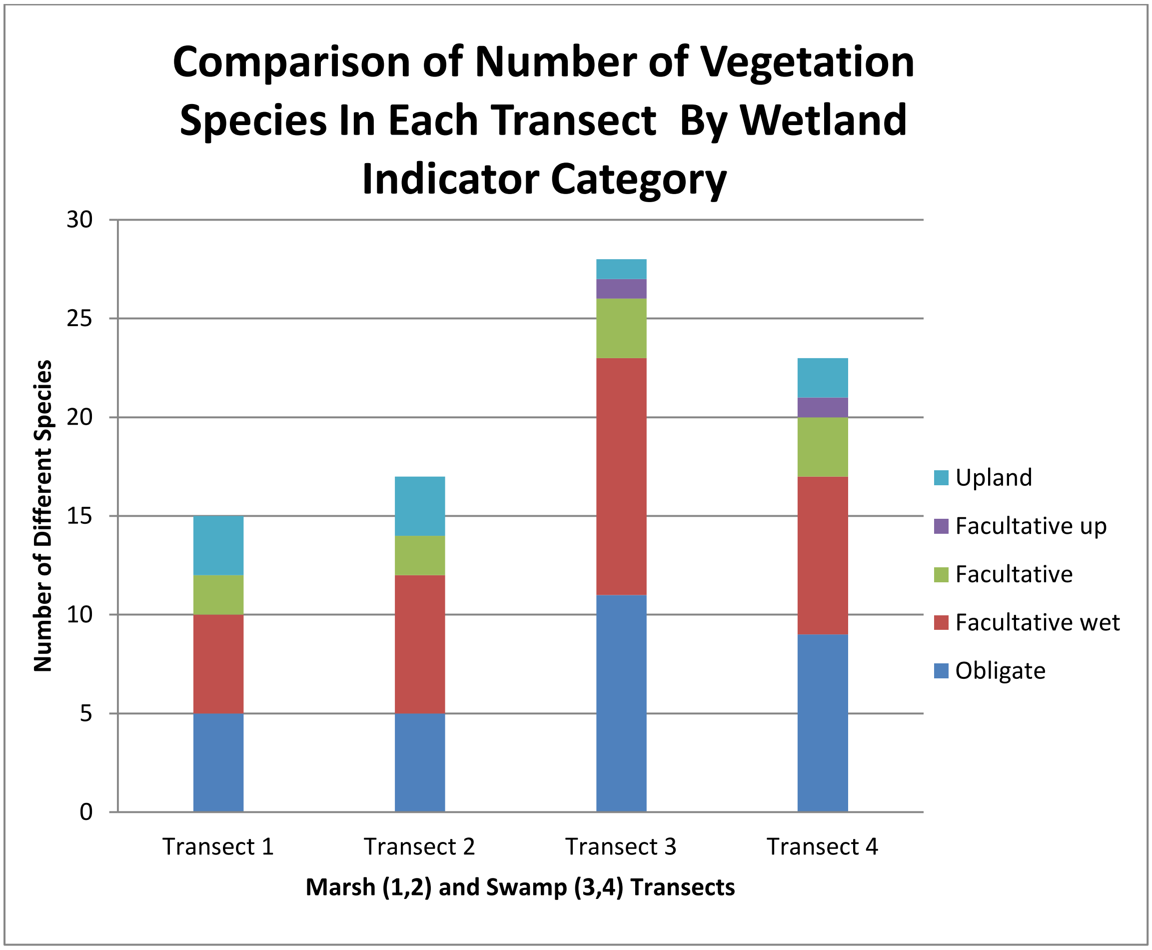

Figure 23. A comparison of the distribution of vegetation species in each monitoring transect by the number of species within each wetland indicator category.

Table 3. Numbers of Different Species of Each Indicator Type in Each Monitoring Transect.

Transect Diversity (Number of different species)				
	Transect 1	Transect 2	Transect 3	Transect 4
Obligate	5	5	11	9
Facultative wet	5	7	12	8
Facultative	2	2	3	3
Facultative up	0	0	1	1
Upland	3	3	1	2
Unknown	1	0	0	0
Total	16	17	28	23

The ratio of wetland species to non-wetland species calculated for each transect resulted in the following mean percent cover of wetland vegetation for each transect:

Transect 1 - 62.6

Transect 2 - 65.5

Transect 3 - 81.9

Transect 4 - 84.4

Birds

The total number of individual birds counted during the monitoring period was 635, consisting of 544 individuals identified to species and 91 unidentified individuals. The failure to identify individuals was usually due to hearing an unknown call but with no visual sighting, or the sighting was too brief and / or too distant to confirm species identification.

The 544 individuals identified resulted in 34 different species identified. The most abundant species was white ibis (*Eudocimus albus*) with 125 individuals observed on 11 events over the 49 week monitoring period. There were six identified species which had only a single sighting. For analysis, bird count data was divided into two groups based on where they were observed. Birds observed in the upstream / undrained creek were identified as swamp birds and those observed in the downstream / drained creek were identified as marsh birds. The complete list of bird species identified, as well as species identified in each area are located in Appendix F.

Swamp Birds

In the unaltered swamp there were a total of 138 individual birds counted, consisting of 60 identified birds and 78 unidentified during the 49 monitoring events. Of the identified birds, 15 different species were identified. The highest number of birds counted, 12, occurred one time in late November (11/28/2010), and the least number, 0, occurred nine times at various times throughout the 49 events (Figure 24.). The mean number of swamp birds counted was 2.82 birds per event, the median was 3, the mode was 0, and the standard deviation was 2.47.

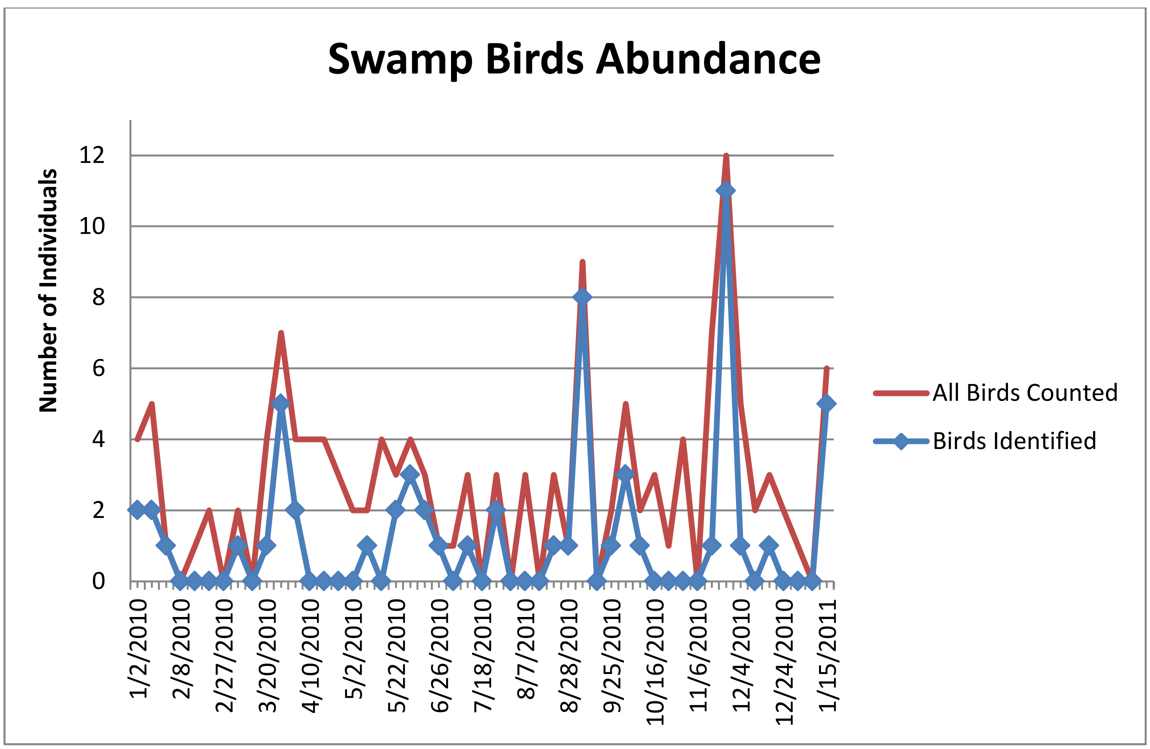

Figure 24. Changes in bird abundance in the Colt Creek swamp during the monitoring period.

Species richness in the swamp for all monitoring events ranged from one to five species, with the highest number, five species, occurring just once on

January 23, 2010. The mean number of species identified per event was 2.06, the median was 2, the mode was 3, which occurred 14 times, and the standard deviation was 1.42 (Figure 25.).

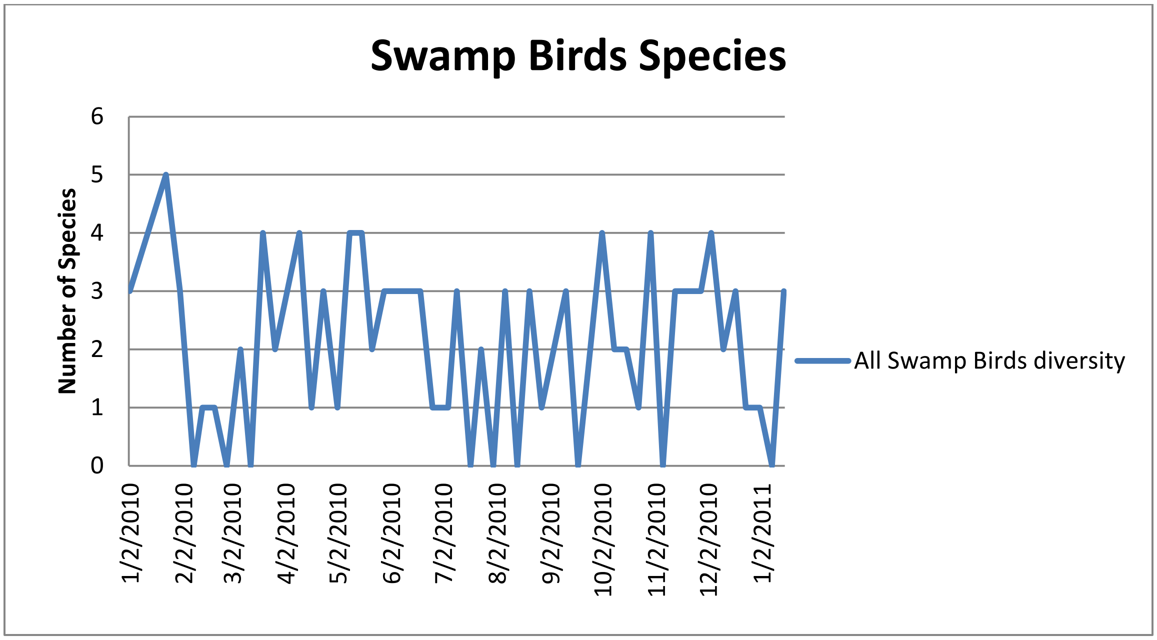

Figure 25. Weekly bird species numbers in the Colt Creek swamp.

Marsh Birds

In the downstream / marsh section of the creek, a total of 497 birds was counted, consisting of 484 individuals identified to species and 13 individuals that were not identified. The 484 birds identified represented 28 species. The maximum number of birds counted at any one event was 57 observed on January 23, 2010. This number of birds is attributable primarily to two species that were particularly abundant on that day: white ibis (30) and tree swallows (*Tachycineta bicolor*) (20). The least number of birds observed was on January

1, 2011, when no birds were counted. The mean number of birds for all 49 monitoring events was 10.10, the median was 5, the mode was 1, which occurred five times, and the standard deviation was 11.25 (See Figure 26.).

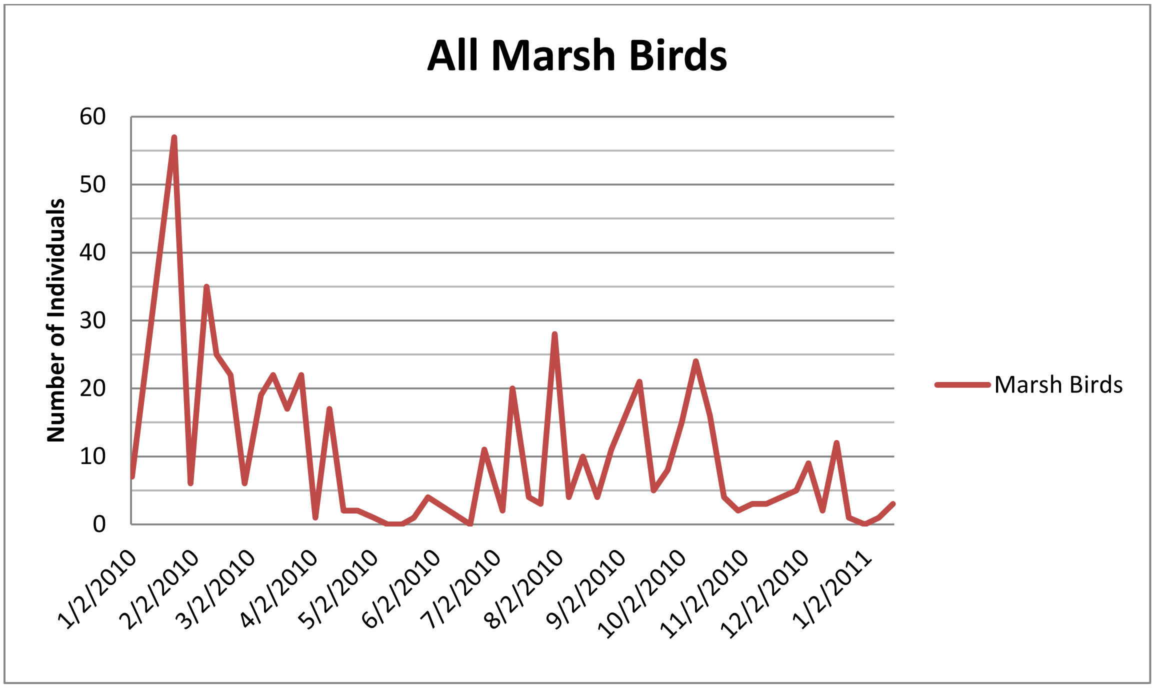

Figure 26. Weekly bird counts in the Colt Creek marsh.

Species richness in the marsh ranged from 1 to 7 species, with the highest number of species, 7, counted October 9, 2010. The mean number of identified species per monitoring event was 2.55, the median was 2, the mode was 2, which was observed on 13 events, and the standard deviation was 1.76 (Figure 27.).

Species diversity and evenness was statistically determined using the Shannon-Weaver index. The result was a value for the swamp bird data of 2.364. The index value for the marsh bird data was 2.624.

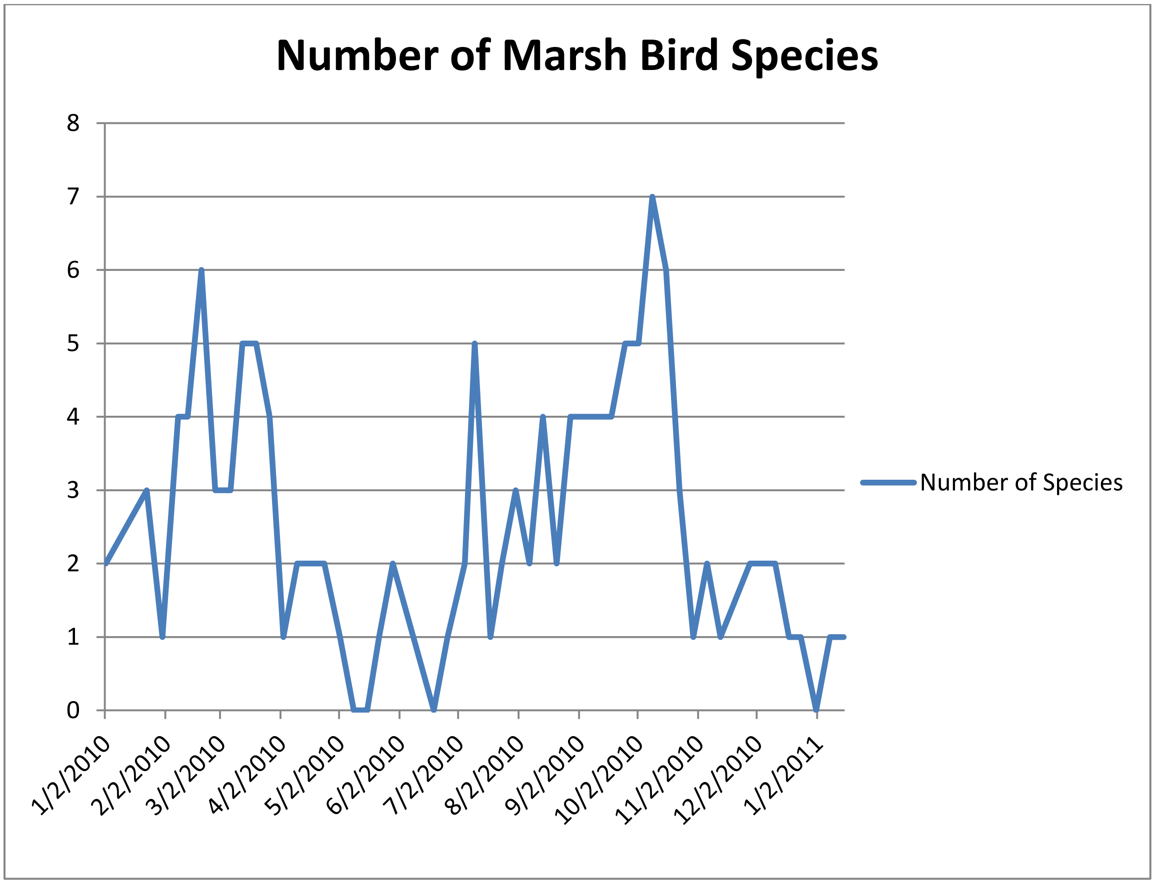

Figure 27. Weekly bird species numbers in the Colt Creek marsh.

Chapter Five: Discussion

It is a known fact that the composition of any vegetative community is related to hydrology and that habitat selection and use is affected by the composition of the vegetative community. Although this study included monitoring and quantifying all three of these factors, hydrology, vegetation, and birds, as stated in the introduction the fundamental component of a wetland is hydrology. By noting hydrologic conditions observed weekly at the two sites and comparing those observations with the water level data, the differences in the hydrology of each of the two areas could be quantified with reasonable confidence. As might be expected due to the bypass ditch, the hydrology of the historic flow way downstream of the ditch (the altered marsh) was determined to be considerably different, i.e., a shorter hydroperiod and less stream flow, than the area upstream of the ditch (the unaltered swamp), at least in 2010. However, despite the reduced hydrology in the downstream marsh, the hydrology is still sufficient such that much of this downstream area meets the criteria to be defined as a wetland by the state wetland delineation rule (Chapter 62-340, Florida Administrative Code). (The exceptions would be primarily areas between elevations 87.0’ and 88.0’ NAVD.) This is also evidenced by the presence of groundcover vegetation in the downstream area which is predominantly wetland species, i.e., obligate or facultative wetland. However, the plant species

composition, including species diversity and the percentage of wetland species, and the density of the groundcover is quite different in each of the two areas. Consequently, what was determined from this study was that the two adjacent areas of Colt Creek are both wetlands with 1) different hydrologic regimes and 2) different plant vegetative composition and structure, not including the fact that the swamp has a mature, intact tree canopy and the marsh has only two relatively small clumps of trees. Based on these two differences, it was reasonable to expect that avian utilization in each area would also differ. In fact, the number of individual birds identified, i.e. total abundance, species composition, and species richness and diversity were all quite different in the two areas (Table 4.).

Table 4. A Comparison of Avian Utilization in the Swamp and the Marsh.

Avian Use Comparisons		
	Swamp	Marsh
Total Abundance	138	497
Mean Abundance (per monitoring event)	2.82	10.10
Maximum individuals counted	12	57
Total species diversity	15	27
Mean Diversity (per monitoring event)	2.06	2.55
Maximum species counted (per monitoring event)	5	7
Shannon-Weaver diversity index (H')	2.364	2.624
Percentage of all species identified (%)	35.7	64.3
Number of species in common	7	7
Percentage of species in common (%)	16.7	16.7
Unidentified individuals	78	13

Whether the difference in habitat use is due to the difference in vegetation (groundcover or canopy) or hydrology, a combination of the two, or another

undetermined factor, was not clearly determined. However, there was a significant, though not particularly strong, correlation of water levels with bird abundance and species diversity. The following is a detailed discussion of the results for each parameter monitored.

Hydrology

As average rainfall for this area of central Florida is 53.84 inches (measured at Dade City, FL), the rainfall measured at the park in 2010, 52.68 inches, was near average. Although the amount of rainfall at the park in 2010 was nearly average, the timing of the rainfall was not typical. There were two significant shifts in the 2010 rainfall from the pattern of when rainfall typically occurred (Figure 28.).

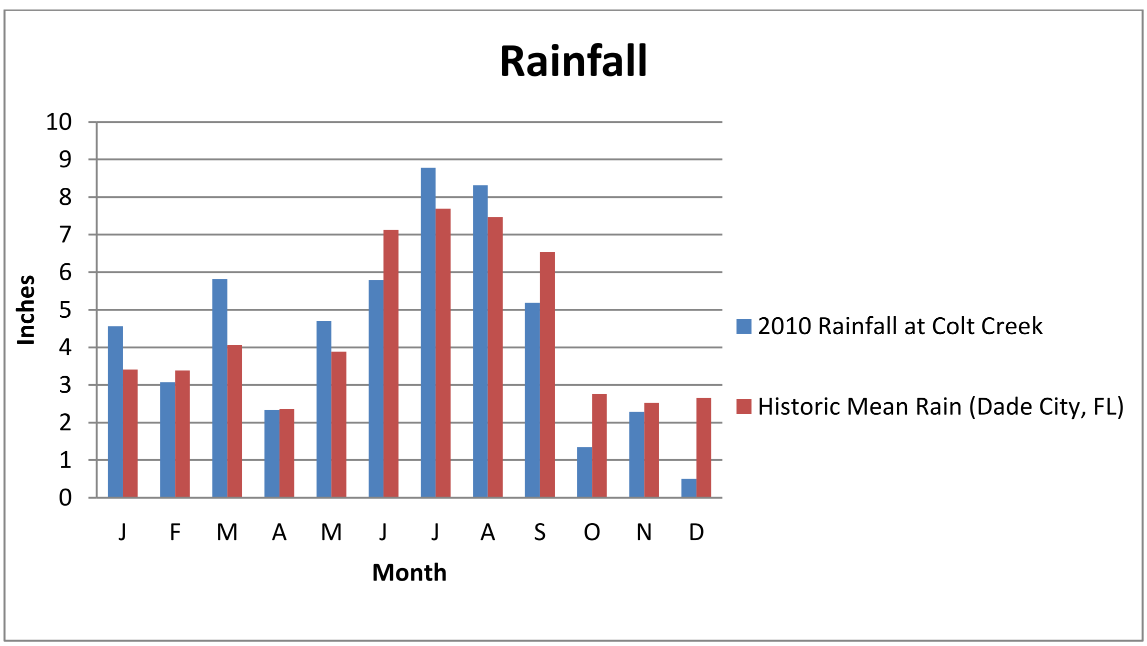

Figure 28. A comparison of 2010 rainfall at Colt Creek with historic mean rainfall in the region.

First, winter and spring 2010 were wetter than average. Specifically, rainfall from January through May at the park was 3.39 inches above average, with the excess rainfall occurring in January, March, and May. (January rainfall was also preceded by 4.28 inches of rain in December 2009, which is 1.65 inches above average for that month.) Second, rainfall in the Fall of 2010 was 3.80 inches below average. Specifically, October, November, and December each had below average rainfall. These two shifts appear to be related to a mild "El Nino" during winter 2009 / 2010 followed by a "La Nina" fall 2010. In addition to these two shifts in rainfall patterns, the summer wet season rain at the park (June through September), although only 0.76 inches below average, was above average in mid-summer (July and August), and below average in June and September. As evident in the water level monitoring hydrograph (Figure 20.), these two events (March and August) depict the two wet seasons (winter / spring and summer) that occurred in 2010.

In central Florida the annual dry season is typically from October 1st to May 31st and the wet / rainy season is the four months of June through September, as seen in the historic mean rainfall graphed in Figure 28. So, it was unexpected that the highest water level recorded at the site in 2010 occurred in March. This is also somewhat surprising in that rainfall in March 2010, though summer-like (5.82 inches), was not as much as in July and August of that year. An exact cause for this anomaly was not determined for this study but it may be due to the antecedent rainfall in 2009. This thought is supported by the water

levels recorded at the site during January and February 2010, which are comparable to water levels recorded during June and September of 2010.

The water level monitoring data show that the upstream / undrained section of Colt Creek was flowing or with some extent of inundation 36 of the 49 weeks of monitoring (73.4%). Surface water hydrology in that part of the creek ranged from completely dry to a maximum water level of approximately 88' NAVD. Based on the monitoring data and on-site observations, when surface water levels were lowest, i.e., 86' to 87', water in the creek was confined to the lowest portion of the flow way and only a few feet in width. At the high water level of 88' the entire flow way / swamp was inundated, which ranged in width from approximately 320 feet wide at a narrow section located approximately 1000 feet upstream of the bypass ditch, to the width of most of the flood plain, i.e., several hundred feet across, on the west side of the swamp immediately upstream of the ditch. From the data it appears these high water / flooding events occurred only twice in 2010: two consecutive weeks in March and two weeks recorded on August 28 and September 11 (No monitoring occurred during the intervening week, so whether the high water levels were continuous between these two weeks is unconfirmed). These four weeks equate to 8.2% of the total monitoring period. During the remaining 32 weeks (65.3%) of inundation in the unaltered/ upstream creek, water levels ranged from approximately 86.0' (almost dry) to approximately 87.6'. Presumably due to El Nino, these 36 weeks of almost continuous flow or inundation occurred from January 2, 2010, through October 9, 2010. However, beginning October 16, the creek dried up and

remained dry through January 15, 2011, with the exception of November 6 and November 13, 2010, when shallow standing water was observed in the creek. This mostly dry period from October 2010 to January 2011 covered 11 of the 49 weeks (22.4%). In addition to this 11-week dry period, there were two other consecutive monitoring events on May 29 and June 19, 2010, when the creek was dry (Note that although this is recorded as two consecutive weeks, no monitoring occurred the two intervening weeks, so it is not known what the water levels were for those two intervening weeks.).

Similarly to the upstream / undrained creek, surface water levels in the downstream / drained creek ranged from completely dry to a high of 88.1' NAVD. At the high elevation of 88.1', the entire creek and floodplain were inundated to the extent that the drained creek section was overflowing back into the bypass ditch downstream from the area where the ditch was flowing into the drained marsh. As both the upstream and downstream sections of Colt Creek were flooded and dry at various times, the hydrologic difference between the upstream and downstream areas is the frequency and duration of inundation and desiccation. As stated previously, the upstream creek was continuously inundated for 36 weeks, with the exception of the weeks in late May and early June. With respect to the downstream / drained creek section, water levels measured during the monitoring period, when combined with observed flow during monitoring events, show that 25 weeks out of the 49 weeks of monitoring (51.0%), the upstream / unaltered portion of Colt Creek had flow but the entire flow / volume bypassed the historic downstream flow way via the bypass ditch.

For an additional 11 weeks of the 49 weeks (22.4%), the upstream creek overflowed the bypass ditch and flowed into / through the historic flow way. Although the bypass ditch overflowed into the downstream / drained section for only 11 weeks, the downstream section of the creek had some measurable surface water for a total of 29 of the 49 weeks (59.2%). So, for 18 of the 29 weeks of inundation there was standing water but no flow in the historic flow way.

These descriptions of the hydroperiods in each section of the creek can be described another way by understanding that there were basically four different hydrologic conditions that occurred at the site during the monitoring period. In the driest condition the entire site, i.e., upstream and downstream, was completely or nearly dry ("nearly dry" meaning there may have been two or three small isolated pools in the lowest depressions but almost the entire site had no standing water). This occurred 13 of the 49 weeks (26.5%) when the water level recorded in the monitor well was generally below 85 feet NAVD. This driest condition occurred primarily (11 weeks) and almost continuously beginning October 16, 2010 through January 15, 2011, with the exception of the two weeks in November mentioned previously. The other two dry weeks were May 29 and June 19, 2010 (Note that only two monitoring events occurred during the four-week period from May 29th through June 19th. As no monitoring occurred during the weeks of June 5th and June 12th, the hydrologic conditions during those two weeks are unknown, so those two weeks were intentionally omitted from the record). This driest condition did not consistently coincide with water levels below elevation 85' during the two dry monitoring events in May and June. The

reason for this inconsistency is unknown although one possible explanation may be an error in the recorded water levels during one or more of monitoring events. (see Figure 20.)

Along the spectrum from driest to wettest, the next hydrologic condition at the site was when the upstream creek was wet / flowing but the downstream area was essentially dry, i.e., no significant surface water. In this condition all upstream flow was diverted through the bypass ditch. This was the least common condition, occurring 7 weeks out of 49 (14.3%) and usually occurred when water levels in the monitor well were between elevation 84.4 feet and 86.0 feet (However, this was not consistent, as there was one week in June and two weeks in October when water levels at the monitor well were recorded within this range but the upstream swamp was dry as well as the marsh, i.e., the driest condition described above). This second-driest condition occurred more or less intermittently from April 17, 2010, through November 13, 2010, although in May there were three consecutive weeks when this condition occurred.

The next wettest condition was when both upstream and downstream sites were inundated but there was no surface water overflow / connection from upstream to downstream. This condition always occurred following a high water event when the upstream creek had been overflowing into the downstream creek. So the source of downstream inundation appeared to be primarily surface water runoff from upstream rather than rainfall directly on the site. This was the most frequent hydrologic condition, occurring 18 out of 49 weeks (36.7%) and occurred when water levels were between elevation 86 feet and 87.2 feet. This

condition occurred intermittently from January 2, 2010, through October 2, 2010. After that date conditions at the site were progressively drier until January 15, 2011, with the exception of the two weeks of November 6 and November 13, 2010.

The fourth and wettest condition was when the upstream creek overflowed the bypass ditch and into and through the downstream site. This condition occurred 11 out of 49 weeks (22.4%) and occurred when water levels were above elevation 87.2 feet (as recorded at the monitor well). The longest duration of this condition was four weeks from January 23 through February 13, 2010. The remaining occurrences were for one or two weeks intermittently until September 11, 2010, when conditions began to dry out, as stated previously.

To summarize the site hydrology (Figure 29):

1. For 13 weeks (26.5%) the entire site was essentially dry.
2. For 7 weeks (14.3%) the upstream creek was wet and downstream was dry.
3. For an additional 18 weeks (36.7%) both upstream and downstream were wet but there was no surface water connection.
4. For an additional 11 weeks (22.4%) the upstream section overflowed the bypass ditch and flowed into and through the historic flow way.
5. There was a total of 25 weeks (51.0%) when the upstream section of the creek had flow but all flow bypassed the downstream section.

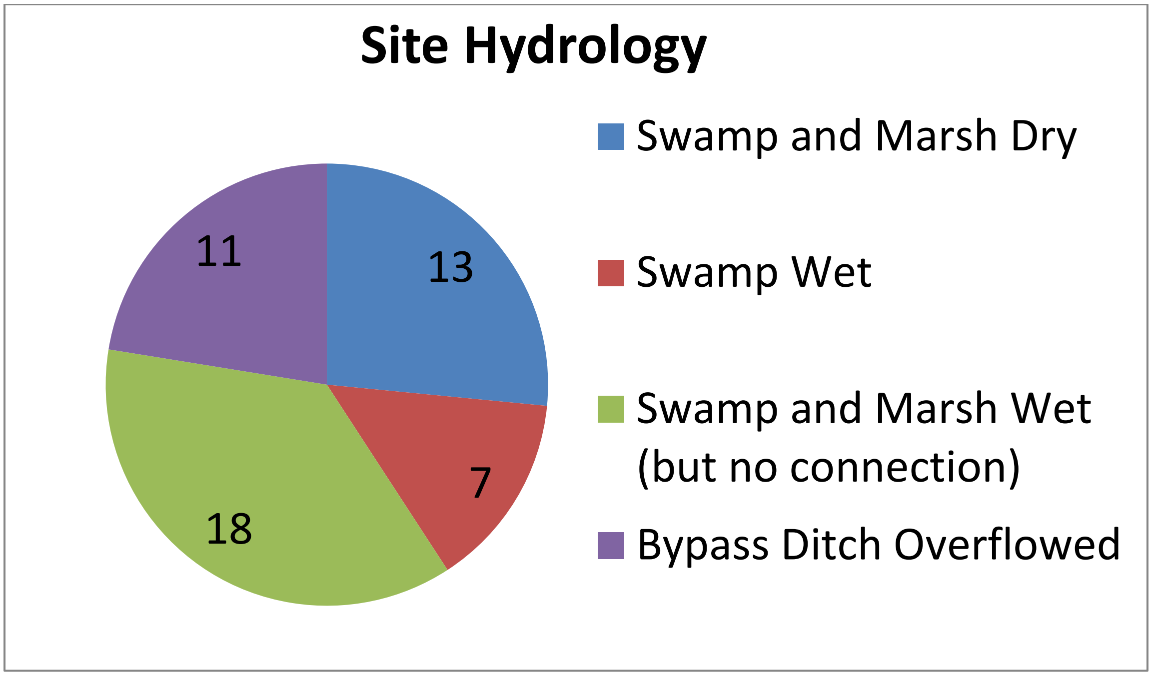

Figure 29. Summary of the site hydrology. Chart units are the number of weeks for each hydrologic condition.

To summarize the hydrologic differences between the upstream swamp and the downstream marsh, in the historic / undrained condition, i.e., with no bypass ditch, the downstream creek would have had some amount of water for a total of 35 of the 49 weeks (71.4%) with the rainfall recorded during 2010. This would be an increase in the current downstream hydroperiod of approximately 7 weeks (14.3%). This assumption is based on the observations during of seven weeks in 2010 when there was water present upstream in the swamp but the marsh was dry.

Furthermore, based on the flow observed upstream, for most of the 35 weeks of inundation in the marsh in 2010, there would have been water flowing through the site, as opposed to the 18 weeks of only standing water in the downstream section, with a likely increase in the downstream water elevation

during the 18-week interval. Again, this is due to the fact that water was flowing in the swamp during those 18 weeks but all flow was “captured” by the bypass ditch and routed past the marsh. As the recorded rainfall for 2010 was only 1.16 inches less than the annual average for this region, these seven weeks and 18 weeks of additional hydration would likely occur in all years with average rainfall (Figure 30.).

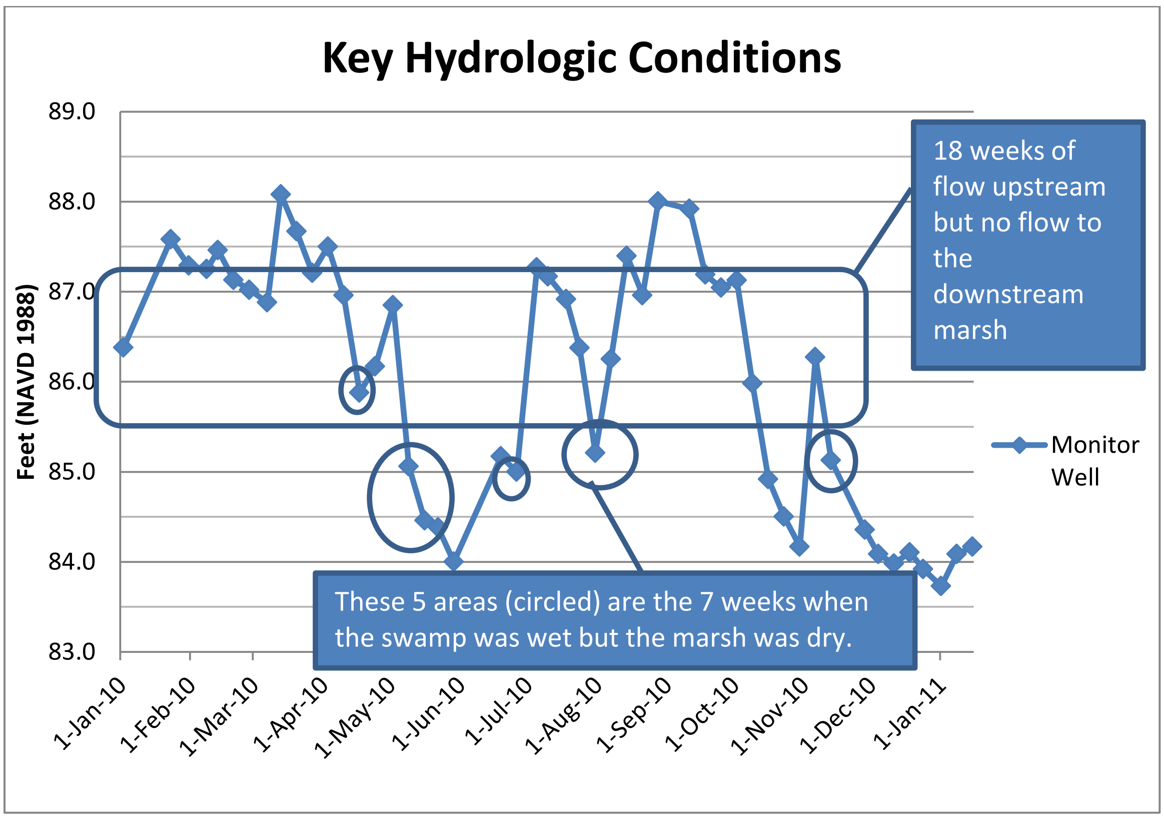

Figure 30. Monitor well hydrograph with the key hydrologic differences between the undrained (upstream) swamp and the drained (downstream) marsh identified.

The profile topography through the center of the historic creek bed (parallel to stream flow) within the study site is almost level. As indicated by LiDAR-derived topography, the elevation change is less than 1.0 foot from near

the east / upstream end of the site to the west / downstream end of the site. This appears to be the historic / natural topography of the site. However, as indicated previously, the farm road crossing culvert located at the downstream boundary of the site was placed with the pipe invert below natural grade. There are also several small depressions located throughout the creek channel that are topographically mapped (LiDAR) at elevation 86' NAVD. With the exception of these scattered depressions, the central flow elevation is approximately 87' NAVD through the entire site. Therefore, for the purposes of this analysis it is assumed from east to west the site is level and water levels measured at the east end of the site, i.e., the monitor well and north culvert, are approximately equal to water levels at the west end of the site. (Note this assumption is necessary due to constraints of the locations of monitoring sites and known elevations, which were located based on a different initial thesis subject. In addition, it was observed that when water levels measured at the monitor well were at elevation 87.1' or 87.2', water in the marsh back-flowed, i.e., flowed upstream, from the marsh into the bypass ditch located near the west boundary of the swamp, indicating that ground elevation at the east / upstream section of the swamp was near elevation 87' NAVD) The creek channel cross section (perpendicular to flow) rises relatively abruptly to 88' NAVD on the north side but is somewhat flatter on the south side, i.e., has a broader flood plain. The historic flow is from east/northeast to west/southwest.

Vegetation

The two transects located in the drained marsh were oriented across the marsh, perpendicular to stream flow, i.e., cross-sections. These transects were located so as to sample the two dominant vegetation zones within the marsh: the wetter central zone (defined topographically as the area lower than 87.0 feet, NAVD), and the drier transitional area (defined topographically as the area approximately located between 87.0 feet and 88.0 feet, NAVD). Note that all vegetation communities within the marsh were not included in the two monitoring transects, but the vegetation community where the transects were located is the dominant community in the marsh. Other areas not included in the monitoring were two small wetter / deeper pools of mostly fire flag (*Thalia geniculata*) and an area dominated by soft rush (*Juncus effusus*).

As indicated by the statistical analysis, Transects 1 and 2 are significantly similar (Table 2). The summary statistics for these two transects are consistent with, and reflect the locations of the quadrats relative to the marsh zonation mentioned previously. For example, Quadrat 7 of Transect 1, and Quadrats 7 and 8 of Transect 2 are all near the wetland edge, above elevation 87' NAVD. These three quadrats all had consistently high percent cover of upland species, primarily one or the other of the two pasture grasses, Bahia or bermudagrass. In addition, two other quadrats had a high percentage of upland grass. The first quadrats (#1) of both Transect 1 and Transect 2 were dominated by Bahia. However, these two quadrats are both located at the south end of their respective transects but a little below the 87-foot LiDAR contour. Therefore,

based on topography alone, dominance by upland vegetation was not expected. Although elevation and the associated hydrology are two primary determinants of vegetation zonation, other factors, such as soils, may account for this unexpected situation.

In addition to topographic zonation, the marsh vegetation data was analyzed to determine and describe seasonal changes through 2010. This was most clearly observed by creating line graphs of the percent cover of each vegetative hydrologic indicator for each quadrat (Appendix E). Whereas the summary statistics provided a numerical comparison of the total percent cover of each indicator category for each quadrat, the line graphs provided a visual comparison of each quadrat over time, i.e., the 11-month monitoring period. The line graphs also show the similarity in the two marsh transects that was seen in the summary statistics. The line graphs show changes in relative cover of each indicator category, e.g., obligate, etc., over time for each quadrat. As would be expected, these graphs are consistent with the summary statistics., but provide additional information. Primarily, they show vegetative shifts in time. Seven of the 15 marsh quadrats had a substantial and dramatic shift in vegetation cover from dominance by upland species to dominance by wetland species. In Transect 1, five of the quadrats had a high percentage of upland vegetation , i.e., 80% or greater, and a low percentage of obligate species, i.e. 5%, at the first monitoring event in March. By April or May, those proportions completely reversed, resulting in 80% or more obligate species and 5% or less upland species in the same five quadrats. This shift also occurred in Transect 2 but only

in two quadrats. The vegetative shift from a dominance of upland species to obligate species may be due to a combination of change in hydrology and seasonal changes. Relative to hydrology, the recorded water levels show that the marsh was inundated with one to two feet of water throughout March and April. This very wet condition going into the beginning of the growing season may explain the cause of the vegetative shift. Also, it should be noted the vegetation data show that a single upland species, Bermuda grass, dominated all of the quadrats that exhibited this shift and a single obligate species, water grass (*Hydrochloa caroliniensis*), became the dominant species as the Bermuda grass died out.

Transects 3 and 4 are located in the upstream unaltered swamp and these vegetation data indicate no apparent zonation, with the exception of the last quadrat (#6) of Transect 4. This quadrat indicates a substantial increase in the facultative up species. This is not unexpected as the transect is oriented such that it covers a slightly higher elevation area toward the end of the transect. This is consistent with observations in the field, although it is somewhat more apparent in the canopy species.

There are no apparent seasonal changes in the groundcover in these two transects. Vegetation cover is generally dominated by obligate and / or facultative wetland species in all quadrats, both temporally and spatially, with the exception of quadrat #6 discussed above. There are fluctuations in percent cover that may be related to hydrologic conditions and / or normal seasonal variation but no consistent pattern is apparent.

The summary statistics and line graphs for Transects 3 and 4 show no readily apparent trends or similarities other than generally the obligate and facultative wet species are dominant, as would be expected considering the locations of the transects in the swamp interior. However, one difference between these two transects was that in Transect 4, facultative wet species were usually found at a higher percentage than obligate species, which may be explained by the fact that this transect is oriented approximately perpendicular to the creek such that as one progresses along the transect the area becomes slightly higher, as it crosses the 87-foot contour. However, this otherwise consistent dominance of facultative wet species along the transect is not exhibited in Quadrat 4 and obligate species become the dominant vegetation. An inspection of the raw data shows this is change is due to the presence of a single obligate species that dominated that quadrat.

In addition to the summary statistics and initial graphs, more specific analyses were done. When all four transects were compared to each other, some aspects of each wetland became apparent that help to characterize differences in the two wetland systems. This comparison was made by two different but complementary analyses. The first analysis was calculating the degree of similarity between each pair of transects and the second analysis was comparing species diversity in all transects.

The Jaccard and Sorensen (Dice) indices were used to determine the degree of similarity of species composition recorded along each transect. (These indices are very similar. The Sorensen (Dice) index is slightly different in that it

weights the number of species common to both areas being compared.) The resulting numbers listed in Table 1 are a quotient multiplied by 100 and reported as percentages of similarity of the species compositions of pairs of transects. The purpose of this assessment was twofold: to quantify how similar the transect pairs in each area were and, more importantly, to quantify vegetation differences between the two areas. So, in addition to comparing the swamp transects with the marsh transects, the marsh transects were compared to each other and the swamp transects to each other as a means to try to detect and quantify variability within the vegetation of each area, i.e., intra-area variability, to the degree possible with only two transects in each area. As seen in Table 1., above, the marsh transects (1 and 2) are the most similar. Also, not surprisingly the swamp transects (3 and 4) are the second most similar transects. Marsh transect 1 and swamp transect 3 are the most dissimilar, although all comparisons of marsh transects with swamp transects scored in the same range.

However, Looman and Campbell (1960) state that a weakness of Sorensen's index is that it does not include a determination of when an index value is large enough to be statistically significant for the two sites being compared. The authors demonstrated a calculation that shows if the similarity calculated for two sites using Sorensen's index was significant. When those statistical calculations were performed for the six transect pairs in this study, only two transect pairs, 1 and 2, and 3 and 4, were found to be significantly similar ($p = 0.005$). These calculated results are consistent with field observations, and the fact that the marsh and the swamp were determined to not be significantly similar

in groundcover species composition further documents how different these systems have become due to the anthropogenic alterations that have occurred.

However, it should be noted that the results of these similarity calculations may be related to sample sizes or species diversity (Wolda, 1981). Wolda's analysis of several similarity indices, including Sorensen's, concluded that only Morisita's similarity index is not affected by sample size and species diversity. Morisita's index requires data consisting of numbers of individuals, i.e., quantitative data. As the vegetation data for this study consists of percent cover of species rather than individual data, Morisita's index could not be used. In retrospect, if the data had been supplemented with individual plant counts, then Morisita's index could have provided additional information to support or refute the results of Sorensen's index.

The calculated transect and area similarities are consistent with species diversity of the transects, although as stated previously, species diversity could not be statistically analyzed for the vegetation due to limitations with the type of data collected. However, Table 3, above, shows that the swamp diversity, with 28 and 23 species identified along each transect is considerably greater than the marsh diversity with 16 and 17 species per transect. When the plant species are categorized according to wetland indicator groups and graphed (Figures 22 and 23), the species similarity in the marsh transects is apparent, only differing in that Transect 1 had five facultative wetland species and Transect 2 had seven. Species diversity in Transects 3 and 4 is relatively similar, though not as similar as Transects 1 and 2. However, these comparisons show a substantial

difference in species composition and diversity between the swamp and the marsh, the swamp being much more diverse. Transect 3 was the most diverse with 28 species and Transect 1 was the least diverse with 16 species.

It is perhaps unexpected and counterintuitive, but important to point out that although groundcover species diversity in the swamp is much higher, the swamp had much lower percentage of total vegetative cover, i.e., more bare ground / litter. Mean percent bare ground / litter in the swamp quadrats ranged from 34% to 84% while the marsh quadrats had little to no bare ground / litter. Transects 3 and 4 generally had 60% to 70% bare ground / litter while Transects 1 and 2 were almost always 100% vegetated. This may be attributable to two factors. One factor is the land conversion associated with the previous agricultural activities. Although the degree of groundcover clearing / conversion to improved pasture in the drained marsh is not entirely known, it is possible and likely that the marsh was plowed and seeded with pasture grasses following draining and clearing. As described previously, the extent of conversion of the marsh to improved pasture appears to be complete by 1984, suggesting that the current groundcover composition in the marsh is the result of natural recruitment since approximately 1984, or 26 years at a minimum. Apparently 26 years is not sufficient time for species diversity to be restored via natural recruitment, although another unknown variable is the intensity and frequency of active management of the converted pasture prior to cessation of most agricultural activities when the site became public property in 2006.

The second factor that has likely affected species diversity and percent groundcover is the lack of canopy / shading in the marsh. It is clearly obvious from the data and somewhat surprising that no recruitment of any tree species was observed anywhere in the marsh. This suggests that the degree of management of the improved pasture prior to 2006 was sufficient to preclude natural recruitment of trees. Management may have included mowing (hay) and occasional burning of the pastures. In addition, the reduced stream flow from the upstream swamp into the marsh may have affected the distribution of water-borne seeds downstream to the marsh. One other explanation for the lack of tree recruitment in the marsh may be the thick groundcover within the marsh. As discussed above, with the exception of occasional open areas created by feral hog rooting, there is essentially no bare ground in the marsh. Furthermore, much of the groundcover grows vertically thick, creating a thatch of living and dead material that may preclude tree seeds from germinating and / or establishing.

Although the hydrologic data and analysis clearly describe different hydrologic regimes in each of the two wetlands, it was thought that this should be clearly reflected in the vegetation in a quantitative way. To that end the relative proportion of wetland vegetation to upland vegetation was calculated for each transect. This calculation was done for all four transects and then for the combined data for the two marsh transects and combined data for the two swamp transects. The results (mean percentage of wetland vegetation in all quadrats) are restated here:

Transect 1 – 62.6

Transect 2 - 65.5

Transects 1 and 2 (averaged) – 64.2

Transect 3 – 86.3

Transect 4 – 84.4

Transects 3 and 4 (averaged) – 85.4

As Transects 1 and 2 each have one quadrat located at elevation 88' NAVD, or slightly lower, and neither Transects 3 nor 4 go very much above 75' NAVD, the relative percentage of wetland vegetation was recalculated without the data from the highest quadrat in both Transects 1 and 3 in order to minimize the effect of topographic zonation on species composition. As expected, the proportion of wetland vegetation was approximately 9.5% higher in both marsh transects when this adjusted calculation was performed:

Transect 1 – 72.5

Transect 2 – 75.0

Transects 1 and 2 (averaged) – 73.9

With this adjustment to minimize variation that could be attributable to differences in ground elevation, the differences in percent wetland species between the marsh transects and the swamp transects ranged from a minimum of 9.4% between Transects 2 and 4, to a maximum of 14.1% difference between

Transects 1 and 3. In other words, the mean amount of groundcover vegetation in Transects 3 and 4 that is wetland species, i.e., obligate and facultative wet, was 9.4% and 14.1% greater than the mean percentage of wetland species in Transects 2 and 1, respectively. To be clear, these percentage differences are not differences in the amount of total groundcover but are the relative amount of wetland species. As stated previously, the swamp groundcover had large percentages of bare ground / litter while the marsh had almost none. Regardless, these differences are consistent with the hydrologic differences in the two wetlands and suggest that the wetland functions in the marsh have been significantly altered.

Habitat Utilization

Swamp Birds

Initial review of the data for the swamp birds did not indicate any apparent trends or patterns in the numbers of individuals or numbers of different species. Overall the number of birds observed in the swamp was considerably less than in the marsh. The mean number of birds counted in the swamp was 2.82 compared to 10.10 in the marsh. Betts et al (2005) stated that the point count method may not be as effective of a method for assessing bird numbers in forested systems and this may at least partly account for the large disparity seen in the marsh and swamp data. This “detectability” problem became apparent during the monitoring. In the swamp, actually seeing the birds for identification was difficult due to two related factors: 1) being unable to see birds within foliage

and behind tree trunks or limbs, and 2) birds were often small and too active for a clear visual identification. Frequently, bird calls were heard but locating the bird for visual identification was difficult or sometimes not possible. A few birds were identified by calls alone, however, a thorough knowledge of bird calls would mitigate these difficulties to some extent.

A graphical comparison of swamp bird abundance with water levels, and species diversity with water levels did not suggest any correlations. In an addition comparison, birds that were identified were divided into two groups: “wetland dependent” species or species that are frequently observed in wetlands and what are referred to here as “generalists” species. Placement in these two categories was based on the investigator’s knowledge and / or descriptions in the bird guide used for this study (Peterson, 2002). This somewhat subjective categorization resulted in the wetland group of 11 individuals in four species, and a generalist group of 49 individuals in 11 species. The same graphical comparisons with water levels were made with the birds divided into these two groups, but again with no apparent trends or correlations to water levels.

Marsh Birds

Of the 497 birds counted in the marsh, 484 individuals were identified to species. Of those 484 birds, 339 individuals in 18 species were categorized as wetland species and 145 individuals in 9 species were categorized as generalist species. Bird counts and identification in the marsh were considerably easier than in the swamp, for the reasons previously discussed. In this case, failure to

identify a bird was usually due to the bird being too far away and / or the observation was too brief. These were typically small passerine birds.

A similar graphical analysis was made of the marsh birds comparing overall abundance with water levels. There appears to be a relationship in that there are two periods of generally higher bird numbers that occurred during the two wetter periods in 2010 (Figure 31.). A very similar pattern is evident when the number of species is graphed with water levels. When the data are grouped by “wetland birds” and generalists, this general relationship is maintained.

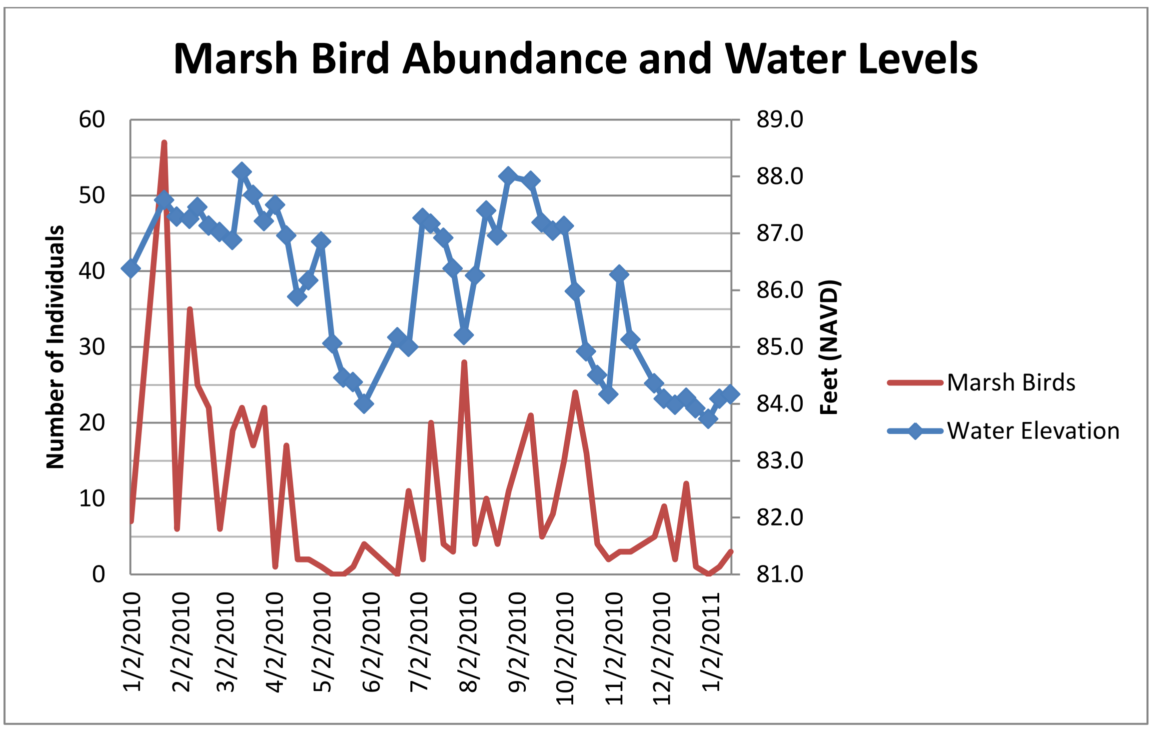

Figure 31. A comparison of bird abundance in the marsh with water levels.

A graphical comparison of abundance in swamp birds and marsh birds does not indicate any apparent correlations and the fluctuation patterns are very different. Fluctuations in marsh bird numbers are greater and are generally

clustered in the two groups previously discussed. Swamp bird numbers fluctuated less and, with the exception of a single monitoring event, never exceeded ten individuals counted at any one event. Figure 32. shows a comparison of bird abundance in the upstream swamp with the downstream marsh. The number of birds counted in the marsh exceeds the number counted in the swamp on all but nine events (81.7% of the monitoring events).

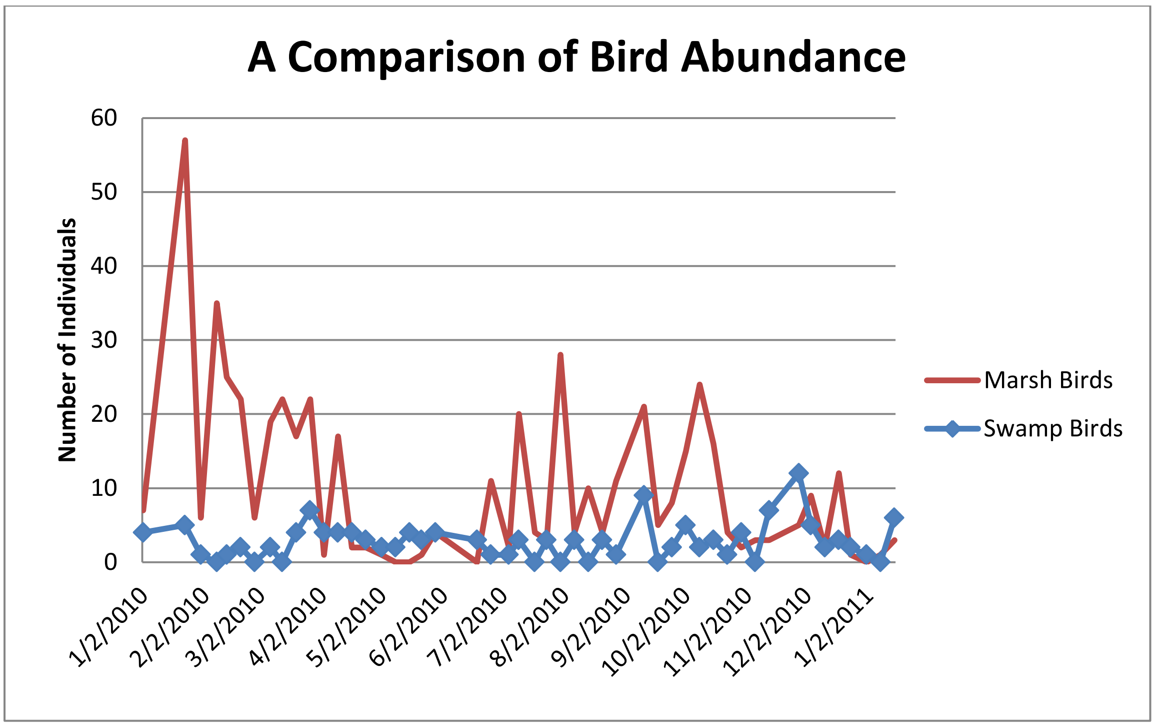

Figure 32. A comparison of bird abundances in the swamp and in the marsh.

The monitoring data indicate that the marsh and the swamp differ substantially in avian abundance and number of species. Considering only number of species, there were 28 different species identified in the marsh compared to 15 identified in the swamp. Nine (9) identified species were found in both the marsh and the swamp. The result to note is that 19 identified species

were found only in the marsh. These 19 species make up 55.9% of all species identified in both the swamp and the marsh. In addition, more than three times the number of individual birds was counted in the marsh than in the swamp. It is acknowledged that considerably more birds observed or heard in the swamp were not identified, i.e. 78 individuals versus 13 in the marsh, due to the detectability and identification issues discussed previously. Therefore, the reported greater species richness in the marsh due to the 19 additional species may not be completely accurate. However, considering the much larger number of birds observed in the marsh, it is reasonable to conclude that overall the marsh is used by more birds than the swamp and it is appears the marsh may also have greater species richness.

When the number migratory species is compared with non-migratory species, four species identified in the marsh were migratory compared to 11 migratory species identified in the marsh. Also, only one of the migratory species identified in the swamp, yellow-bellied sapsucker (*Sphyrapicus varius*), was not also identified in the marsh.

In addition, the marsh is also used by more species listed for special protection by the state wildlife agency. Six identified at the study site are listed as “imperiled species” by the Florida Fish and Wildlife Conservation Commission (FFWCC). Specifically, four species are listed as “species of special concern”, which is the lowest protection category, and two species are listed as “threatened”, which is an intermediate level category of protection (Table 5). Of these six species, five species were observed only in the marsh. Only white ibis (*Eudocimus albus*) was observed in both the marsh and the swamp.

Table 5. State Listed Avian Species Identified at the Colt Creek study site.

Species	FWC
Egretta caerulea	SSC
E. tricolor	SSC
E. thula	SSC
Eudocimus albus	SSC
Falco sparverius	T
Grus canadensis pratensis	T

Species of Special Concern (SSC) and Threatened (T). Florida Fish and Wildlife Conservation Commission (FWC)

While creating and maintaining altered, unnatural habitats is not being advocated here, the marsh, with the hydrology restored, obviously provides greater wetland habitat diversity than was previously available before the swamp was cleared. It would appear that the additional habitat diversity provided by the marsh, results in increased avian utilization, both in overall abundance and species richness, and utilization by listed and migratory species.

Finally, habitat utilization by birds is one of the functions of wetlands and was intended in this study to be an indicator of functional differences between the two wetlands. It is apparent from the monitoring data that the abundance and diversity of birds in the two systems is very different, and any statistical comparison of the two seemed pointless. However, analyses were done to see if there were correlations between bird utilization in each wetland and some of the other variables monitored. Regression analyses were done comparing various combinations of the bird data with water levels and daily high temperatures. Those analyses included total abundance of marsh birds compared with water

levels only, and also water levels and daily high temperatures. The same was done for marsh wetland species, swamp birds only, swamp wetland birds, all marsh and wetland birds combined, and marsh species diversity. All correlations were significant (at $p = 0.05$ level, or less) except for analyses of only swamp birds. However, r and r^2 values were consistently low. The highest value, $r = 0.595$ / $r^2 = 0.354$, was for marsh species diversity correlated with water levels and daily high temperatures. Also, the correlation of abundance of all birds (swamp and marsh birds) with water levels and daily high temperatures was $r = 0.500$ / $r^2 = 0.250$.

Chapter Six: Conclusions

The purpose of this study was to determine if there were significant functional differences between two different wetlands. One wetland appeared to be structurally and hydrologically intact and therefore, assumed to be completely functional. The information obtained for this study did not change that initial perception. The adjacent downstream wetland has been significantly altered both structurally and hydrologically and therefore, reasonably assumed to have different functions or perhaps having the same functions operating at different levels or degrees. Starting with that premise, the intent was to quantify those differences to some degree through assessments of hydrology and vegetation, and ultimately to determine if those differences included differential wildlife utilization of the wetland habitats, using birds as a representative measure. Stated as the research question, are there significant functional differences between a relatively unaltered forested wetland strand and one which has been drained and cleared, and is wildlife utilization a reasonable indicator?

The sub-questions and opinions of the researcher based on the research results are as follows:

1) What are the differences in the hydrologic regime between the unaltered and altered wetlands, i.e., hydroperiod, depth of inundation / seasonal high water level and extent of inundation (floodplain)?

It is clearly apparent that there were differences in hydrology in the two systems during 2010. Most notably were the differences in hydroperiod. It appears that without the bypass ditch in place, or blocked / controlled as is the proposed final condition, during this year and any year with approximately mean annual rainfall, the time of inundation in the downstream marsh would be approximately seven weeks longer than it was this year with the bypass ditch in place. In addition to the seven weeks, the upstream swamp would have flowed through the marsh for 18 weeks more than it did in 2010. In other words, there were 18 weeks when the marsh had standing water from rainfall directly on the marsh, runoff from the adjacent uplands, and / or water remaining that had flowed into the marsh during previous weeks but had not drained downstream, percolated, or evaporated. This additional flow may not have had an effect on increasing the hydroperiod but flowing water likely has a different effect on the habitat such as water quality changes, e.g., water temperature, dissolved oxygen, detritus and sediment transport, etc., and may have increased water levels and therefore the extent of floodplain inundation.

2) What are the differences in vegetative structure, i.e., species composition, relative composition of wetland, upland, and transitional species?

The vegetative composition of the swamp and the marsh are different in several ways, including species composition, species diversity, density (percent cover), and relative cover of wetland species and upland species. Groundcover in the

swamp, although less densely distributed than in the marsh, was more species diverse. The mean number of different species identified in the swamp was 25.5 species and in the marsh it was 16 species. Mean bare ground and leaf litter, i.e., unvegetated, in the swamp was 60.6% and in the marsh it was 1.9%. The percent cover of wetland species in the swamp relative to all species identified in the swamp was approximately 11.8% higher than the relative percent cover of wetland species in the marsh.

3) How does wildlife utilization differ? Will there be a statistically significant correlation between wildlife utilization, i.e., avian abundance and species composition or richness, and differences in vegetation between the unaltered and altered wetlands? Will there be a statistically significant correlation between wildlife utilization and differences in hydrology between the unaltered and altered wetlands?

This was the most difficult question and the one for which the data was least conclusive. It seems clear from the bird abundance data that the swamp is used less by birds than the marsh. In addition, species diversity was shown statistically to be significantly greater in the marsh than in the swamp. Correlations of abundance and diversity to water levels and ambient high temperatures were shown to be statistically significant for marsh birds but with somewhat low regression values. Similar correlations with the swamp birds were not statistically significant. The correlation between habitat use and wetland

water levels does not seem to be uniformly applicable at this site. There may be a type of habitat selection hierarchy involved here in which a primary criterion must be met before a secondary criterion can be met in order for a habitat to be selected. For example, when water levels were high in the marsh, they were also high in the swamp, but the vegetation, i.e., canopy and / or composition of the groundcover, may have precluded the use of the swamp or made the marsh a more favorable selection. In other words, the first selection criterion is vegetative composition and the second criterion is water levels.

Typically, the goal of restoration is to re-establish as close as possible the previous natural condition of a site. In the case of Colt Creek, although restoring the tree canopy would be appropriate to return the site to its natural condition, the current habitat diversity provided by the marsh (with the hydrology of Colt Creek restored), seems to provide for greater avian species richness, including some listed species. It is likely that with the restored hydrology, the canopy species would slowly re-establish in the marsh as the trees recruit from upstream and nearby wetlands. In the meantime, the marsh could provide habitat functions that are less common in the Green Swamp.

The thesis statement is, “Differences in hydrology and vegetation between an altered wetland and a relatively unaltered wetland result in differences in wetland functions, such as wildlife utilization.” Stated another way, habitat functions provided by a forested wetland strand are significantly different from habitat functions provided by a wetland which has been altered by drainage and clearing. Those functional differences appear to be related to differences in both

hydrology and vegetation. The data indicate there are measurable differences in hydrology and vegetation between these two wetlands, and suggest or imply differences in functions. There are also differences in avian utilization of the two wetlands but the data are insufficient and / or the interactions between birds, water levels, and vegetation so complex that the precise relationships and processes involved in the habitat selection are not clear.

Future Study

There are several areas where future research on Colt Creek could help clarify or refine the work done for this study. However, the two areas in particular where research may be most needed is the habitat utilization aspect begun with this study, and an assessment and analysis of changes in the wetlands as a result of the hydrologic restoration which is in progress.

Further research on habitat selection and habitat use would benefit from a more detailed focus on this complex process. That research would likely require more extensive and intensive monitoring of birds and / or other wildlife groups. Specifically, a more detailed comparison of bird species and abundance in the swamp and the marsh is needed, including minimizing the number of unidentified birds so as to accurately describe differences in habitat use in the two areas. This would be important information to guide planned vegetation restoration at Colt Creek and elsewhere.

In addition, the ongoing restoration of Colt Creek would provide an opportunity for a multi-year study of the restored hydrology along with the

vegetative response and / or changes in habitat use. This may be a benefit not only to FDEP and the Colt Creek State Park staff in their management and other restoration goals, but hopefully would be generally applicable to other stream and wetland restoration efforts, particularly in similar systems in the southeast U.S.

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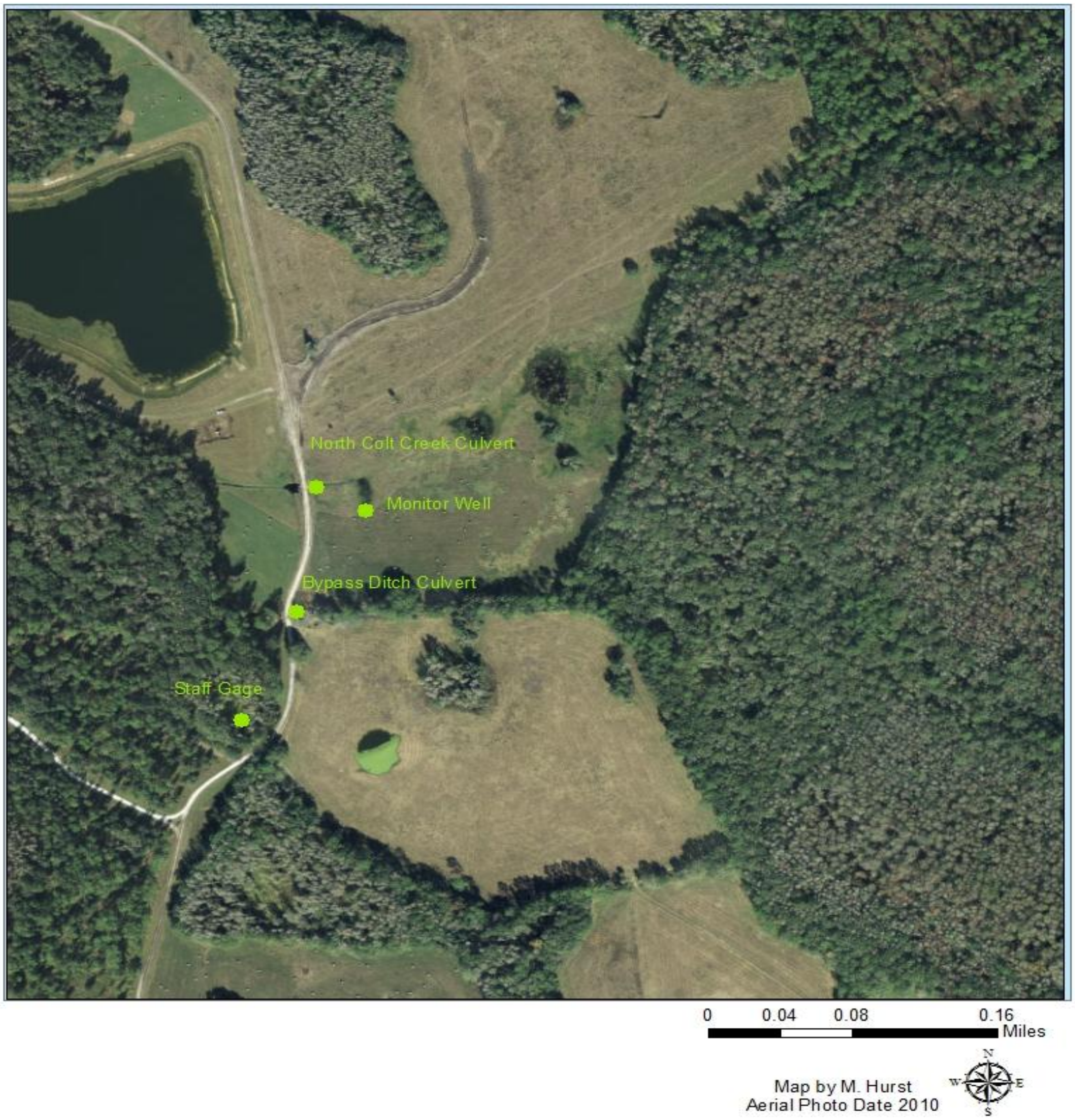
Appendix A: Water Level Monitoring Locations


North Colt Creek Culvert
Monitor Well
Bypass Ditch Culvert
Staff Gage
0
0.04
0.08
0.16
Miles
Map by M. Hurst
Aerial Photo Date 2010

Appendix B: Vegetation Monitoring Form

Veg Transect No. 1				
Date:				
Event #				
Transect / Quadrant	**Species**	**Relative %**	**%**	**Notes**
T1 / Q1	P. notatum			
	Hydrocotyle sp.			
	A. philoxeroides			
	(mock bishops weed)			
	C. longii			
	unknown			
T1 / Q2	Hydrochloa sp.			
	Hydrocotyle sp.			
	A. philoxeroides			
	C. longii			
	P. repens			
	(bermuda)			
T1 / Q3	Hydrochloa sp.			
	A. philoxeroides			
	Hydrocotyle sp.			
	(bermuda)			
T1 / Q4	Hydrochloa sp.			
	A. philoxeroides			
T1 / Q5	Hydrochloa sp.			
	A. philoxeroides			
	P. repens			
	Hydrocotyle sp.			
	(bermuda)			
	Polygonum			
	P. notiflora			
T1 / Q 6	Hydrochloa sp.			
	P. notiflora			
	A. philoxeroides			
	C. longii			
T1 / Q7	P. notatum			
	(bermuda)			
	Urena sp.			
	Unknown			

Appendix C: Vegetation Species Lists

All Identified Species (alphabetical) with Indicator Category

Acer rubrum - facw	*Ludwigia sp. - obl*
Alternanthera philoxeroides - obl	*Panicum rigidulum - facw*
Ampelopsis arborea - fac	*Panicum sp. (Dichanthelium) - facw/obl*
Aster subulatus - obl	*Paspalum notatum - u*
Axonopus sp. - fac	*Paspalum sp.*
Baccharis sp. - fac	*Persea sp. - obl*
Blechnum serrulatum - facw	*Phyla nodiflora - fac*
Boehmeria cylindrica - obl	*Polygonum sp. - obl*
Carex gigantea - obl	*Ptilimnium capillaceum - facw*
Centella asiatica (erecta) - facw	*Quercus laurifolia - facw*
Commelina diffusa - facw	*Rhynchospora miliacea - obl*
Cynodon dactylon - u	*Saururus cernuus - obl*
Digitaria sp. - fac	*Smilax auriculata - facu*
Diodia virginiana. - facw	*Smilax sp. - u*
Hydrochloa caroliniensis - obl	*Smilax walteri - obl*
Hydrocotyle sp. - facw	*Toxicodendron radicans - fac*
Iris hexagona - obl	*Ulmus americana - facw*
Itea virginica - obl	*Urena lobata - u*
Liquidambar styraciflua - facw	*Vitis sp. - fac*
Ludwigia repens - obl	

Appendix C: (Continued)

Vegetation Species by Monitoring Transect

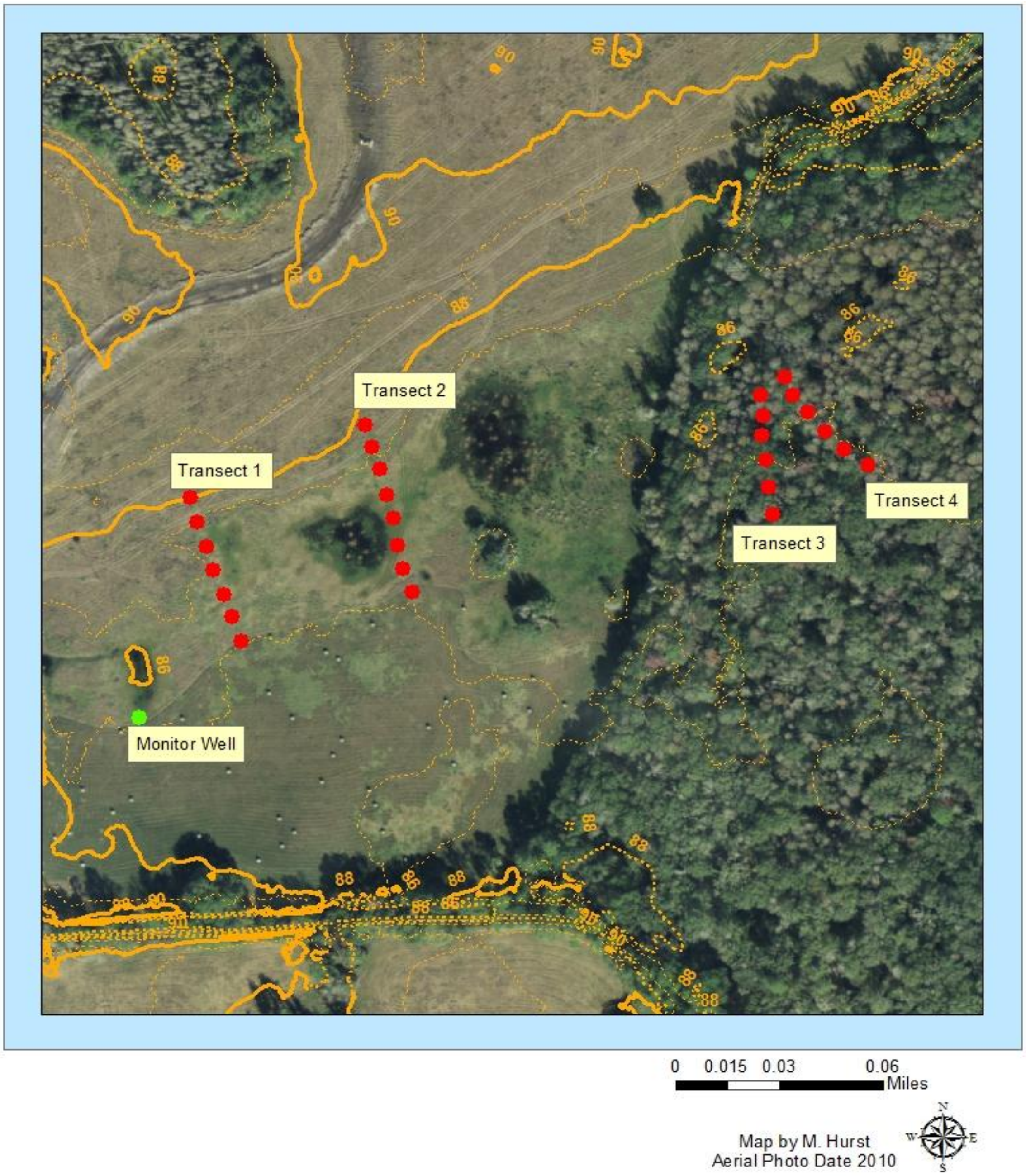
Transect 1	Transect 2
Alternanthera philoxeroides - obl	*Alternanthera philoxeroides - obl*
Aster subulatus - obl	*Aster subulatus - obl*
Carex longii - facw	*Carex longii - facw*
Commelina diffusa - facw	*Centella asiatica (erecta) - facw*
Cynodon dactylon - u	*Commelina diffusa - facw*
Digitaria sp. ? - fac	*Cynodon dactylon - u*
Hydrochloa caroliniensis - obl	*Digitaria sp. - fac*
Hydrocotyle sp. - facw	*Hydrochloa caroliniensis - obl*
Ludwigia sp. - obl	*Hydrocotyle sp. - facw*
Panicum rigidulum - facw	*Ludwigia sp. - obl*
Paspalum notatum - u	*Panicum rigidulum - facw*
Paspalum sp.	*Paspalum notatum - u*
Phyla nodiflora - fac	*Paspalum sp.*
Polygonum sp. - obl	*Phyla nodiflora - fac*
Ptilimnium capillaceum - facw	*Polygonum sp. - obl*
Urena lobata - u	*Ptilimnium capillaceum - facw*
	Urena lobata - u

Appendix C: (Continued)

Vegetation Species by Monitoring Transect

Transect 3	Transect 4
Acer rubrum - facw	Acer rubrum - facw
Alternanthera philoxeroides - obl	Alternanthera philoxeroides - obl
Ampelopsis arborea - fac	Ampelopsis arborea - fac
Axonopus sp. - fac	Axonopus sp. - fac
Baccharis sp. - fac	Blechnum serrulatum - facw
Blechnum serrulatum - facw	Boehmeria cylindrica - obl
Boehmeria cylindrica - obl	Carex gigantea - obl
Carex gigantea - obl	Centella asiatica (erecta) - facw
Centella asiatica (erecta) - facw	Commelina diffusa - facw
Commelina diffusa - facw	Diodia sp. - facw
Diodia virginiana. - facw	Hydrocotyle sp. - facw
Hydrocotyle sp. - facw	Itea virginica - obl
Iris hexagona - obl	Ludwigia repens - obl
Itea virginica - obl	Panicum sp. (Dichanthelium) - fac/facw/obl
Liquidambar styraciflua - facw	Polygonum sp. - obl
Panicum sp. (Dichanthelium) - facw/obl	Quercus laurifolia - facw
Persea sp. - obl	Rhynchospora miliacea - obl
Polygonum sp. - obl	Saururus cernuus - obl
Ptilimnium capillaceum - facw	Smilax auriculata - facu
Quercus laurifolia - facw	Smilax sp. - u (?)
Rhynchospora miliacea - obl	Toxicodendron radicans - fac
Saururus cernuus - obl	Ulmus americana - facw
Smilax auriculata - facu	Urena lobata - u
Smilax walteri - obl	
Toxicodendron radicans - fac	
Ulmus americana - facw	
Urena lobata - u	
Vitis sp. - fac	

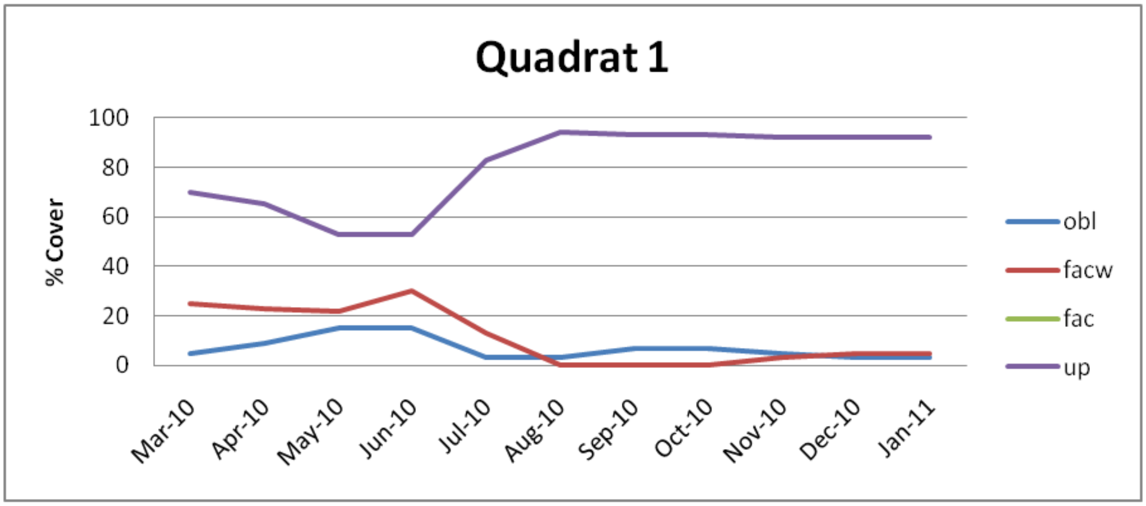
Appendix D: Vegetation Monitoring Locations

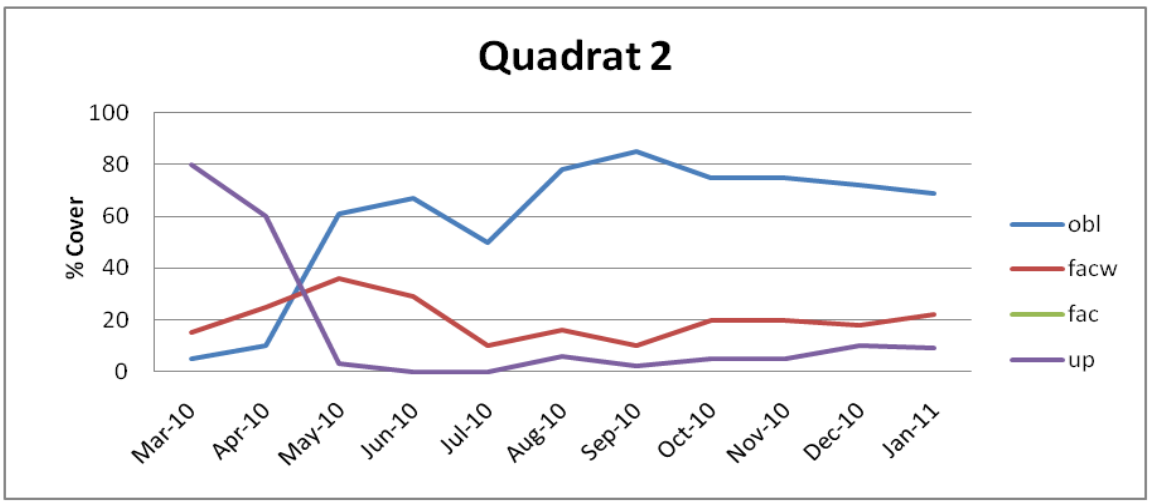


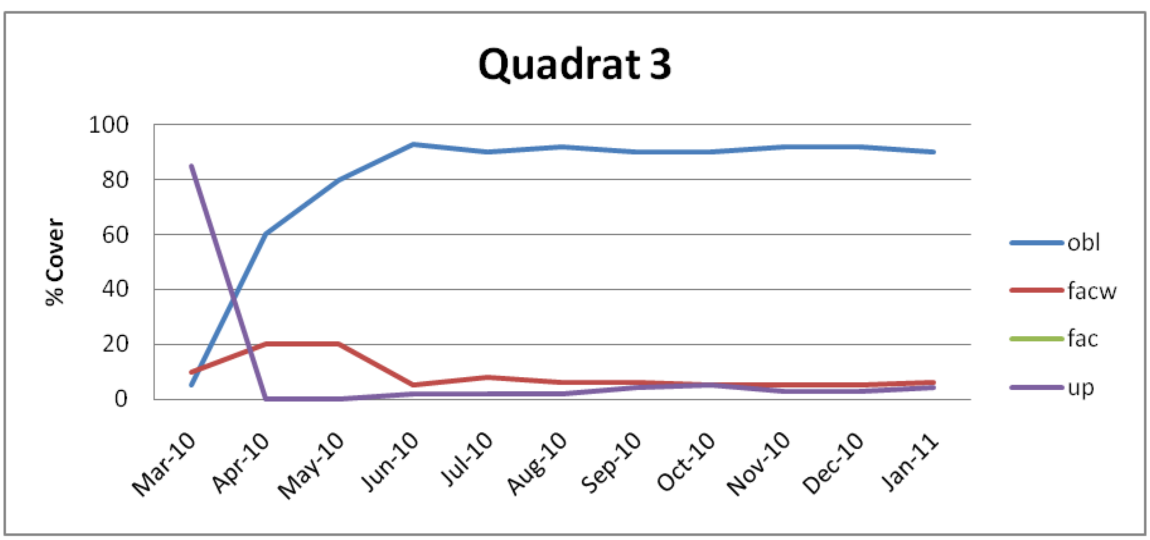
Transect 1
Transect 2
Transect 3
Transect 4
Monitor Well
0 0.015 0.03 0.06
Miles
Map by M. Hurst
Aerial Photo Date 2010

Appendix E: Vegetation Cover Graphs

Appendix E: Vegetation Cover Graphs
Transect 1







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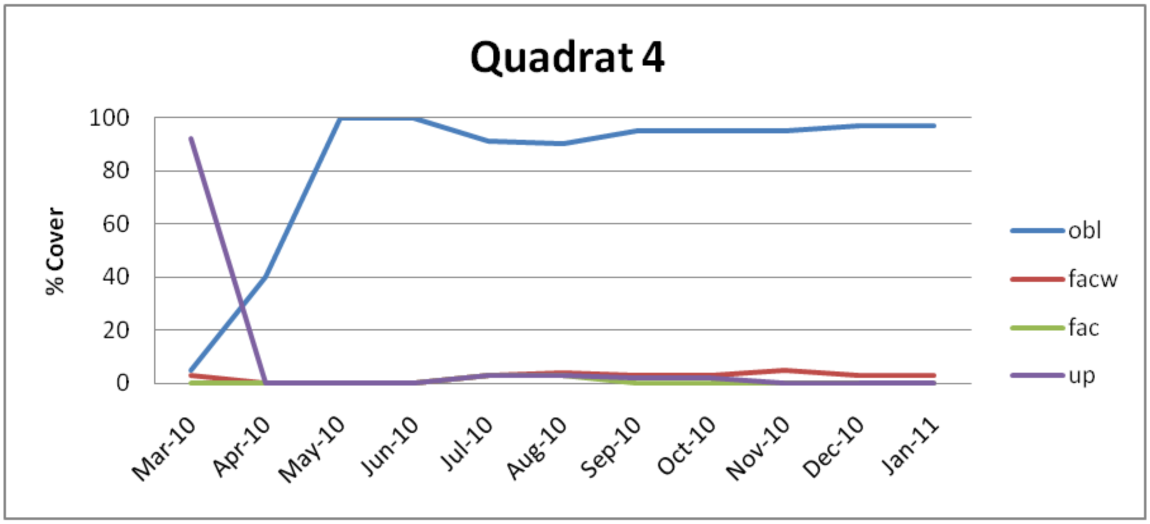

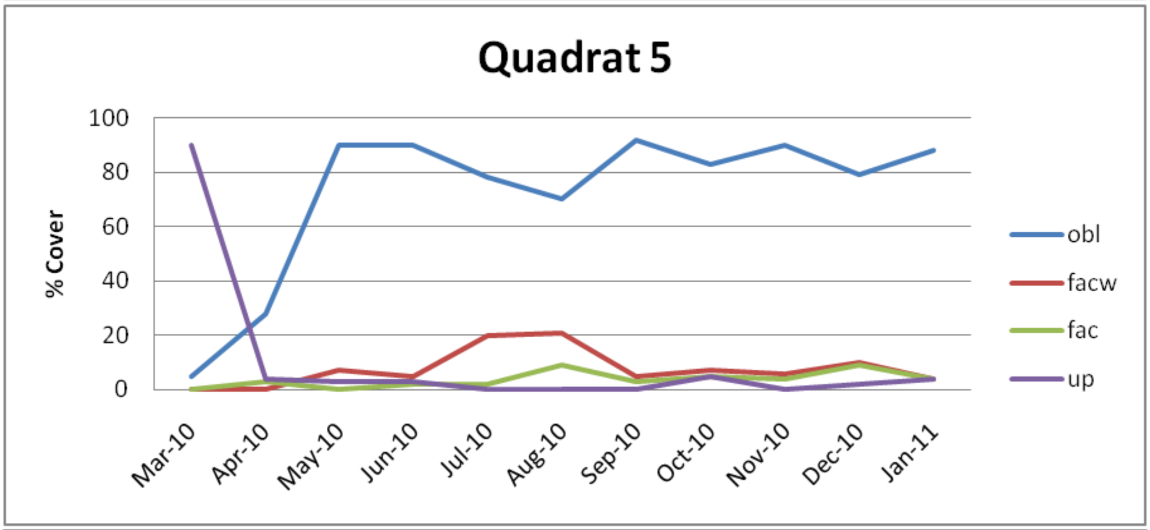

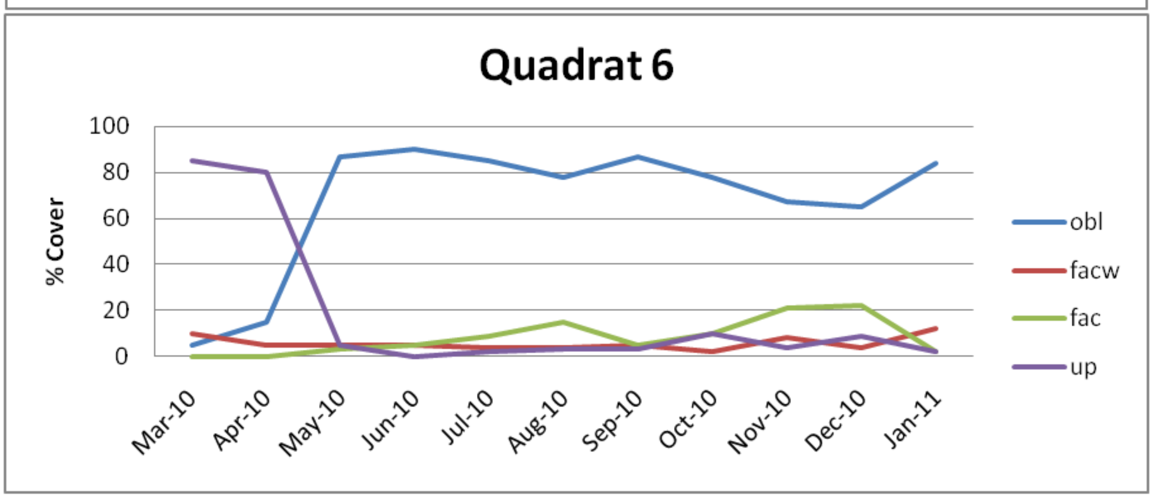

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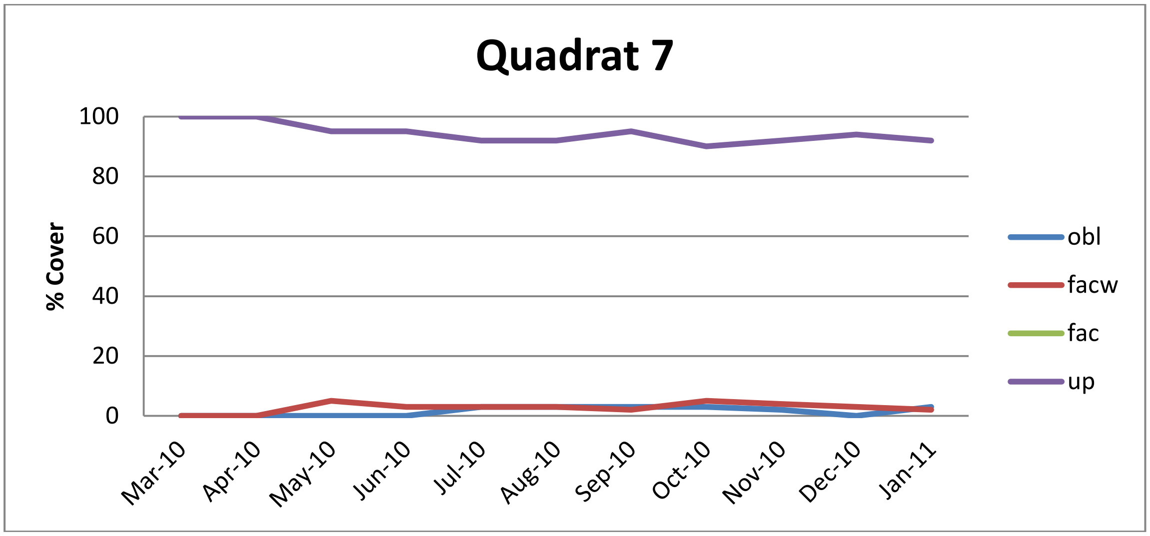

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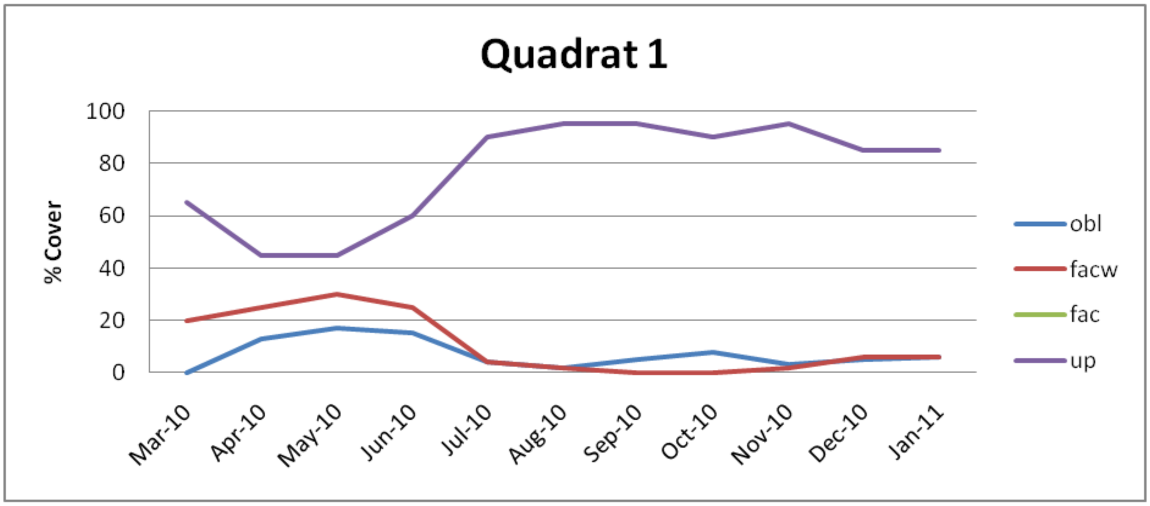

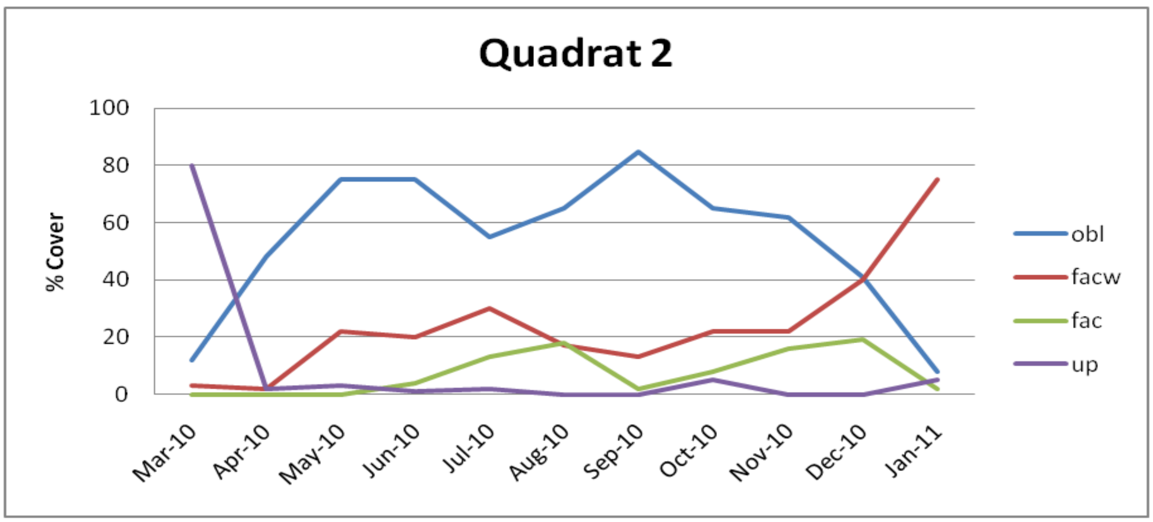

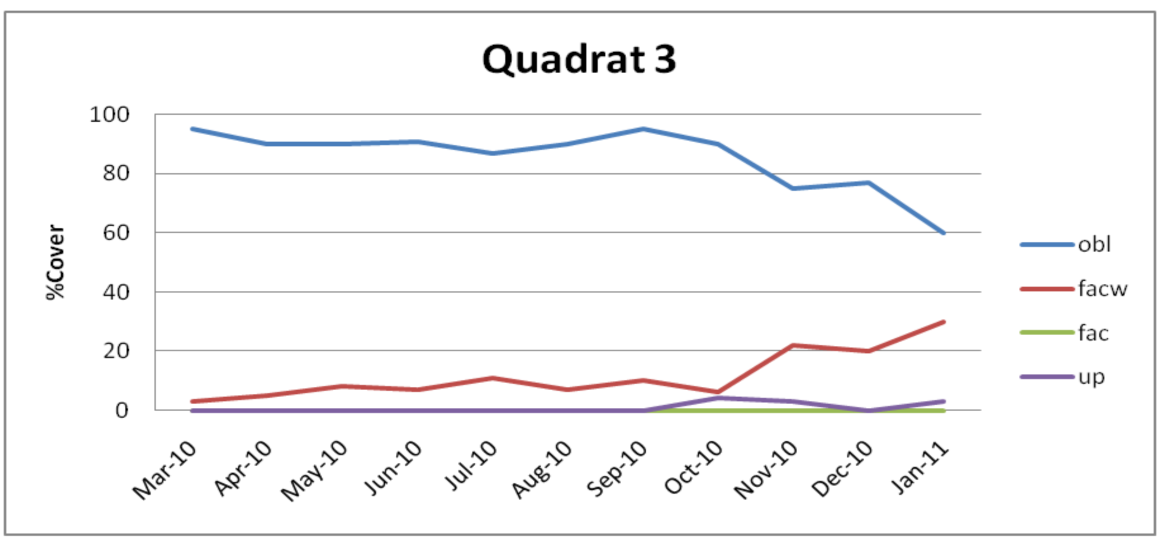

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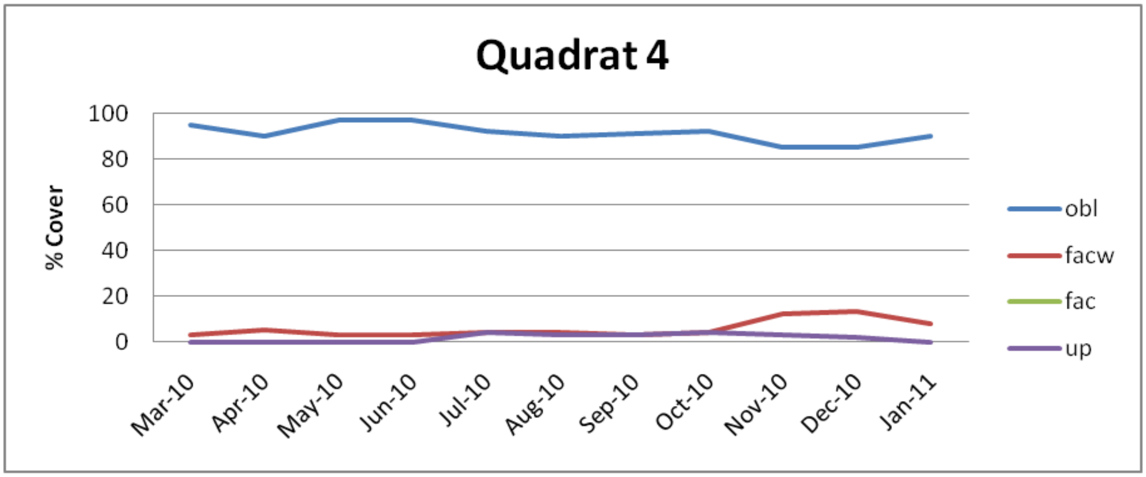

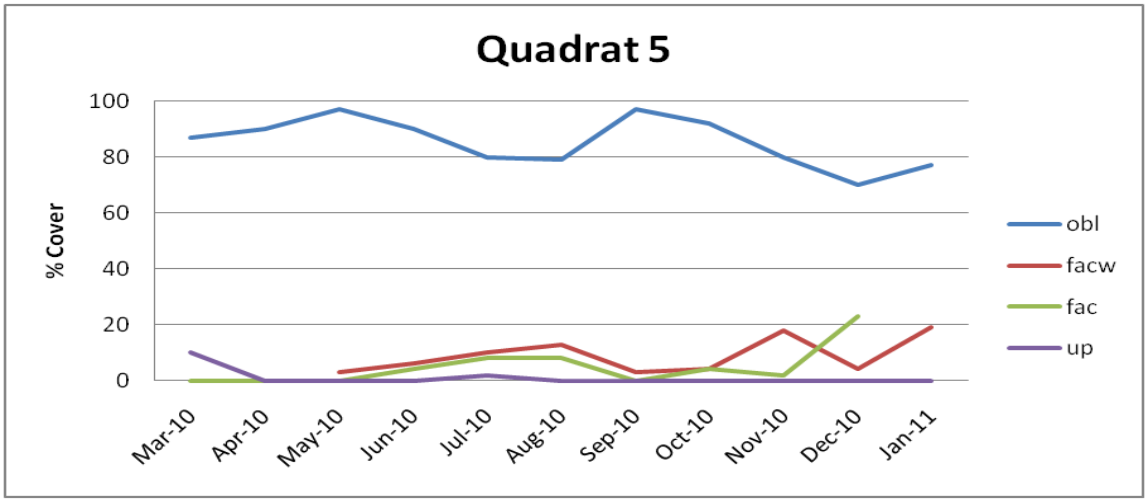

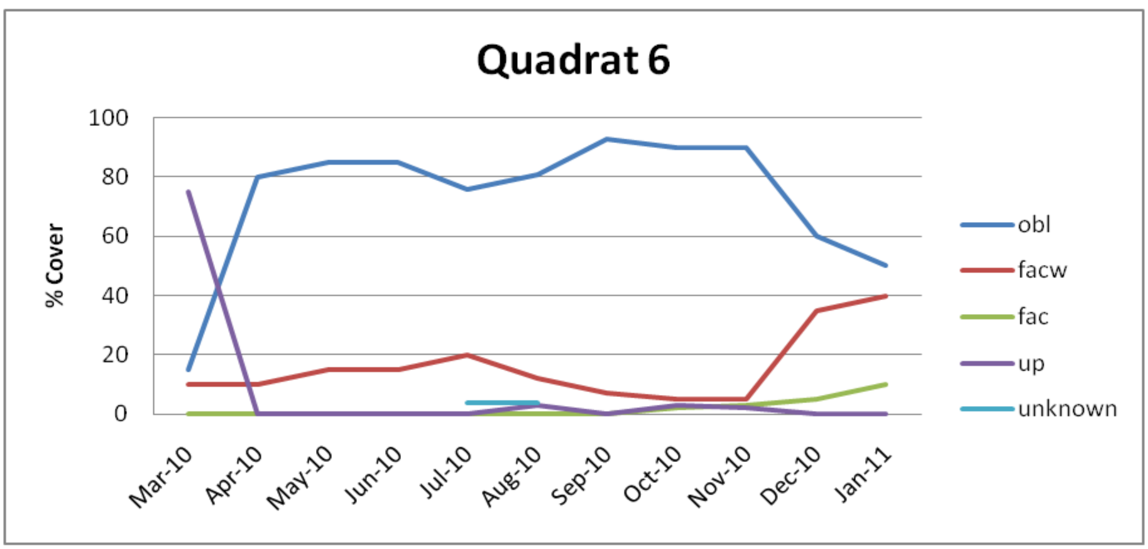

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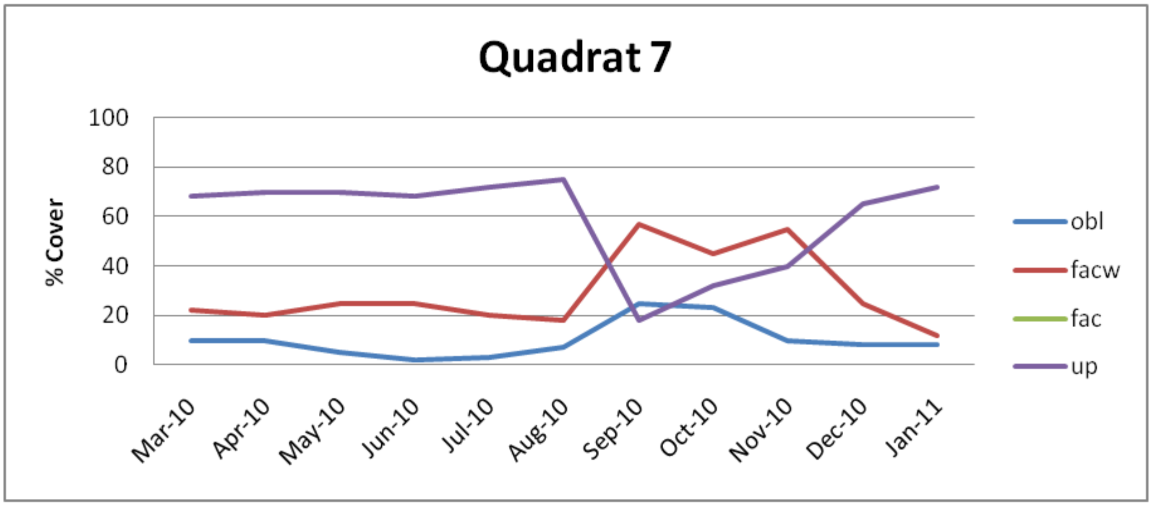
Transect 2



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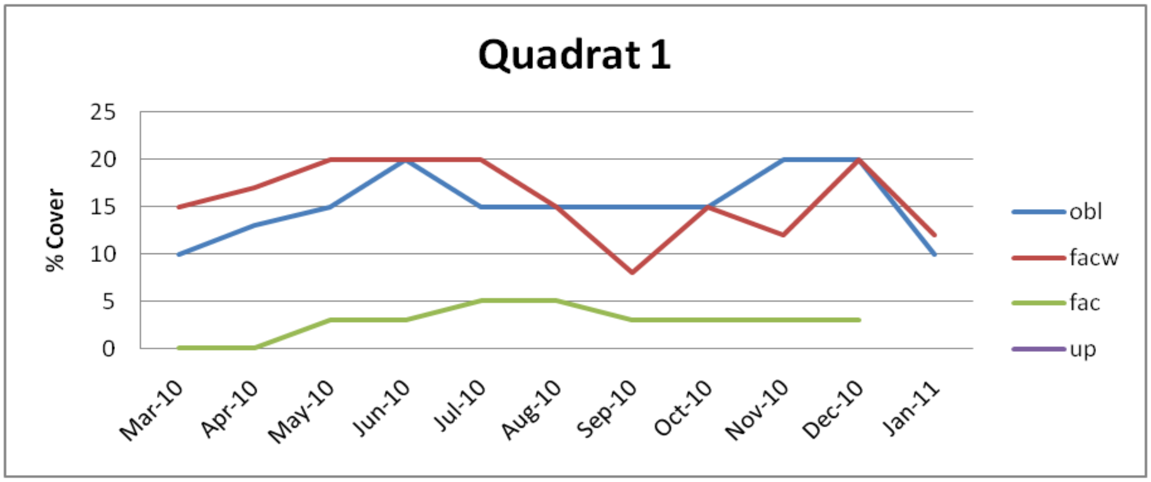

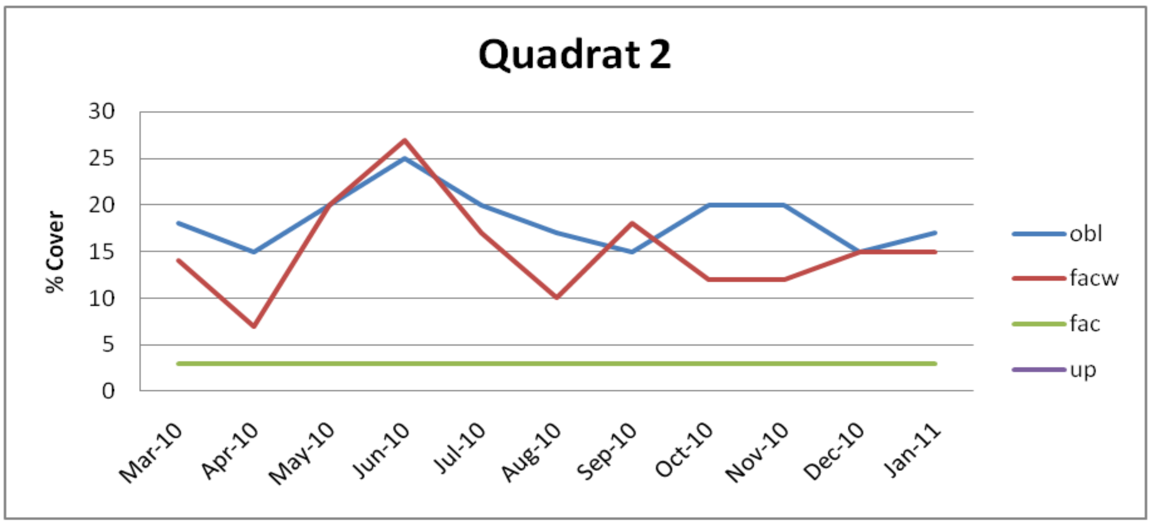

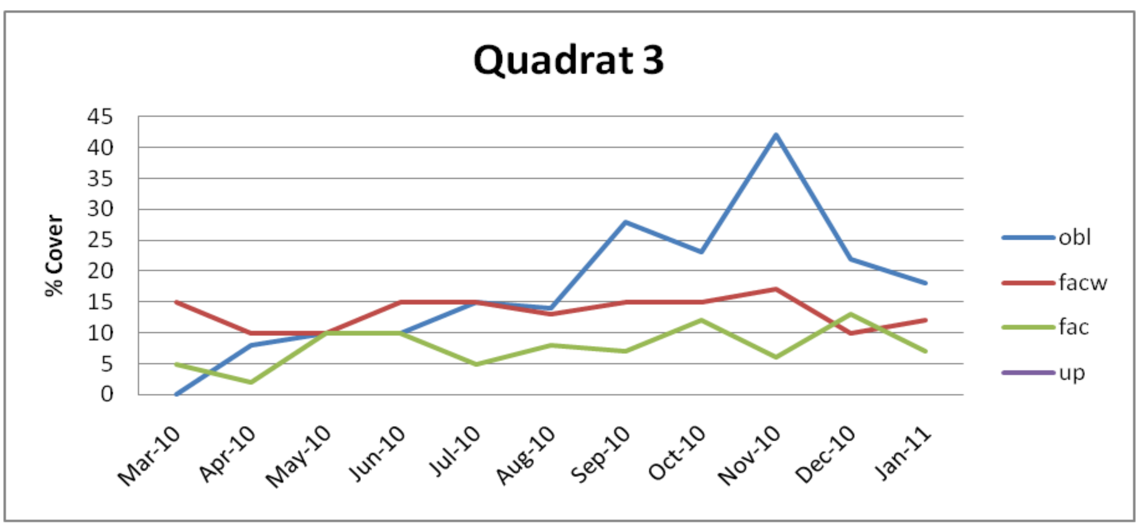

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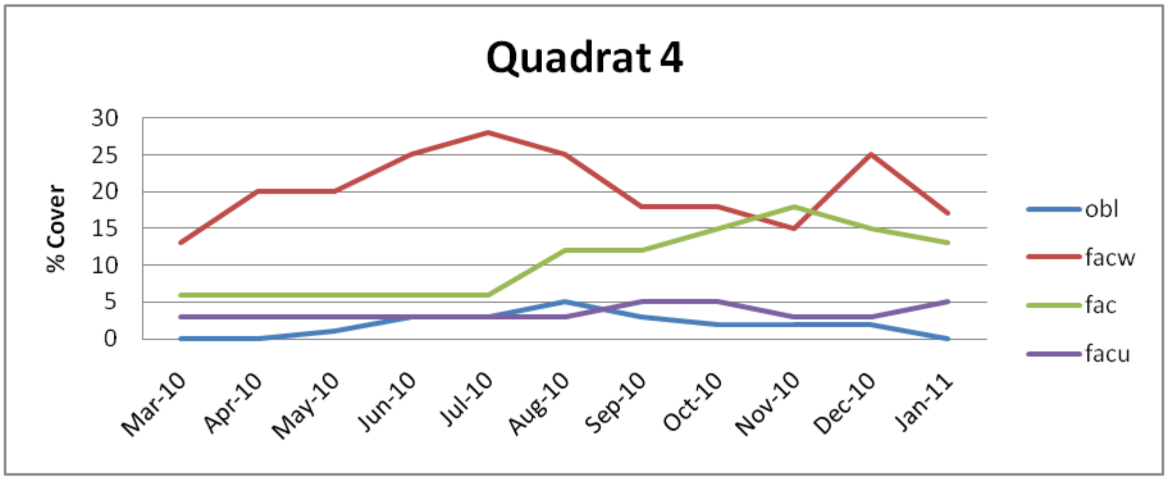
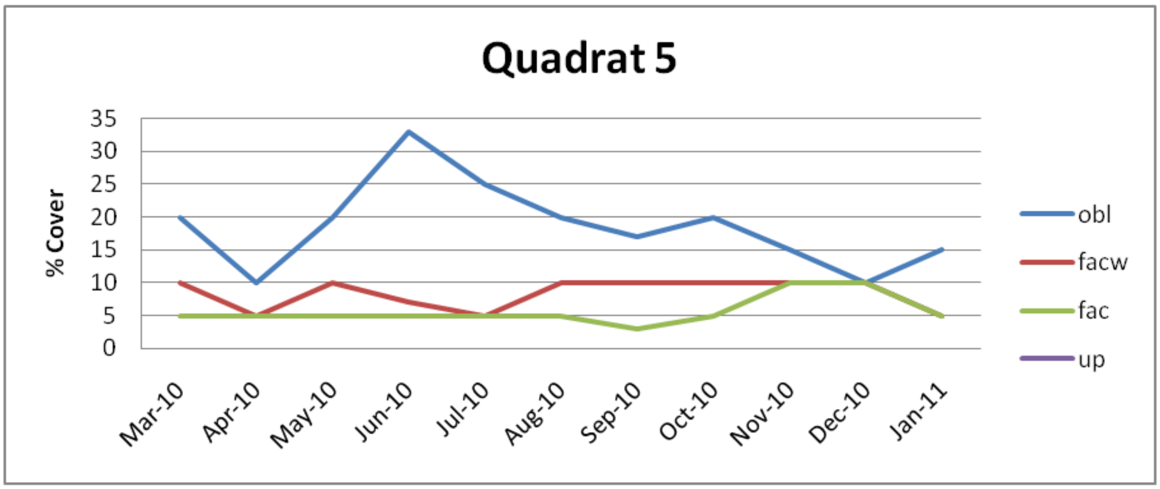
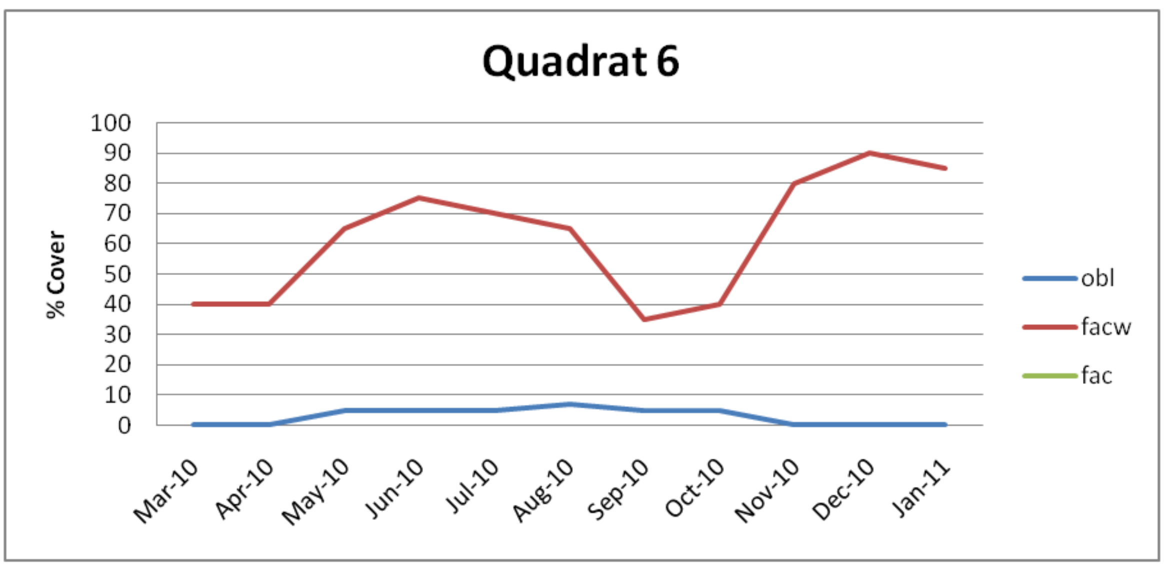
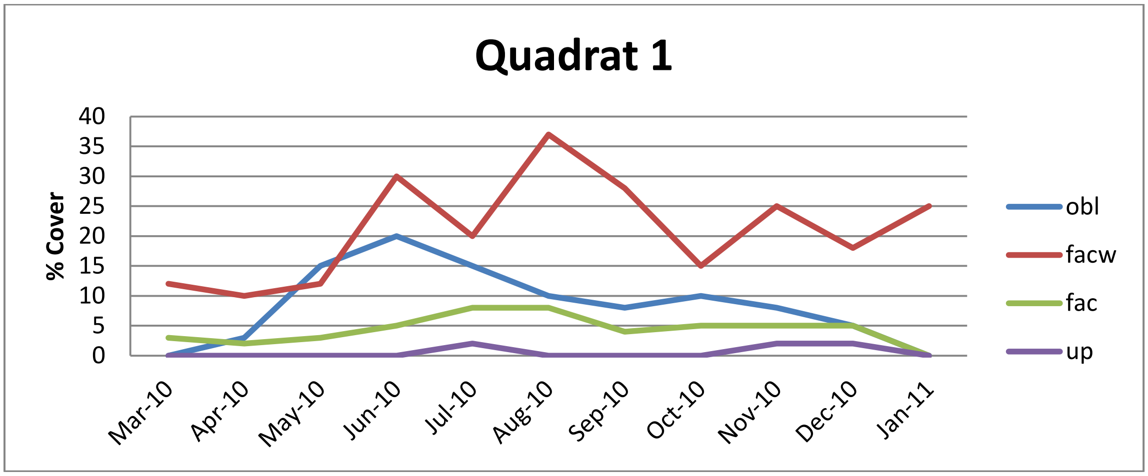
Transect 3

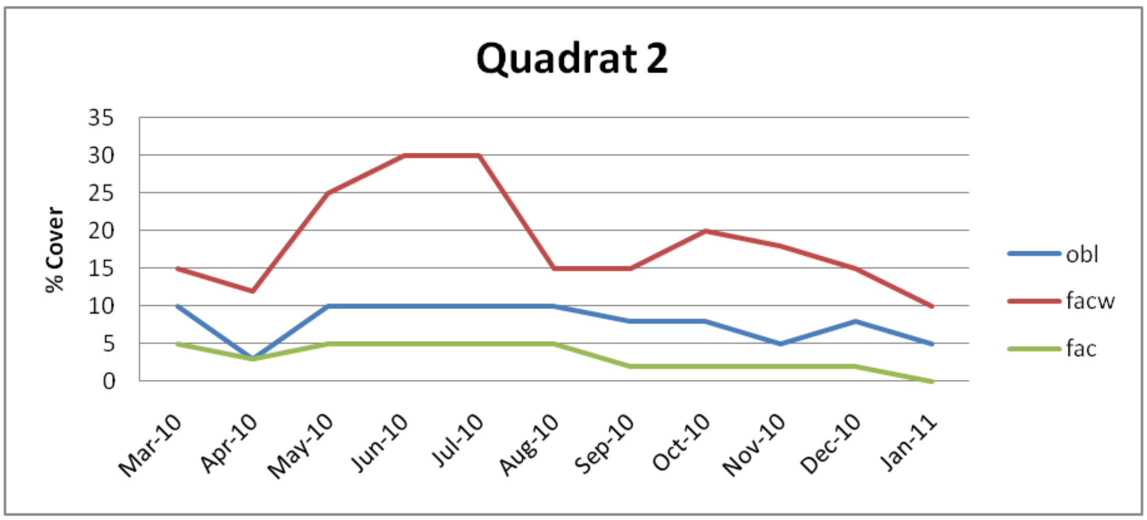


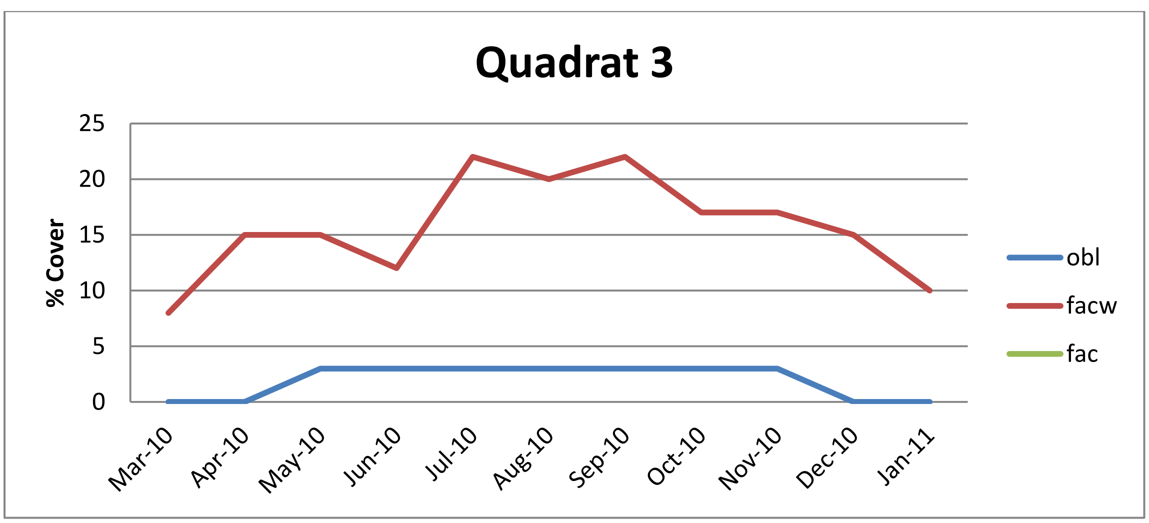




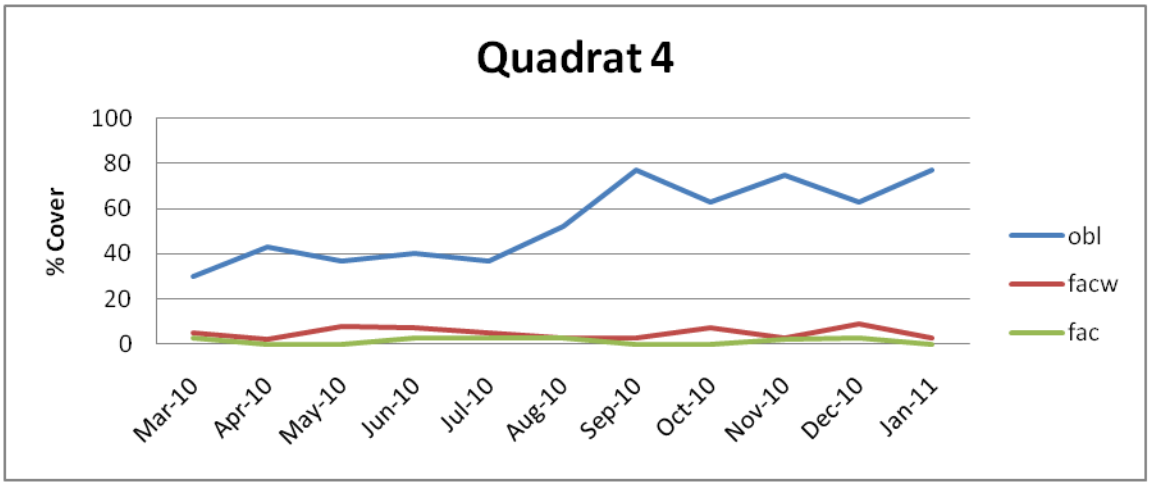
Appendix E: (continued)
Transect 4

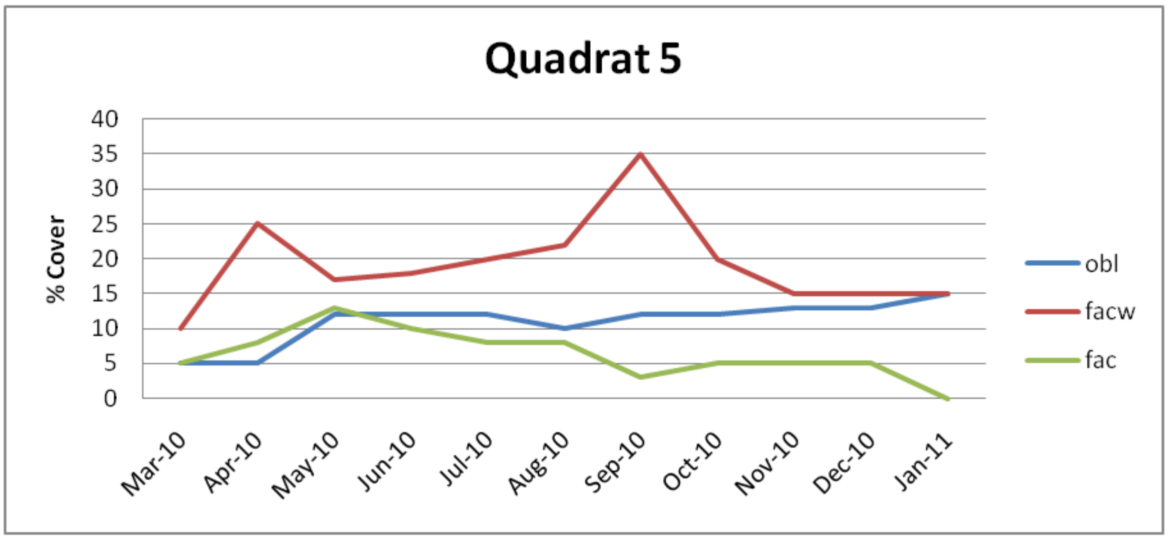


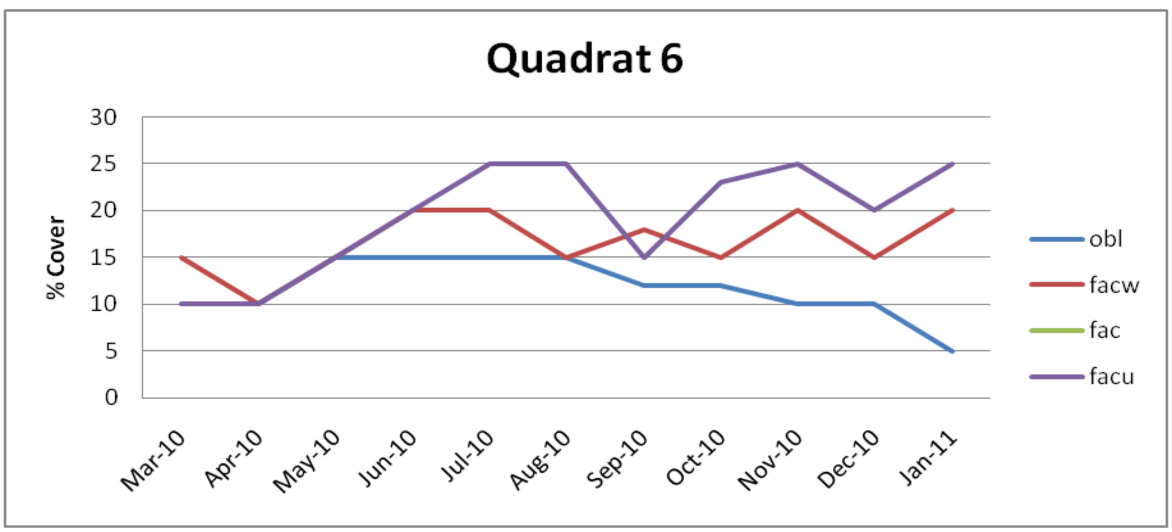




Appendix E: (continued)
Transect 4







Appendix F: Avian Species Lists

Appendix F: Avian Species Lists

All Identified Species (alphabetic)

Actitus macularia

Agelaius phoeniceus

Anas platyrhynchos
Ardea alba
Ardea herodius

Bubulcus ibis

Buteo jamaicensis

Buteo lineatus

Butorides virescens

Cathartes aura

Ceryle alcyon

Charadrius vociferous

Circus cyaneus

Cistothorus palustris

Corvus brachyrhyncos

Dendrocygna autumnalis

Dendroica spp.

Dryocopus pileatus

Egretta caerulea

E. thula

E. tricolor

Eudocimus albus

Falco sparverius

Gallinago gallinago

Grus canadensis

Melanerpes carolinus

Picoides pubescens

P. villosus

Plegadis falcinellus

Sayornis phoebe

Sphyrapicus varius

Sturnella magna

Tachycineta bicolor

Tringa melanoleuca

Turdus migratorius

Appendix F: Avian Species Lists
Species by Area

Marsh	Swamp
Actitus macularia	*Ardea herodius*
Anas platyrhynchos	*Bubulcus ibis*
Ardea herodius	*Buteo jamaicensis*
Ardea alba	*Buteo lineatus*
Bubulcus ibis	*Cistothorus palustris*
Butorides virescens	*Ceryle alcyon*
Cathartes aura	*Corvus brachyrhyncos*
Ceryle alcyon	*Dendroica spp.*
Charadrius vociferous	*Dryocopus pileatus*
Circus cyaneus	*Eudocimus albus*
Cistothorus palustris	*Melanerpes carolinus*
Corvus brachyrhyncos	*Picoides pubescens*
Dendrocygna autumnalis	*Picoides villosus*
Dendroica spp.	*Sayornis phoebe*
Egretta caerulea	*Sphyrapicus varius*
E. thula	
E. tricolor	
Eudocimus albus	
Falco sparverius	
Gallinago gallinago	
Grus canadensis	
Picoides pubescens	
Plegadis falcinellus	
Sayornis phoebe	
Sturnella magna	
Tachycineta bicolor	
Tringa melanoleuca	
Turdus migratorius	
Highlighted species are species found in both marsh and swamp.	

Appendix G: Avian Monitoring Points

Appendix G: Avian Monitoring Points

Appendix H: Site Photographs

Appendix H: Site Photograph

1. Looking upstream at the unaltered flow way of Colt Creek. The natural flow way joins the bypass ditch at the bottom of the photo. When flowing, the deepest, main channel flows from the upper left in this photo (under the fallen tree) and into the bypass ditch.

2. Looking downstream along the Colt Creek bypass ditch just downstream of the confluence with the unaltered creek (Photo 1.). The ditch is approximately 15 feet wide by 16 inches deep at this location.

Appendix H: (continued)

3. Seventy-two inch culvert in the bypass ditch where water levels were measured.

4. Vegetation monitoring transect 3.

5. **Appendix H: (continued)**

5. Vegetation monitoring transect 4


6. Looking east across the Colt Creek marsh

Appendix H: (continued)

7. Vegetation monitoring transect 1.

8. Vegetation monitoring transect

Appendix H: (continued)

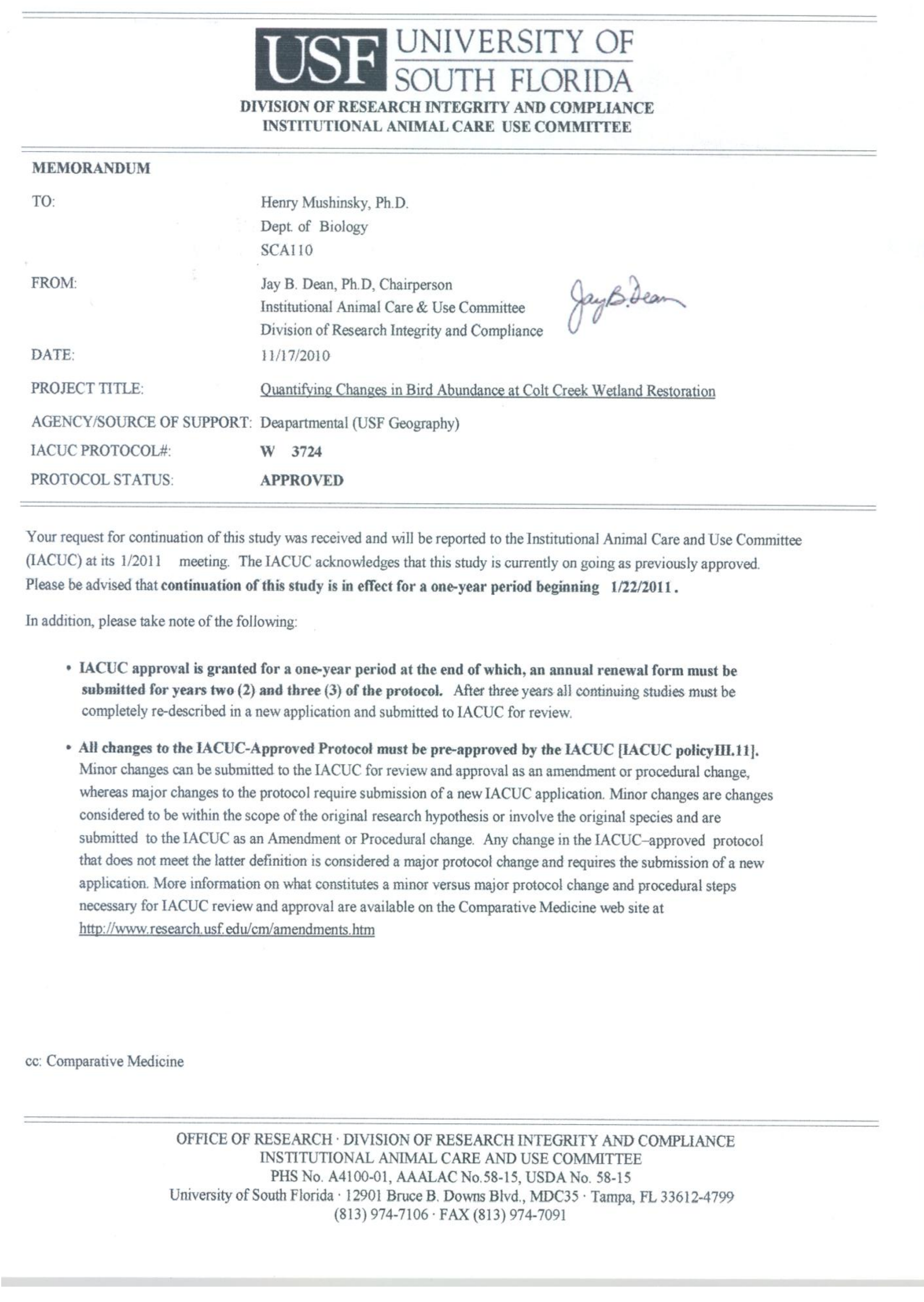
9. North culvert in the historic Colt Creek flow way at the west boundary of the study site.

Appendix H: (continued)

10. Monitor well installed in the historic Colt Creek flow way.

Appendix I: Institutional Animal Care and Use Committee (IACUC) Permit

Appendix I: Institutional Animal Care and Use Committee (IACUC) Permit



USF UNIVERSITY OF SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
INSTITUTIONAL ANIMAL CARE USE COMMITTEE

MEMORANDUM

TO:	Henry Mushinsky, Ph.D. Dept. of Biology SCA110
FROM:	Jay B. Dean, Ph.D, Chairperson Institutional Animal Care & Use Committee Division of Research Integrity and Compliance
DATE:	11/17/2010
PROJECT TITLE:	Quantifying Changes in Bird Abundance at Colt Creek Wetland Restoration
AGENCY/SOURCE OF SUPPORT:	Deapartmental (USF Geography)
IACUC PROTOCOL#:	**W 3724**
PROTOCOL STATUS:	**APPROVED**

Your request for continuation of this study was received and will be reported to the Institutional Animal Care and Use Committee (IACUC) at its 1/2011 meeting. The IACUC acknowledges that this study is currently on going as previously approved. Please be advised that **continuation of this study is in effect for a one-year period beginning 1/22/2011.**

In addition, please take note of the following:

- **IACUC approval is granted for a one-year period at the end of which, an annual renewal form must be submitted for years two (2) and three (3) of the protocol.** After three years all continuing studies must be completely re-described in a new application and submitted to IACUC for review.
- **All changes to the IACUC-Approved Protocol must be pre-approved by the IACUC [IACUC policyIII.11].** Minor changes can be submitted to the IACUC for review and approval as an amendment or procedural change, whereas major changes to the protocol require submission of a new IACUC application. Minor changes are changes considered to be within the scope of the original research hypothesis or involve the original species and are submitted to the IACUC as an Amendment or Procedural change. Any change in the IACUC–approved protocol that does not meet the latter definition is considered a major protocol change and requires the submission of a new application. More information on what constitutes a minor versus major protocol change and procedural steps necessary for IACUC review and approval are available on the Comparative Medicine web site at http://www.research.usf.edu/cm/amendments.htm

cc: Comparative Medicine

OFFICE OF RESEARCH · DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE
PHS No. A4100-01, AAALAC No.58-15, USDA No. 58-15
University of South Florida · 12901 Bruce B. Downs Blvd., MDC35 · Tampa, FL 33612-4799
(813) 974-7106 · FAX (813) 974-7091

Appendix J: Florida Department of Environmental Protection Research Permit

Appendix J: Florida Department of Environmental Protection Research Permit

Florida Department of Environmental Protection
District 3 Administration
1800 Wekiwa Circle
Apopka, FL 32708

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

September 11, 2009

Mr. Mark K. Hurst
Southwest Florida Water Management District
501 North Road
Lakeland, FL 33809

Dear Mr. Hurst:

Attached is your research/collecting permit which will allow you to conduct research on the restoration of a forested wetland strand at Colt Creek State Park. Be sure to familiarize yourself with the special conditions section of the permit, particularly special condition 1, which concerns coordination with park staff and scheduling of visits. You will need to contact the park manager and myself a minimum of one week in advance of your visits for coordination and arrangements. If you have a set schedule of field activities, the park manager and I will accept that in lieu of advance notice before each field visit. The park manager (Scott Spaulding) can be reached at (863) 815-6761 and I can be reached at (407) 884-2000.

Please also note special condition 8, which addresses reporting requirements. We require that species lists and any research reports concerning project data must be submitted to our office as well as to the park by the ending date of your permit (9/11/10); copies of any other reports, publications, theses, or dissertations that result from the permitted work must also be provided to the district biologist upon their availability.

Your permit may be extended or modified upon submission of the annual report and a letter or email requesting renewal. Good luck with your research, and let me know if I may be of further assistance

Sincerely,

Alice M. Bard

Alice M. Bard
District Biologist

AMB/amb
Attachments: research/collecting permit and application
cc: Scott Spaulding, Colt Creek State Park

"More Protection, Less Process"
www.dep.state.fl.us

Appendix J: (Continued)

Florida Department of Environmental Protection
Division of Recreation and Parks

Permit Number
09110913

RESEARCH/COLLECTING PERMIT
This Permit Must Be Carried At All Times While Conducting Research/Collecting Activities

Names of Collectors:	Address, Phone, Fax and Email:	Issue – Expiration Dates
Mark K. Hurst	Southwest Florida Water Management District and the University of South Florida 501 North Road Lakeland, FL 33809 (863) 534-1448 mkhurst@mail.usf.edu	**9/11/09-9/11/10**

Representing: Southwest Florida Water Management District and the University of South Florida

Permitted Activity: Research on the restoration of a forested wetland strand, to include the installation of shallow monitoring wells

Permitted Collection: Only data collection is required

In the Following Areas: Colt Creek State Park

Special Conditions or Restrictions:

A permit from the Florida Department of Agriculture and Consumer Services may be necessary to collect certain plant species. That permit is the responsibility of the permittee. Contact FDACS, Division of Plant Industry, Bureau of Plant and Apiary Inspection, at (352) 372-3505 ext.155.

1. Contact the park manager and district biologist a minimum of one week in advance of visits for coordination and arrangements. Failure to do this may result in denial of park entry. **It will be necessary to coordinate with the park manager to have a certified archaeological monitor present during ground-disturbing activities, such as monitoring well installation**.
2. Check in with the park manager upon arrival at and departure from the park. Collected material is subject to inspection.
3. Collect only materials as stated above, in the quantities and manner indicated in the attached application form or proposal.
4. Collect no state or Federally listed, or rare endemic species or forms, or any parts of these listed or rare endemic species or forms.
5. Research/collecting activities shall be conducted in such a manner as not to attract attention or cause damage to the environment. Vehicular traffic shall be limited to park roads; other methods of access must be approved by the park manager. All gates shall be left as found.
6. You are required to GPS the location of all permanent or semi-permanent site markings that you add (e.g., wells) and submit these coordinates to the park manager and district biologist within 2 weeks of the start of your work. You are required to mark all non-permanent site markings (flagging tape, pin flags, etc.) with your permit number. Site markings must not be detrimental or cause harm to the resources of the park (e.g., no markings may be nailed onto trees). Unless approved in advance by the park manager or district biologist, you will be required to remove all site markings upon completion of your work. Any unauthorized site markings will be removed by FDEP staff.
7. Collected objects may not be sold, bartered, or traded.
8. A summary report concerning project data, including species lists, shall be submitted to the park manager and district biologist by **9/11/10**. Copies of any other reports, publications, or theses that result from this work must also be provided to the district biologist upon their availability. Acknowledgement of FDEP, Florida Park Service will be included in any presentations, posters, reports, publications, or theses that result from this work. Failure to submit a report may result in denial of future research requests.
9. Any other applicable state and Federal permits are the responsibility of the permittee. If any ground-disturbing activities are necessary, a separate permit from the Department of State, Division of Historical Resources may be required prior to the commencement of work.
10. The permit is non-transferable. It must be in the possession of the permittee(s) or their research associates and assistants when conducting research/collecting activities in the park.
11. This permit may be revoked for failure of the permittee to abide by permit conditions and policies of FDEP.
12. The permittee will not be subject to park day-fees when entering the park for research purposes.
13. The permit may be extended or modified upon submission of the annual report and a letter or email requesting renewal. Contact the issuing office for amendment or extension.
14. Any liabilities incurred to the researcher and/or his/her associates are the sole responsibility of the researcher.
15. The Florida Park Service may request that the researcher give a program in the park or in the local community on their work.

Appendix J: (Continued)

Approved By: (name & title)	Issuing Office:
Alice M. Bard Environmental Specialist II	Bureau of Parks, District 3 1800 Wekiwa Circle Apopka, FL 32712 (407) 884-2000

Attachment: Application for Research/Collecting Permit

cc: Scott Spaulding, Colt Creek State Park

FPS-R010 rev. 8/31/09