Inventory, Assessment, and Restoration Potential of Ephemeral Wetlands on FFWCC Wildlife Management Areas

Caravelle Ranch WMA Final Report

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EXECUTIVE SUMMARY

Ephemeral wetlands are biologically unique systems that serve as focal points of animal and plant diversity in the southeastern United States. Despite their typically small size, these wetlands are extremely valuable in terms of biological diversity and ecological function. Historically, ephemeral wetlands were largely ignored by scientists, regulatory agencies, and land managers. Because of their small size, they were believed to have lower biological diversity and less significant ecological function than larger, more permanent water bodies. Consequently, many smaller, isolated wetlands have been destroyed or their ecological integrity degraded through human activities that include logging, ditching, draining, fire suppression, and mechanical site preparation. After over 20 years of research on hundreds of sites across the country, we now know that ephemeral wetlands are not just subsets of larger wetlands, but rather they hold their own unique and intrinsic biological value.

This pilot project was created to provide the Florida Fish and Wildlife Conservation Commission (FWC) with the site-specific tools and knowledge it needs in order to carry out the long-term ecological management of Florida's ephemeral wetlands by identifying them using remote sensing tools such as GIS, DOQQs, and topographic maps, conducting on-the-ground assessments of ephemeral wetland conditions using quantitative and qualitative metrics, and recommending restoration strategies for each identified wetland or management unit. Seven FWC-lead Wildlife Management Areas (WMAs) were selected for study: Aucilla WMA, Big Bend WMA, Caravelle Ranch WMA, Chassahowitzka WMA, Guana River WMA, Half Moon WMA, and Triple N Ranch WMA.

We used Digital Orthophoto Quarter Quadrangles (DOQQs) and topographic maps to remotely identify potential ephemeral wetlands on each property. We then ground-truthed potential ephemeral wetlands, obtained a GPS location, and conducted a standardized quick assessment of wetland and surrounding upland conditions. The data were entered into a GPS unit on site in order to generate a spatially referenced database for each property. Additional data were collected on a per property basis as requested by WMA personnel. Multiple photographs were taken of each wetland to provide a current "snapshot" of their physical appearance. We made restoration recommendations for each wetland based on wetland concerns identified in the field and the custom needs and challenges of each WMA.

We inventoried at total of 1513 isolated, ephemeral wetlands across the 7 WMA properties. The majority of wetlands (72%) were marshes. Forested swamps accounted for 9% of wetlands visited, shrub swamps 9%, and mixed swamps 8%. Another 2% of wetlands were of another classification such as borrow pits and sinkhole ponds. A total of 424 wetlands (28%) were in excellent condition with no associated wetland concerns. The three most prevalent wetland concerns were woody encroachment, feral hog damage, and roads/firelines.

Woody encroachment was the most ubiquitous wetland concern across all WMAs. A total of 494 wetlands (33%) were affected by woody plant encroachment. The percentage of wetlands impacted by woody plant encroachment varied per property from 3% of inventoried wetlands up to 74%. Half of all wetlands with woody encroachment were marshes. Within marshes, the

majority of woody encroachment was in the form of slash pine and wax myrtle encroaching from the wetland edge. Woody plant establishment in marshes represented a major threat to ephemeral wetlands in many of the visited WMAs and is largely a result of the lack of fire in the wetland basin. Canopies formed by woody plants in a marsh over time will shade out herbaceous marsh vegetation, eventually transforming the marsh into a swamp. To combat woody plant encroachment in marshes, we recommended that land managers remove encroaching woody plants in a single treatment using a variety of techniques depending on the situation, and subsequently implement long-term fire management in the wetland, if it wasn't already in effect.

There were 352 wetlands (23%) that were impacted by some degree of observable past or present feral hog activity. Some properties were more impacted by hogs than others, the percentage of wetlands impacted varied per property from 4% of inventoried wetlands up to 67%. Feral hogs can alter the plant and animal composition of wetlands and damage wetland soils. We made recommendations on feral hog management based on the severity of the damage and, using the generated database, the spatial extent of the damage. We recommended that trapping be used in combination with sport hunting and control hunting as a 3-pronged approach to reduce the impacts to ephemeral wetlands in heavily damaged areas of some properties.

Roads and firelines affected 2-19% of wetlands inventoried per property, a total of 125 wetlands (8%) were impacted project-wide. The placement of firelines and roads through or tangential to wetlands is detrimental to wetland habitat because the swath of exposed soil and denuded vegetation is a direct alteration of wetland habitat, can impact wetland hydroperiod, and can facilitate the spread of invasive species. Most, if not all, observed road-related impacts were created in the past. Now, current land managers must decide how to implement ephemeral wetland restoration of road impacts while balancing the need to access and partition the property for both public and managerial use. We made recommendations on a case-by-case basis.

Cattle grazing was permitted on 3 of the WMAs we visited. Cattle grazing pressure over time can degrade both wetland and upland habitats by altering plant communities and subsequently reducing landscape biodiversity. Furthermore, cattle frequently congregate in ephemeral wetland basins. Impacts to wetlands include nutrient overloading from concentrated urine and feces, trampling, altering plant community structure, facilitating the spread of invasive/exotic species, and soil compaction. We observed varying degrees of cattle impacts to wetlands during this project. Immediate recommended actions varied per property but in general we recommended cattle be phased out of WMAs altogether as part of a longer-term management strategy to maintain long-term ecological health of ephemeral wetlands and their surrounding uplands.

This pilot study has illuminated the need for future scientific research in several areas of ephemeral wetland restoration. There is a paucity of experimental data and peer-reviewed literature relating to the management of ephemeral wetlands. While some experimental data do exist, and we relied on it heavily for this report, most of the information we have compiled was acquired from our field expertise or through personal communications with land managers and other scientists. One major area that needs to be studied is the ecological response of wetlands to woody plant encroachment and the most effective methods for restoring wetlands impacted by woody encroachment. The long term effects of feral hogs on ephemeral wetland biodiversity

and community composition is another area for which there is little research. A final information gap we have identified is the fire ecology of ephemeral wetlands including targeted fire return interval, impacts of dormant versus growing season fires, and community composition response to varying fire regimes.

Although we've identified information gaps, this report is the most comprehensive compilation of knowledge about ephemeral wetland management and restoration to date. Results from this project provide an enormous database of the ecological status of ephemeral wetlands on state managed properties in Florida. This project also supplies baseline data that can be used in future studies of wetland response to management techniques and a template for future studies to identify, inventory, assess, and implement restoration actions for ephemeral wetlands on other properties.

The deliverables for this project include a final report for each of the 7 WMAs (of which this is one report), a spatially-referenced database of wetlands inventoried (in the form of a shapefile per property), and a catalog of wetland photographs. A DVD of reports, shapefiles, and photographs was sent to each of the 7 WMAs and to the AHRES project manager, Beacham Furse. The reports also were posted on, and the shapefiles made available upon request from, Coastal Plains Institute's website: www.coastalplains.org.

ACKNOWLEDGEMENTS

We would like to thank the WMA personnel who assisted us with land access, property history and management information, land management expertise, and general project development: Jason Slater and Jimmy Conner (CRWMA), Morgan Wilbur (AWMA), Justin Ellenberger (GRWMA), Chad Allison and Jennifer Roberts (CWMA), Nancy Dwyer (HMWMA), Dan McDonald, Sharon Hester, Randy Havens, Nuria Sancho, and Brent Howze (BBWMA), and Jeremy Olson (TNRWMA). Kevin Kemp was our AHRES representative and provided invaluable comments and insights to the project. Our project manager, Beacham Furse, helped to conceive this project and assisted us in its execution.

We would also like to thank our colleagues Lora Smith (Joseph W. Jones Ecological Research Center), David Printiss (The Nature Conservancy), and Bruce Means (Coastal Plains Institute) whose comments, input, and experiences contributed greatly to this project. Katherine Finn (University of Florida) and Kathy Steinheimer (Coastal Plains Institute) provided indispensible administrative assistance. And a special thanks to Memaw for taking care of Skyla from Aucilla to Triple N.

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INTRODUCTION

Ephemeral wetlands are biologically unique systems that serve as focal points of animal and plant diversity in the southeastern United States. Despite their typically small size, these wetlands are extremely valuable in terms of biological diversity and ecological function. For example, at least 12 Florida amphibians, including the federally listed flatwoods salamander (*Ambystoma bishopi, A. cingulatum*) and other candidate species (e.g., striped newt (*Notophthalmus perstriatus)* and gopher frog (*Rana capito*)), breed exclusively in this wetland type (Dodd and Charest 1988, Means and Means 1998, Printiss and Hipes 1999, Enge and Wood 2000, Greenberg et al. 2003). Even small wetlands (<1 ha) can support a high diversity and density of species (Dodd 1992, Semlitsch 2000, Means 2007).

Ephemeral wetlands are usually small and isolated with a cyclic nature of drying and refilling. Termed "hydroperiod," the duration an ephemeral wetland holds water can vary from 1 or 2 weeks to 1 or 2 years, and hydroperiod can vary from year to year and wetland to wetland. The water-holding capacity of a wetland is a function of multiple factors including underlying geology, soil characteristics, rainfall, wetland depth and size, evaporation, evapotranspiration, and tree canopy cover (Williams 1987, Hart and Newman 1995, Blood et al. 1997, Tiner et al. 2002). Bands of herbaceous vegetation around the wetland periphery, known as the littoral zone, move upslope and downslope depending on the water level of the wetland and reflect soil moisture conditions (LaClaire and Franz 1990).

The ephemeral nature and isolation of these wetlands make them unsuitable for fauna requiring longer hydroperiods, such as predatory fish. While some amphibians can breed in the presence of fish, the lack of predatory fish in ephemeral wetlands is essential to the successful reproduction of a large portion of Florida's amphibian species.

Our region's biological diversity is greatly enhanced by the presence of ephemeral wetlands. Ephemeral wetlands provide habitat to a large diversity of plants, invertebrates, reptiles, mammals, and birds (LaClaire 1992, Tiner et al. 2002, Comer et al. 2005, Scheffers et al. 2006, Means 2007). At least 10 federally and state-listed species facultatively or obligately utilize isolated wetlands for some portion of their life cycle (Hart and Newman 1995). These wetlands also serve as water sources for game species such as white-tailed deer (*Odocoileus virginianus*), bobwhite quail (*Colinus virginianus*), and waterfowl. Additionally, the aesthetic value of small wetlands is of great importance to a society that places a major emphasis on the value of water bodies.

The longleaf pine ecosystem, once widespread across the southeastern Coastal Plain, has been reduced to <2.2% of its original extent (Frost 2006). In just the past 50 years, a quarter of Florida's forest and wetland habitats have been cleared (Cox et al. 1994). The cumulative effect of ephemeral wetland destruction in Florida has not been measured, but studies by Semlitsch and Bodie (1998) and Gibbs (1993) illuminate the problems associated with the loss of small wetlands. Small wetlands are crucial for maintaining regional biological diversity and are important because they support plants,

microcrustaceans, and aquatic insects that would be negatively impacted by their loss. From an amphibian metapopulation standpoint, reducing the number of wetlands reduces the amount of young individuals dispersing into surrounding uplands. Ephemeral wetland reduction also increases the dispersal distance among wetlands. While some amphibians can travel up to 2 km (Franz et al. 1988), these dispersal distances appear to be rare. The majority of individuals appear to stay within 1 km of their breeding wetland (Johnson 2003, Rosnik 2007), so increasing dispersal distance could negatively impact amphibian populations. An increase in dispersal distance also may increase the extinction rate of populations of small mammals, turtles, and other less vagile species (Gibbs 1993).

Historically, ephemeral wetlands were largely ignored by scientists, regulatory agencies, and land managers. These wetlands were generally thought to be subsets of larger wetlands. Because of their small size, they were believed to have lower biological diversity and less significant ecological function than larger, more permanent water bodies (Moler and Franz 1987). Studies over the past 20 years have dispelled that notion. We now know that ephemeral wetlands are not just subsets of larger wetlands, but rather they hold their own unique and intrinsic biological value. However, wetland regulations and management plans maintain their focus on larger wetlands. Consequently, many smaller, isolated wetlands have been destroyed or their ecological integrity degraded through human activities that include logging, ditching, draining, and mechanical site preparation. Additionally, fire suppression or improper use of prescribed fire has altered the natural conditions of many ephemeral wetlands.

Coastal Plains Institute (CPI) biologists recently completed a Florida Fish and Wildlife Conservation Commission (FWC) State Wildlife Grant project entitled “Management Strategies for Florida’s Ephemeral Ponds and Ephemeral Pond-Breeding Amphibians” (Means 2008). Through that project, CPI identified and prioritized the necessary steps to improve the management of ephemeral wetlands in Florida. Upon completion of that project, the next logical step in the goal of proper ecological management of Florida’s ephemeral wetlands was the development of the current project. Proper ephemeral wetland management was given the highest priority at “Ephemeral Pond-Breeding Amphibians: Threats and Research Gaps,” a 2007 meeting of amphibian biologists at which research needs of ephemeral wetlands and associated biota were identified and prioritized. The current project will provide FWC with the site-specific tools and knowledge it needs in order to carry out the long-term ecological management of Florida’s ephemeral wetlands by:

1) Identifying ephemeral wetlands using remote sensing tools such as GIS, DOQQs, and topographic maps
2) Conducting on-the-ground assessments of ephemeral wetland conditions using quantitative and qualitative metrics
3) Recommending restoration strategies for each identified wetland or management unit

Seven FWC-lead Wildlife Management Areas (WMAs) were selected for study based on FWC-identified restoration potential priorities and the distribution and occurrence of

amphibian Species of Greatest Conservation Need, as identified from CPI's geo-referenced database developed as part of the recent CPI project funded by a State Wildlife Grant (Figure 1). This current project serves to assist FWC land managers by identifying, inventorying, and assessing the restoration need of ephemeral wetlands on the following WMAs:

- Aucilla (AWMA)
- Big Bend (BBWMA)
- Caravelle Ranch (CRWMA)
- Chassahowitzka (CWMA)
- Guana River (GRWMA)
- Half Moon (HMWMA)
- Triple N (TNRWMA)

This report provides an inventory, characterization, and restoration assessment for ephemeral wetlands on CRWMA, the first of the 7 WMA's visited as part of this project.

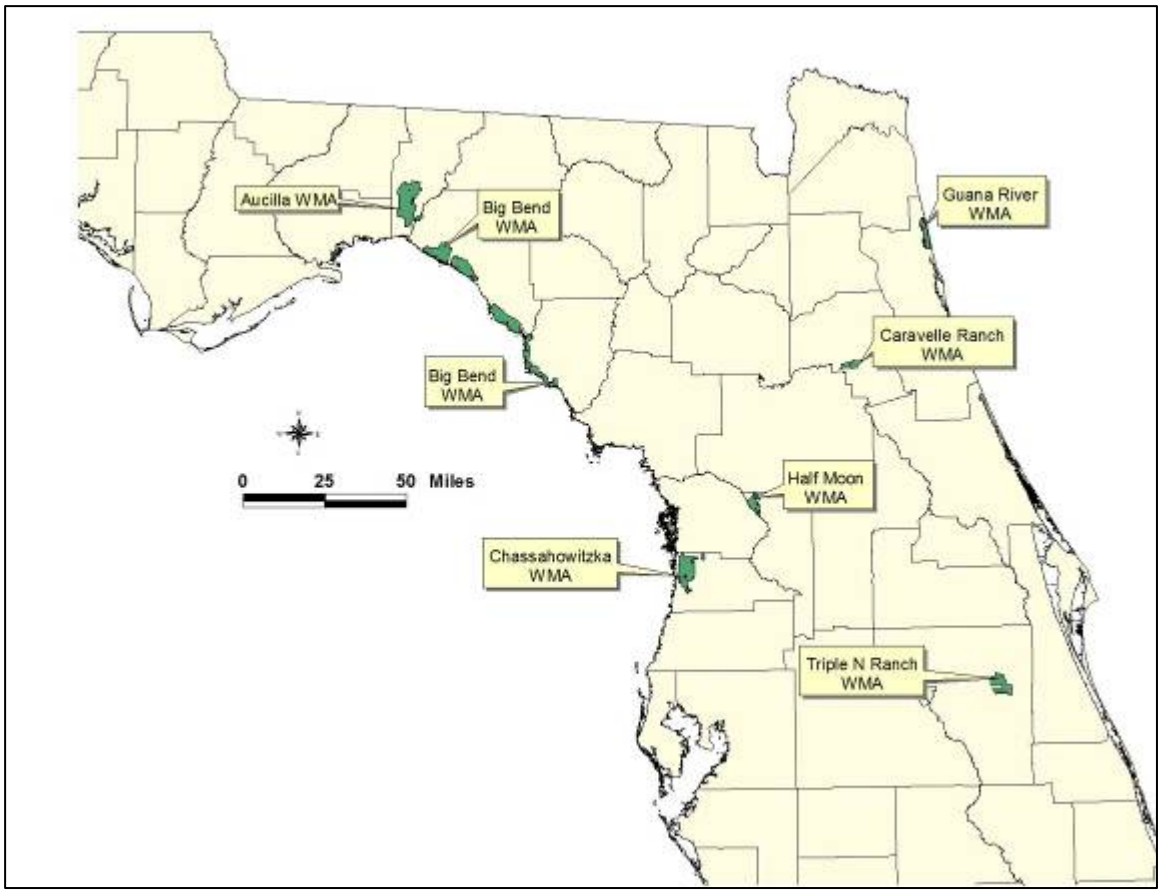


Figure 1. Map depicting the location of the 7 FWC-lead WMAs targeted for this study.

EPHEMERAL WETLAND ECOLOGY AND RESTORATION

Ephemeral wetlands also are known as temporary ponds, isolated wetlands, Carolina bays, seasonal ponds, cypress domes, sinkhole wetlands, seasonal marshes, intermittent ponds, pineland depressions, depressional wetlands, and vernal pools. They can be classified as either marshes, shrub swamps, or forested swamps (Whitney et al. 2004). Marshes are dominated by herbaceous vegetation; grasses and forbs that can be emergent, submergent or floating. Swamps are wetlands dominated by woody vegetation. Shrub swamps are dominated by shrubs and forested swamps are dominated by trees.

Both fire and water residency time (hydroperiod) play major roles in shaping the ecological function and the physical appearance of isolated wetlands in Florida landscapes. In the case of marshes, fire and hydroperiod work in unison to produce open, ephemeral, herbaceous marshes. A marsh is likely to succeed into a shrubby or forested swamp over time if two things occur in the wetland: 1) dry conditions ensue long enough for woody plants to become established in the newly exposed wetland floor; 2) fire is absent in the wetland during the dry period.

Historically, wildfires occurred during dry periods and burned across the Florida landscape. The absence of fire from an ephemeral wetland during a prolonged dry period enables the establishment of woody plants in a marsh. Woody invaders into marshes will create a shading effect over time and eliminate low-lying herbaceous vegetation through competitive exclusion. Succession of a marsh into a swamp can be a natural process but much more often, on lands that have been impacted by humans over the long-term, marshes are succeeding into shrub and forested swamps. Over the last century of human growth and development in Florida, a great many marshes in Florida may have succeeded into shrubby and forested swamps as a result of fire suppression induced by humans. This conversion of wetland type may be a factor in the decline of some ephemeral wetland-breeding species such as the striped newt and the gopher frog.

Just as it is possible for marshes to succeed to swamps, it is also possible for marshes to become too choked with herbaceous vegetation (i.e. sawgrass or maidencane) if they do not burn frequently enough. High densities of a single species in wetlands can eliminate open water pools, create a shading effect, and reduce species diversity. Grass-choked marshes are usually best managed with fire.

Dry periods coupled with lack of fire in an ephemeral marsh will lead to woody encroachment, competitive exclusion of herbaceous vegetation, and subsequent loss of marsh habitat. We have observed significant woody shrub and tree encroachment in many ephemeral marshes and swamps in most of the WMA's visited as part of this project. All wetlands exhibiting signs of fire suppression should be encouraged to burn during landscape level prescribed fires. Various other restoration techniques are available to catalyze restoration of fire-suppressed marshes. These additional techniques are discussed in the Wetland Concerns portion of the Site Assessment section. In the short term, marshes should be given higher restoration priority over swamps. Marshes

will rapidly succeed to swamps if not properly managed, whereas swamps are more enduring, already canopied, wetland habitats.

The most important management strategy for ephemeral wetlands and the surrounding landscape is to actively maintain or restore historic fire regimes. Fire suppression was identified as one of the top 8 threats to amphibian conservation (Means 2008) and frequently is cited as a cause for decline in wetland-breeding amphibian populations (Palis 1997, Franz and Smith 1999, Hipes 2003, Jensen and Richter 2005, Means 2007) as well as other taxa (Stoddard 1931, Mushinsky 1985, Brennan et al. 1998, USFWS 2003). The Florida Comprehensive Wildlife Conservation Strategy ranked "incompatible fire" as one of the highest overall threats across all Florida's terrestrial habitat (FWC 2005). Most land managers recognize the necessity of fire to maintain the longleaf pine ecosystem, but there is debate regarding the importance of fire season versus fire frequency (Bishop and Haas 2005) and as to the appropriate fire frequency (Schurbon and Fauth 2003, Means et al. 2004, Robertson and Ostertag 2004). Additionally, many managers have to contend with managing units or entire properties that have heavy fuel loads resulting from long-term fire suppression. These heavy fuel loads present specific fire safety and ecological concerns.

Regardless of upland burn season and frequency, managers should ensure ephemeral wetland basins burn at least every 1-4 years (Wade et al. 1980, Printiss and Hipes 2000, Ripley and Printiss 2005, Means 2007). Because some wetlands may be severely fire suppressed, several treatments of annual or biennial burns may be necessary to initially suppress the hardwoods (Printiss and Hipes 2000). Historically, fires were ignited by lightning during the spring and early summer and had the potential to burn across large portions of the landscape (Robbins and Myers 1992). Wetlands were often dry during this time and fires were more likely to burn through the wetland basin. Fire reduces hardwood encroachment and buildup of organic matter (Wade et al. 1980). Fire also encourages growth of the herbaceous vegetation around the wetland edge, an area referred to as the littoral zone. This shallow zone is extremely important to adult amphibians for use as breeding and ovipositioning sites and to amphibian larval for food and cover habitat.

We primarily recommend the use of growing season prescribed fires in Florida landscapes in order to mimic the historical fire regimes that occurred here prior to European induced fire suppression. Embedded ephemeral wetlands within upland landscapes should be allowed and encouraged to burn. However, we recognize that dormant season burning may have to be conducted by land managers in many cases, especially in the initial phases of landscape restoration.

From an amphibian conservation perspective, burning of the wetland basin may be as important as the attention given to upland burn frequency and season. The U.S. Forest Service (USFS), in cooperation with Florida State University (FSU), are experimenting with whether dormant season upland burns combined with intentional burning of wetlands will improve conditions for flatwoods salamander populations in the Apalachicola National Forest (C. Hess, USFS/FSU, pers. com.). The uplands

surrounding the wetlands were burned during the USFS's normal winter burning season, but the researchers returned later when the wetland basin was dry and conducted a burn through the wetland basin. Because the fuel load of the surrounding area had been eliminated during recent burns, the researchers were able to conduct a hot, ring fire in the wetland basin. The resulting elimination of woody vegetation and the creation of an herbaceous community in the wetland basin were dramatic and extremely successful (C. Hess, USFS/FSU, pers. comm.). This method can be implemented to improve the ecological condition of ephemeral wetland basins suffering from fire-suppression due to dormant season burning when wetlands are typically filled with water.

The ecological health of an ephemeral wetland is unequivocally connected to that of the surrounding upland habitat (Semlitsch and Jensen 2001, Gibbons 2003, Semlitsch 2003). Wetlands are part of a larger landscape unit comprising a network of energy transfers and chemical interactions among organisms that are directly or indirectly dependent on surface water when it is present (Gibbons 2003). Studies of amphibians in ephemeral wetlands illuminate the enormous wetland-upland biomass exchange. In Florida, 14 amphibian species exclusively or principally breed in ephemeral wetlands and at least a dozen more species utilize the habitat opportunistically (Means 2008). These species spend the majority of their life cycle in the uplands, migrating to wetlands to breed. Travel distances of greater than 400 m have been recorded for many species (Lannoo 2005). The number of individual amphibians entering and exiting a wetland in a given year is often in the thousands (Dodd 1992, Johnson 2001, Means 2007) and even tens of thousands (Semlitsch et al. 1996, Means 2007).

When considering how to properly restore and manage ephemeral wetlands, it is important to note that landscapes typically contain a multitude of ephemeral wetlands that may vary in hydroperiod, floral and faunal species composition, and other ecological characteristics. Whereas some ephemeral wetlands appear quite similar to one another, each is a unique ecological entity possessing unique ecological qualities and processes. Ephemeral wetlands are dynamic ecosystems that constantly undergo ecological succession, responding to abiotic (e.g. climate change, hydroperiod, fire) and biotic (e.g. plant succession, faunal reproductive activity, alteration by humans) factors that are continually ongoing. Whereas in some cases we will recommend how to manage wetlands that need specific attention, the goal of ephemeral wetland management should be to manage at a landscape level for long-term ecological health and biodiversity of the entire ecosystem, including all embedded ephemeral wetlands.

In cases where wetlands can be restored to mimic the natural condition that existed before alteration occurred, we make recommendations on how to accomplish this. We make every effort to tailor our recommendations to the specific needs of each WMA visited. Because little work has been conducted in the field of ephemeral wetland restoration, we may recommend experimenting with different restoration techniques. Any or all of the following techniques may be recommended for the proper, long-term, ecological management of specific ephemeral wetlands or management units that contain multiple similarly impacted wetlands visited within this project:

- Landscape (or ecosystem) management
- Prescribed growing season fire
- Prescribed dormant season fire
- Fireline placement
- Spot use of herbicide on exotic or invasive flora
- Filling or plugging of drainage ditches
- Physical elimination/reduction of damaging exotic wildlife (e.g. hogs)
- Grazing reduction/elimination
- Hand removal of encroaching vegetation
- Mechanical removal of encroaching vegetation
- Mechanical flattening of bedding or windrows
- Re-routing roads

STUDY AREA

Caravelle Ranch Wildlife Management Area is located in Putnam County, 15 km southwest of the town of Palatka. It is composed of 10,862 ha of pine flatwoods, hardwood river swamp forest, oldfield, and improved pasture with grazing cattle. Management for this area is divided between FWC, St. Johns Water Management District, and Department of Environmental Protection Greenways and Trails. Only the FWC-lead management portion of this property (2065 ha) was inventoried. The property is situated in between the Ocklawaha and St. Johns Rivers, just south of the east-west trending Cross Florida Barge Canal. State Road 19 runs north to south and bisects the property nearly in half (Figure 2).

Aerial photography from the 1940's indicates that pine flatwoods with numerous embedded small, isolated, ephemeral wetlands occupied both the east and west sides of the property. During the 1960's and 1970's the Caravelle Ranch Cattle Company of Palatka removed trees and ditched and diked the land to create pasture for cattle grazing. Since the 1960's, cattle have grazed the property, but the east side was more extensively altered and cleared. Numerous wetlands were directly drained by ditches at that time.

Today, the east side of the property (east of SR 19) primarily harbors oldfield and improved pasture communities with cattle grazing. The current stocking rate is 142 animal units (14.8 acres of pasture or native plant communities per animal unit), which is half the Natural Resources Conservation Service stocking recommendation (J. Slater, CRWMA, pers. comm.). The west side of the property is primarily mesic pine flatwoods. Despite efforts to drain the property in the 1960's, there are still many isolated, ephemeral wetlands on both sides of the property. The property is divided into 72 management units, each surrounded by maintained fire breaks or roads.

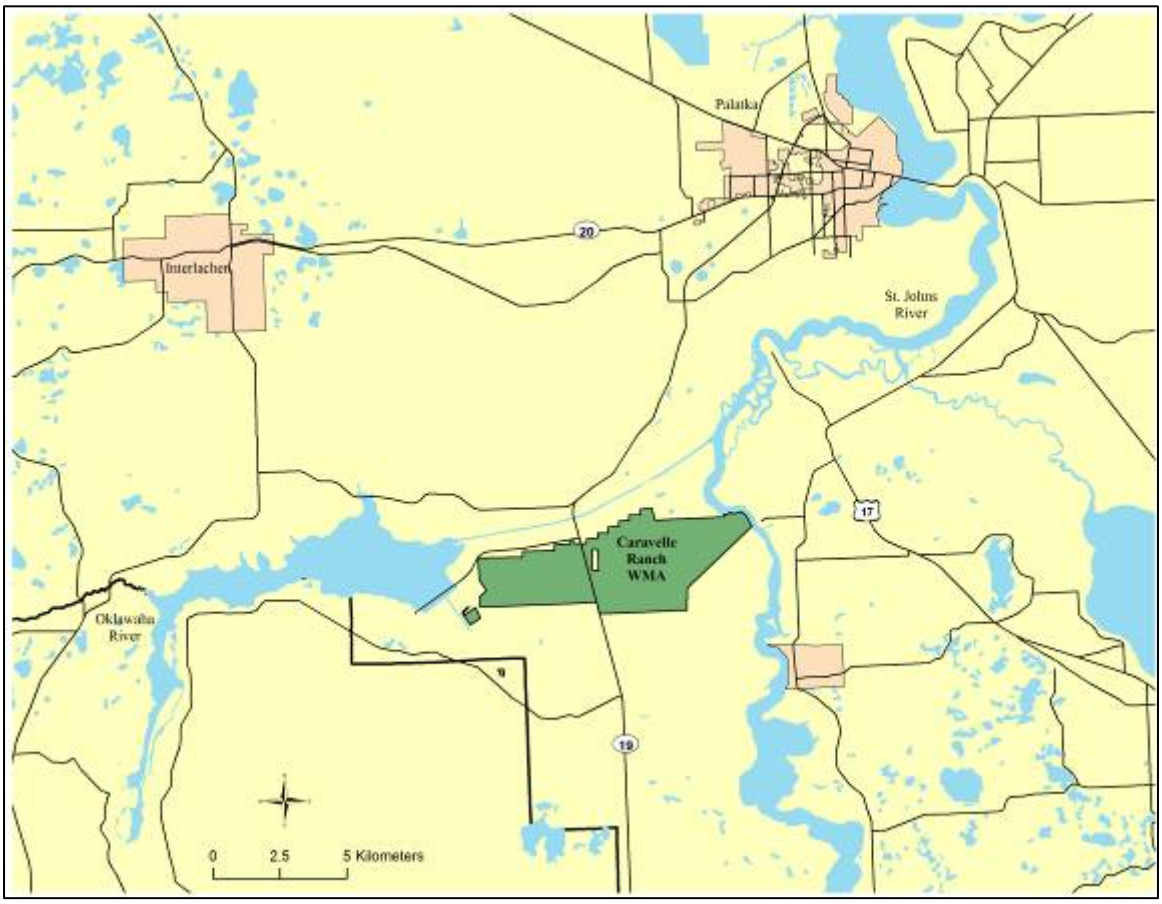


Figure 2. Map depicting the location of Caravelle Ranch WMA. CRWMA is located 15 km southwest of the town of Palatka, in between the Oklawaha and St. Johns Rivers.

METHODS

We conducted an initial meeting with CRWMA personnel Jimmy Conner, District Wildlife Biologist, and Jason Slater, Area Wildlife Biologist, on 18 November 2008 to familiarize ourselves with land access, burning schedules, management priorities and concerns, and other pertinent issues.

We used Digital Orthophoto Quarter Quadrangles (DOQQs) and topographic maps to remotely identify potential ephemeral wetlands on the property. We identified and generated maps for approximately 120 potential ephemeral wetlands. For this study, ephemeral wetlands were defined as depressional features containing wetland-indicating vegetation, isolated from much larger and deeper wetland strands, swamps, basins, lakes, or other more permanent wetlands. We concentrated on ephemeral wetlands embedded in upland ecosystems. Unless specifically requested by a land manager, we did not visit wetlands surrounded by swampy lowlands such as hydric hammock and tidal marsh. No minimum or maximum size was required to designate a wetland as an ephemeral wetland, but this study focused on inventorying wetlands that were relatively small in size to assist land managers in potentially discovering wetlands that they formerly did not know existed.

We obtained a GIS location at each wetland using a TDS Recon 400x with a Garmin 10 Bluetooth. A standardized quick assessment of wetland and surrounding upland conditions was conducted and recorded on an ephemeral wetland inventory datasheet (Appendix A) and entered into the Recon datalogger. Multiple photographs were taken of each wetland to provide a current "snapshot" of their physical appearance. Definition of select data collected at each wetland follows.

Wetland ID

Wetlands were given an ID that corresponds to the Management Unit (MU) number, and the wetland number. For example, 74-02 is the second wetland inventoried in MU 74.

Wetland Type

We placed each wetland into one of 5 generalized categories based on descriptions from Ewel (1990), Kushlan (1990), and Whitney et al. (2004):

Marsh – dominated by herbaceous vegetation rooted in or emergent from shallow water - examples include basin, depressional, swales, and wet prairie

Shrub swamp – dominated by shrub or midstory woody vegetation

Forested swamp – forested or wooded wetland - examples include heads, bogs, domes, strands, and hammocks

Mixed swamp – forested wetland with a heavy shrub midstory

Altered – damaged wetland whose original ecological classification is unrecognizable -examples include drained, logged, or mechanically altered wetlands

Basin Area

Length and width of wetland were measured using a range finder, where feasible. Basin area was estimated using the measure tool and DOQQs in ArcMap.

Hydroperiod

Highly Ephemeral – wetlands with a very short hydroperiod, estimated to have standing water only a few months out of a year. Estimations are based on wetland vegetation, soil conditions, and amount of standing water during site visit.

Ephemeral – wetlands with an intermediate hydroperiod, estimated to have standing water for up to 8-10 months out of a year. Estimations are based on wetland vegetation, soil conditions, and amount of standing water during site visit.

Semi-permanent – wetlands with a long hydroperiod, estimated to have standing water for more than a year. Estimations are based on wetland vegetation, soil conditions, and amount of standing water during site visit.

SITE ASSESSMENT

We began our inventory of wetlands on 18 November 2008 and completed the assessment on 27 November 2008. We ground truthed all 120 potential wetlands on CRWMA, 88 of which we identified as ephemeral wetlands. The wetlands were located in 36 of the 72 management units (Figure 3).

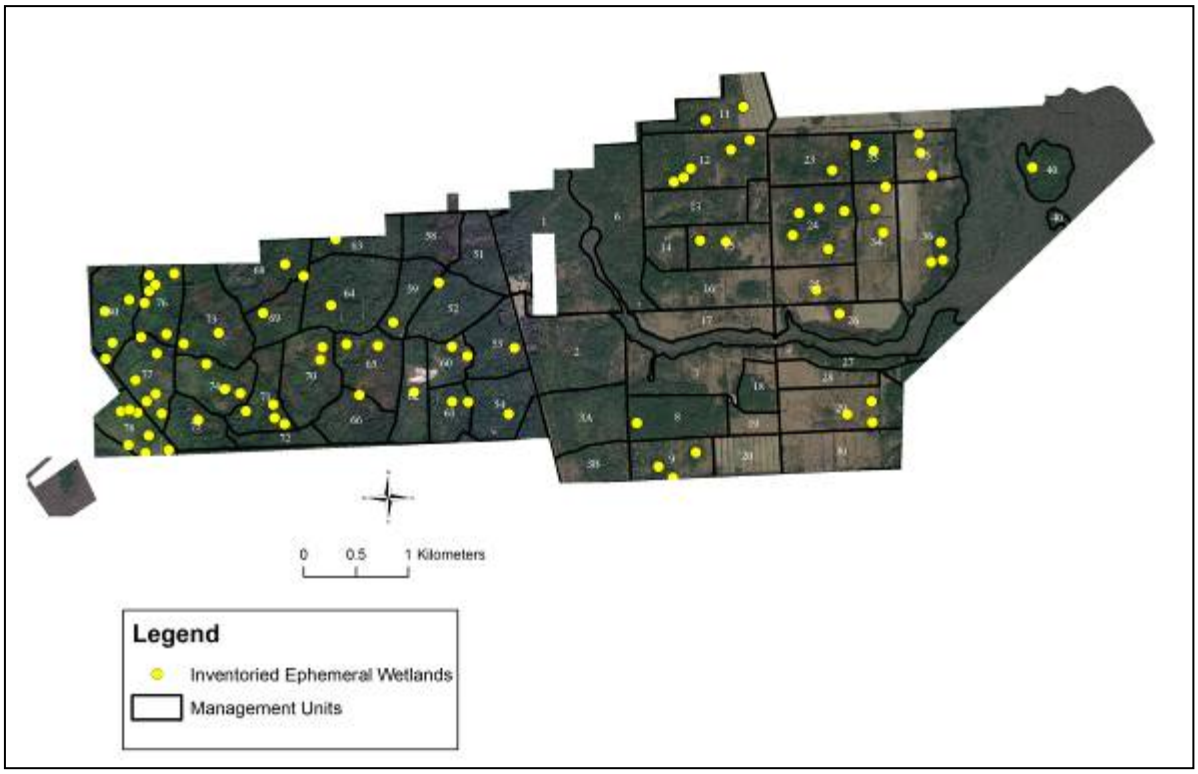


Figure 3. Map depicting the 88 wetlands inventoried on CRWMA.

Of the 88 wetlands we inventoried, 11 wetlands (13%) were in excellent condition with no associated disturbances or concerns. Wetlands to the west of SR 19 generally were in better ecological condition than those on the east side. The wetland concerns on the west side primarily were related to woody encroachment and feral hog damage. The majority of wetland concerns on the east side of the property were related to direct (grazing, trails) and indirect (upland condition) cattle issues.

We identified 27 wetlands (31%) on CRWMA affected by some degree of woody encroachment. The most prevalent woody encroachment issue was related to dense brush rings (44%). In some cases, the encroachment was due to the historical land use practice of ditching and draining the property for cattle grazing.

We identified 22 ephemeral wetlands (25%) on CRWMA affected by feral hog damage to some extent. Feral hog damage appears to be concentrated in some areas (Figure 4).

We made recommendations to address feral hog damage based on severity and extent of damage on a landscape level.

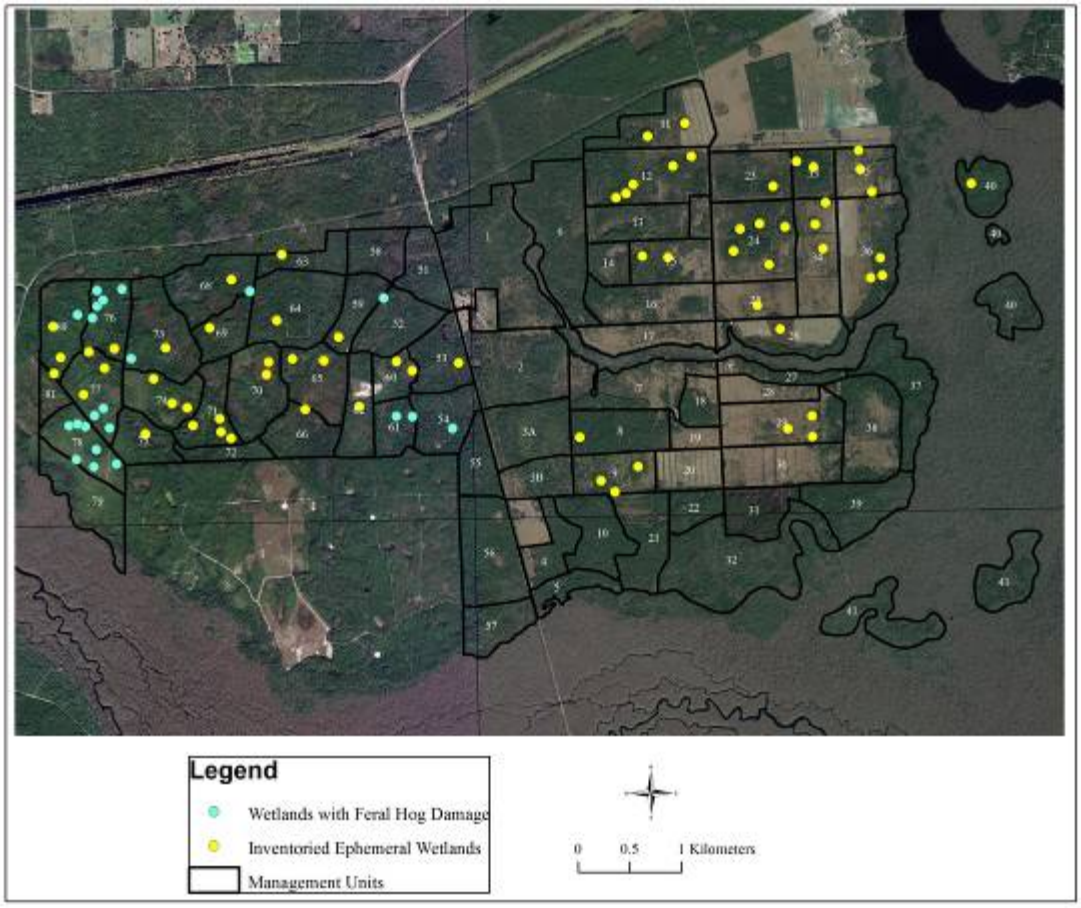


Figure 4. Map depicting ephemeral wetlands affected by feral hog damage.

Upland condition was a concern affecting 34 wetlands (39%) on CRWMA. While not an issue for which we provide restoration actions, we made note of this impact because of the close connection between uplands and wetland. When considering the restoration of ephemeral wetlands, the condition of the uplands and upland corridors connecting multiple wetlands is a vital part of that endeavor.

Wetland Concerns

Wetland Concerns were identified for each wetland to highlight areas that may need to be addressed. When deciding what concerns to address, we first recommend using a landscape perspective. The condition of an individual wetland is not as important as the condition of the wetlands as a whole over the landscape. In addition, there is no universally-accepted target condition for every wetland. A mosaic of different wetland conditions is desirable and increases the diversity of the property. For example, if only 1 or 2 wetlands in an area are impacted by woody encroachment, WMA personnel may decide to address this concern by using general landscape management techniques such as periodic, prescribed fire. However, if multiple wetlands are impacted, it may signify a

larger issue that may need to be addressed and/or the affected wetlands may need to be custom managed through vegetation removal, burning when the wetland is dry, removing fire breaks, etc. We provided a database for each property to facilitate the use of GIS to spatially identify problem areas (see Database section below).

Depending on resource constraints, landscape conditions, the presence of focal species, or other factors it may be more advantageous to manage at an individual wetland level. Therefore, we also provided restoration actions for each individual wetland. These actions may need to be prioritized (see Restoration Prioritization section below).

Below we detail the impacts of each Wetland Concern and how it pertains to CRWMA. Not all Wetland Concerns were identified on each property but we included them as a reference for WMA personnel.

Bedding

Historically, much of Florida's flatwoods were bedded in order to provide higher, less water-logged sites on which to plant pine trees. Sometimes bedding was constructed through the edge or center of wetlands. Typically this practice occurred with smaller wetlands. We generally recommend allowing bedding to erode over time. However, more severely damaged wetlands, such as those with feral hog damage or altered hydrology, may provide a good experimental situation for mechanically flattening bedding in or around a wetland basin when the wetland is dry. If bedding removal proves successful (i.e. retention of native wetland plants, maintenance of hydroperiod), the method could be used on other, less severely damaged wetlands to restore bedding impacts. In some cases we may recommend specific wetlands where experimental bedding removal could be undertaken. All mechanical activity must be conducted when the wetland is completely dry to minimize soil damage and rut formation.

We encountered no wetlands impacted by bedding on CRWMA.

Cattle

Impacts of cattle grazing to a natural landscape in both wetlands and uplands include nutrient overloading from concentrated urine and feces, trampling, altering plant community structure, facilitation of invasive/exotic species colonization, and soil compaction. We recommend that cattle-grazing be phased out of WMAs altogether as part of a longer-term management strategy to maintain long-term ecological health of ephemeral wetlands and their surrounding uplands. Due to their affiliation with water sources, cattle are a danger to the ephemeral wetland community. If cattle cannot be removed from the property, we recommend continuing the current management practice of keeping them on habitat already degraded by past land use practices. Grazing densities should be kept as low as possible, particularly in MUs with ephemeral wetlands. The use of excluder fencing may be needed for severely damaged wetlands or wetlands with SGCN or other target species.

The direct impact of cattle grazing was evident in 11 wetlands (13%) on CRWMA. Additionally, the uplands surrounding many wetlands on the east side of the property were converted from forest land to pasture or old field in order to provide habitat for cattle grazing. This indirect impact is addressed in the Upland Condition section below.

Drainage Ditching, Berms, and Roadside Ditching

Ditches have been used in Florida to drain wetlands for decades. Drainage ditches alter the hydrological regime, and therefore the ecological character, of a wetland over time. Berms are linear, earthen raised rows usually running parallel to a ditch. These features sometimes run near, through, or around wetlands. Berms can alter wetland hydrology and provide a platform for the establishment of upland plant species through a wetland. Many times berms are created during road-building. The result is an elevated road with ditches on one or both sides of the road. In many cases, access roads run tangent to wetland edges, and have associated roadside ditches of varying depth and hydroperiod. Roadside ditches along wetland edges can provide an unnatural avenue for connectivity to other wetlands located along the road. Roadside ditches may also become refuges for fish if they are deeper with longer hydroperiods than the affected wetland.

It is important to break the connection between ditches and wetlands. We typically recommend filling in all drainage ditches, because it is likely that ditches affect the long-term hydrological regime of a wetland. If filling in the ditch is not an option, the ditch should be plugged as close to the wetland edge as possible.

In the case of roadside ditches tangent to isolated wetlands, we suggest experimental restoration of 1 or 2 wetlands. In order to preserve the drainage functionality of the ditches as well as sever the connectivity between ditches and wetland, 2 culverts could be employed to divert all water to the ditch on the opposite side of the road. The recipient ditch may need to be expanded to accommodate the increase in flow. The modified ditch and culvert system would need to be monitored during heavy rains and, if successful, the method could be used property-wide. An explanatory diagram is provided as Appendix B.

Sometimes ditches themselves are ephemeral and the wetland does not appear to be hydrologically impacted by the ditch. Although priority should be given to filling/plugging deep ditches, we still recommend filling ephemeral ditches because there may be unseen effects difficult to ascertain in a short period of time without ecological monitoring.

We identified 8 wetlands with ditches on CRWMA, of which 1 was associated with a road. Additionally, CRWMA personnel already have plugged several ditches on the east side of the property.

Dug-outs

Dug-outs are features that were created primarily to serve as watering holes for cattle. These structures commonly were excavated within already existing wetland basins. Dug-outs alter the original hydrology of the surrounding wetland by providing a deep, permanent water body that may harbor predatory fish in wetlands that otherwise would not support fish. The unnatural presence of fish in ephemeral wetlands makes them unsuitable for certain rare amphibian species to breed such as the striped newt, gopher frog, and ornate chorus frog (*Pseudacris ornata*).

We recommend that deep dug-outs within ephemeral wetland basins be filled and leveled with the surrounding wetland bottom in order to restore the natural topography and hydrology of the original wetland basin. Existing earthen mounds can be the fill material source. Established permanent wetland animals (e.g. fish, turtles, alligators) could be trapped and moved to other suitable natural wetlands prior to filling the dug-out. Wetland vegetation should quickly reestablish over the filled area.

We encountered no dug-outs on CRWMA.

Feral Hog Damage

Feral hogs (*Sus scrofa*) have occupied Florida for almost 500 years (Belden and Frankenberg 1977) and have been recorded in all 67 counties of the state (Layne 1997). Among exotic mammals in Florida, feral hogs have the most destructive impact on natural habitats (Layne 1997). The list of these impacts is long and includes preventing the natural regeneration of native plants such as the longleaf pine (Lipscomb 1989), facilitating the spread of exotic species (Jensen and Vosick 1994), adversely affecting soil microarthropods (Vtorov 1993), transmitting disease (Forrester 1991, Maffei 1997), destroying the nests of birds, turtles, and snakes (Maffei 1997), and affecting species composition (Randall et al. 1997). Habitat damage by feral hogs is most pronounced in wet environments (Choquenot et al. 1996). From an amphibian conservation perspective, rooting and subsequent habitat alteration can destroy amphibian breeding habitat as well as upland refugia (Printiss and Hipes 2001, Means and Travis 2007). Foraging by feral pigs during amphibian breeding events has been observed and could result in the consumption of significant numbers of breeding adults (Jolley 2007).

Most land managers, biologists, and conservationists agree that feral hog reduction and removal should take place to reduce the many impacts hogs have on the natural environment. However, the removal of feral hogs from a property is problematic from both a political and ecological standpoint. The main political obstacle to hog removal often is a strong sport hunter's lobby. Even if managers decide to reduce or remove hog populations, it is extremely difficult to fully eradicate them due, in part, to their high fecundity and the substantial resources required for total eradication. However, it is possible to significantly reduce hog populations and their impacts on a landscape with the use of certain removal techniques.

Sport hunting and direct culling have been used with varied success (Belden and Frankenberger 1977, Ferriter et al. 1997, Engeman et al. 2007). Other possible techniques include fencing of wetlands or wetland clusters (Hone and Atkinson 1983, Lipscomb 1989) and immunocontraception (Killian et al. 2006). Trapping hogs in baited pen traps is one of the most successful techniques to reduce feral swine in a landscape (Engeman et al. 2007; D. Printiss, The Nature Conservancy, pers. com.).
In a study on Eglin Air Force Base, hogs were trapped and control hunted on a portion of the property closed to sport hunting where hog populations were relatively high (Engeman et al. 2007). In this study, hog populations and impacts to seepage slopes were dramatically reduced within the closed-to-hunting zone in the first year of hog removal and reduced further in subsequent years. Furthermore, reductions of hogs and impacts also occurred property-wide where hunting has taken place for decades. The researchers calculated economic valuations of seepage slopes and demonstrated substantial benefit-cost ratios to application of swine removal over a three-year period.

Funding to manage feral swine and restore habitat is finite and must be carefully managed to optimize the positive impact on the protected resources (Engeman et al. 2007). In spite of the difficulties encountered with feral hog removal, trapping and hunting can be used to successfully reduce hog populations and their impacts on a given property (e.g., Engeman et al. 2007).

On WMA's where hog populations are dense, sensitive areas that are sustaining heavy hog damage and areas with SGCN could be identified through ecological monitoring. Once identified, these areas could be targeted for hog removal as in the Engeman et al. (2007) study. Benefits mostly would occur in the targeted area, adjoining areas likely would also profit.

We encountered 22 wetlands (25%) impacted to some degree by feral hog damage on CRWMA. For the most part, feral hog damage was clustered on the extreme western side of the property on 4 adjoining MUs (76, 77, 78, and 80). Feral hogs also had impacted all 3 wetlands in the adjoining MUs 54 and 61 (Figure 4). Damage was severe and widespread in the cluster of wetlands within MUs 76 and 80. We recommend aggressive action such as trapping and/or harvesting be taken in this area to prevent wetland degradation. Feral hog impacts in wetland clusters in MU 77s and 78 and in MUs 54 and 61varied and we recommended that these wetlands be monitored. If feral hogs continue to be active, it may be necessary to take aggressive action in these areas as well.

We recommend that trapping be used in combination with sport hunting and control hunting as a 3-pronged approach to reduce the impacts to ephemeral wetlands on these MUs. Hog-trapping can be conducted using WMA personnel or by soliciting the services of the US Department of Agriculture Wildlife Services, the federal agency responsible for managing conflicts with wildlife (Engeman et al. 2007, US Department of Agriculture 1997). To simultaneously provide hunting opportunities and reduce hog impacts to sensitive areas, hunting could take place year-round and in management units (MU's)

that have fewer sensitive areas and SCGN while the most sensitive areas are targeted for hog removal.

Firelines/Management Unit Boundaries/Roads

The placement of firelines and roads through wetlands is detrimental to wetland habitat because the swath of exposed soil and denuded vegetation is a direct alteration of wetland habitat and can impact wetland hydroperiod. We recommend firelines and roads be rerouted at least 15m from a wetland edge to prevent damage to the wetland littoral zone. For wetlands that are located adjacent to MU boundaries, we recommend delineating the wetland edges with flagging or some other method so the machine operators will be alerted to diverge from their straight line paths.

We typically recommend allowing abandoned firelines to fill in with vegetation over time. However, WMA personnel have employed mechanical treatments to rework and restore fire plow lines in and around wetlands. Using a low-ground pressure bulldozer and disc for minimal ground disturbance, old wildfire suppression plow lines have been rehabilitated on CRWMA. WMA personnel have observed a more natural hydroperiod and the ability to reintroduce fire into the wetland basin (J. Slater, CRWMA, pers. com.). Firelines bisecting wetlands also have been reworked on GRWMA to address hydrological impacts (J. Ellenberger, GRWMA, pers. com.).

In some instances, a road does not appear to be negatively impacting a wetland and we do not recommend moving the road. In these cases, the action of re-routing a road might be more destructive than leaving it in place. Additionally, we recognize that there are cases where firelines and roads in or near wetlands cannot be rerouted. If firelines/roads cannot be moved, the affected wetlands can be monitored to ensure they burn periodically and do not become impacted by encroaching woody vegetation, sand run-off, or other disturbances. Firelines can be plowed and maintained when wetland is completely dry to prevent large ruts from developing. Vehicular traffic should be discouraged along these firelines.

Where MU boundaries mark a property line with a private landowner, we recommend contacting the private landowner to see if the MU boundary can be moved to encompass the entire wetland. If the wetland is of particular interest (surrounded by intact uplands, potential breeding location for striped newt, etc.), a land swap may be an option to acquire ownership of the entire wetland.

If the road cannot be re-routed, it may be appropriate to experiment with filling in a roadside ditch where it connects to the wetland (see Ditching section). More severely damaged wetlands provide a good opportunity for such an experiment. If successful at these wetlands, the method could be used on other, less severely damaged wetlands to restore ditch impacts. All activity must be conducted when the wetland is completely dry to minimize soil damage and rut formation.

Firelines and roads were not a widespread problem on CRWMA. We encountered 5 wetlands affected by firelines/MU boundaries and 3 wetlands affected by a road, a total of 7 affected wetlands (8%). See individual wetland characterization pages for details.

Herbaceous Plant Density

The herbaceous community within a wetland is in constant ecological flux. Between fire and inundation, the density of herbaceous vegetation changes over time. For example, immediately following a fire, standing crop biomass of herbaceous vegetation is almost or completely eliminated; however, roots, rhizomes, and seeds of these plants remain resident in the soil and regenerate quickly following fire. Over time, herbaceous vegetation grows back and, if too much time passes between fires or inundation, becomes extremely dense. Wetlands with dense herbaceous vegetation have low plant species diversity and often are completely dominated by one species, usually maidencane or sawgrass. Additionally, these wetlands provide poor habitat for amphibian reproduction and for other species.

For any given WMA property that has a multitude of isolated ephemeral wetlands, the optimum ecological condition is a mosaic of wetlands in different stages of flux. Unless multiple wetlands in an area exhibit dense herbaceous vegetation, long-term ecological fire management of the landscape is sufficient to favor ecological health of a single wetland.

We identified 16 ephemeral wetlands (18%) on CRWMA with dense herbaceous vegetation. We highlight these wetlands so that WMA personnel can monitor their condition. If the condition becomes more severe over time, the wetland may need to be custom burned by waiting until the wetland is dry or intentionally lighting the wetland if a firebreak is present. Prescribed burning of a choked herbaceous marsh reduces vegetation density, increasing sunlight into the wetland ecosystem, and increases overall ecological productivity of the wetland.

Logging

Old tree stumps or stump hummocks were observed in many ephemeral wetlands on multiple properties during this project, direct evidence of past logging practices. Most of the stumps appeared to be cypress. Sometimes, old logging stumps became hillocks or hummocks onto which woody shrubs established. This process was particularly prevalent on AWMA.

In some cases, cypress stumps were observed within swampy ephemeral wetlands that currently are forested by cypress trees. This indicates that the original plant community of the wetland re-established after logging within the wetland basin. In some wetlands, dense brush established on the old stump hummocks or as a result of fire suppression, and the cypress canopy did not reestablish. These wetlands became shrub swamps or marshes.

We did not report logging as a Wetland Concern in the Wetland Characterization section because all the logging we encountered occurred long ago and most logged wetlands we observed had reforested. We did describe the presence of stumps or hummocks in the wetland description paragraph in an effort to be as descriptive as possible. In general, we do not recommend that any action be taken to remove old stumps or hummocks, unless they exist within a densely brushy wetland that is a candidate for experimental brush removal, or otherwise needs some other restoration attention. If a wetland becomes densely brushy, and this process is facilitated by the presence of stump hummocks, periodic fire should keep brush in check and stump hummocks should oxidize.

Planted Pine Trees

Public lands previously owned by timber companies often have evidence of past silviculture practices. Pine trees were planted through small wetland basins, often associated with bedding. Both the shade from the tree canopy and the needle duff can eliminate the herbaceous vegetation vital to the ecological health of a marsh. In most cases, we recommend removing the planted pines in an ephemeral wetland.

We encountered no wetlands impacted by planted pine trees on CRWMA

Push Piles

Push piles are earthen mounds commonly formed during the process of land clearing. Heavy machinery is used to scrape clean the harvested landscape. After tree removal, remaining limbs, branches, small trees and shrubs often are pushed into piles and prepared for elimination by burning. Sometimes push piles are not burned, but left behind. In either case, an earthen hillock usually is created in the process, and logged landscapes can have these so-called “push piles” present for decades. Push piles can be several feet high and dozens of feet in diameter. During logging operations of the 20th century, it was not uncommon for land clearing personnel to create push piles within dried ephemeral wetland basins.

Push piles in wetlands can alter the original wetland ecology in at least 2 ways. First, there is the issue of direct reduction of wetland habitat. Second, a raised pile of dirt in a wetland favors establishment of small upland habitats where upland plants and trees can grow. If allowed to grow to maximum height, upland trees (most frequently pines) can create a canopy over a potentially large portion of a wetland. If the wetland in question originally was a marsh, the problem mirrors that of woody encroachment into a marsh, namely the shading and subsequent exclusion of native herbaceous wetland vegetation.

Push piles are unnatural and undesirable structures in wetlands. Depending on severity, push piles in ephemeral wetlands should be removed mechanically or be allowed to erode over time, depending on the size and impact of a given pile. Small piles having little impact on a given wetland should be allowed to erode over time. Large push piles in wetlands that are significantly impacting a given wetland should be mechanically removed when the wetland basin is dry. The dirt and any established trees can be

removed and distributed in nearby uplands in such a way as to not damage uplands. Alternatively, dirt from push piles could be used for other purposes such as road and ditch fill, etc. A pile should be removed down to the level of the rest of the wetland basin.

We encountered only 1 wetland affected by a push pile on CRWMA. The push pile was not extensive but we recommended its removal if a more natural condition was desired at the wetland.

Slash

Slash is a term used to describe the treefall and brush byproducts of logging operations. After tree removal, slash is scraped into piles for burning or left to decompose, or the slash is scattered across the ground to decompose. Sometimes slash is left in a wetland. Unless it is a minor amount, we do not recommend slash be left in a wetland. The slash we encountered within wetlands was usually a byproduct of recent mechanical tree thinning or brush removal as part of the restoration process. Depending upon the amount of brush left in a wetland, we recommend two different approaches to eliminate slash within wetlands.

If a significant portion of the wetland is covered with slash, the slash pile is dense, and/or mechanical treatment is needed for some other restoration concern, we recommend removal by root rake or mechanical means when the wetland is completely dry. Slash can be distributed in the uplands and should decompose and/or burn during the next prescribed fire. If the slash amount is minor and is not covering significant proportion of a wetland basin, we recommend encouraging fire in the wetland basin to eliminate the slash.

We encountered no wetlands affected by slash on CRWMA.

Upland Condition

Discussing upland management is beyond the scope of this project. However, we briefly characterized the uplands around each visited wetland. We used the phrase “Upland Condition” to identify wetlands surrounded by altered uplands or uplands needing restoration attention. When managing for the long-term ecological health of ephemeral wetlands, the ecological condition of surrounding uplands and upland corridors connecting multiple wetlands is equally important. For more information about wetland buffer zones, upland corridors and managing the uplands surrounding wetlands see Semlitsch and Jensen 2001, Semlitsch 2003, and Means 2008.

As previously mentioned, the uplands on the east side of CRWMA were ditched and drained to improve conditions for cattle grazing. We encountered 34 wetlands (39%) that were surrounded by uplands impacted by cattle grazing. The full ecological function of these wetlands will not be restored unless the uplands also are restored.

Vehicular Damage

Vehicles as a wetland concern usually are related to either recreational use or a result of mechanical activity related to vegetation clearing. Vehicles can impact ephemeral wetlands by compacting soil, destroying the wetland littoral zone, creating ruts that can alter hydrology, and/or facilitating the spread of invasive species. Additionally, the open soil left from vehicular damage can encourage further damage from feral hogs. In the case of recreational vehicles, gates, fencing, and road closures may be needed to reduce access and have been used successfully in some areas (C. Petrick, U.S. Forest Service, pers. com.). We recommend machinery be used around wetlands only when the wetlands are completely dry.

In general, ruts and tracks can be left to erode and revegetate over time. If a wetland is highly damaged and mechanical activity is recommended for another reason, the vehicular damage could be treated mechanically. We acknowledge that some minor vehicular ruts may be created along the edge of wetlands while personnel are working to mechanically remove dense vegetation for the purpose of habitat restoration. To keep rut formation and soil damage to a minimum, all mechanical activity should be conducted when the wetland is completely dry.

We encountered only 1 ephemeral wetland on CRWMA with vehicular damage. The damage occurred when equipment used to eliminate brush was employed before the wetland was dry.

Woody Vegetation Encroachment

Throughout the evolutionary history of the longleaf pine-wiregrass ecosystem, wildfires frequently occurred during the growing season and were common across the Florida landscape, particularly during dry periods (Means, 1996, Platt 1999). Since European colonization, humans have altered the natural fire regime in Florida by suppressing fire during the hot, dry growing season or, more recently, by prescribe burning during the dormant season. Suppressing fire during the growing season allows for dried, exposed wetland soils to be colonized by encroaching woody shrubs and trees. The practice of prescribed dormant season burning, while frequent, corresponds to the time when wetlands typically hold water, a condition which prevents thorough burning of wetlands. During this project, we have observed many ephemeral wetlands with dense, encroaching woody vegetation. This change in community structure has altered the fire feedback mechanism necessary to maintain a fire-adapted wetland community (Martin and Kirkman 2009).

The encroachment of woody vegetation usually manifests as a dense brush ring around the wetland edge, gradual encroachment from the wetland edge, and/or the colonization of plants throughout the wetland basin. Slash pine and wax myrtle are the two most predominant encroaching species into marshes we observed. These native Florida plant species normally occur in the upland/wetland ecotone and along the edge of wetlands and are maintained at low densities under a natural fire regime. However, during drought and

fire suppression, these species can vigorously colonize open wetlands in unnaturally high densities along the edge and across the wetland basin. Once established, these species can shade out and exclude herbaceous vegetation, particularly in marshes.

Woody encroachment in marshes is considered on a case by case basis but generally we define it as having greater than 5% of the wetland basin covered by off-site, encroaching species that clearly have become established across the wetland basin during a dry period and fire suppression. Woody-encroached marshes should be managed in the short-term both by fire and other techniques that focus on the direct thinning of invading species. Encroaching woody vegetation in marshes, particularly slash pine and wax myrtle, should be addressed as soon as possible because succession and subsequent exclusion of marsh habitat can happen relatively quickly. Woody encroachment in a forested swamp is defined by having greater than 50% of the wetland midstory covered by shrubs.

There are some woody species that naturally grow in parts of marshes. Buttonbush, for example, is a wetland shrub that often becomes established in deeper sink depressions within marshes where a natural fire shadow exists in the wetland because of increased hydroperiod. Deep areas are less likely to burn over time because they are usually water-filled. These deep areas will and should burn during dry periods. Any native shrubs or trees that become established in the deepest part of a marsh should not be removed—prescribed fire alone is the proper management tool.

Our primary recommendation to reduce encroaching woody vegetation is the use of prescribed fire. If upland burning occurs during a period of wetland inundation, fire crews can return later in the year when the wetlands are dry and provide fire to any unburned wetlands. Because the surrounding uplands will have little to no fuel load, a hot, ring fire can be ignited around the wetland basin, thereby improving chances the entire basin burns. This technique has been successful in restoring an herbaceous community to hardwood-encroached wetlands (C. Hess, USFS/FSU, pers. com.) and has been used successfully as a management technique (N. Dwyer, HMWMA, pers. com.). Sometimes specific attention to lighting fire at the edges or center of a wetland during regular upland burns may be all that is needed. If a fire shadow exists around the wetland, a combination of mowing and chopping of shrubs can be very effective to get fire into the wetland and change the vegetation composition, particularly with saw palmetto (J. Ellenberger, GRWMA, pers. com.).

We recognize that some wetlands are dominated by deciduous hardwoods that will not readily burn and there are cases with larger wetlands where hardwood encroachment is too extensive and/or budget or logistical constraints prevent the use of prescribed fire alone. Some of these wetlands provide a good experimental situation for mechanically removing the vegetation (12-01, 24-04, 60-01, 62-01, and 75-01). If the desired results are achieved, the method could be used to restore other wetlands.

Below we provide alternative restoration recommendations for each of the 3 woody encroachment scenarios. These alternative recommendations should be used as a tool to return the wetland to a restored state, after which the wetland can be managed by fire

alone. Martin and Kirkman (2009) were able to re-establish the herbaceous community-fire feedback mechanism in hardwood dominated wetlands by removing hardwoods and taking advantage of a persistent seed bank. Their paper is an important reference and represents one of the only published experiments on hardwood removal in southern ephemeral wetlands.

In cases where there is uncertainty about how to manage an impacted ephemeral wetland, we recommend acting on the side of caution and simply manage the surrounding landscape and associated wetlands with frequent prescribed fire. Assuming that everything else in the landscape is functioning close to naturally, frequent fire and periodic inundation will ultimately restore wetland function.

Dense brush rings occur when fire is not allowed to burn to the wetland edge, usually due to the presence of a fireline or because burning occurs when the wetland contains water. Mechanical removal can be used to reduce a thick and potential hazardous fuel load, after which the use of regular, growing-season fire can be used to maintain the natural ecology and prevent re-sprouting. Where mechanical treatment prior to burning is necessary, we recommend using a gyrotrack or bushog (mower). Single pass, single drum roller-chopping, followed by burning, also has successfully been used around wetland edges to reduce the midstory component while allowing grasses and herbs to germinate (J. Slater, CRWMA, pers. com.). All mechanical activity must be conducted when the wetland is completely dry to minimize soil disturbance and rut formation.

Woody vegetation encroaching from the wetland edge occurs during a dry period when the wetland is dry for an extended period of time. Woody vegetation (primarily pine and wax myrtle) from the surrounding uplands then has an opportunity to encroach and establish if fire is not allowed to burn into the wetland. Sometimes, there are large, mature slash and loblolly pines established around the outer wetland margin or in slightly elevated regions that connect multiple depressions within a single large marsh. Large pines should be thinned and harvested using the least disruptive techniques to the wetland. Similarly, wax myrtle shrubs encroaching from the wetland edge can be thinned by chopping or bush hogging, depending on severity of encroachment. We recommend a single thinning of encroaching woody species per marsh in the short-term. After the thinning event, a marsh could be managed solely by periodic prescribed fires over the long-term.

Establishment of woody vegetation in a wetland basin also occurs during a dry period when the wetland is dry for an extended period of time accompanied by a lack of fire. In this scenario, woody vegetation (primarily slash pine trees and wax myrtle) sprouts and colonizes across the entire wetland basin, not just along the wetland edge. There are cases where simply hand chopping young slash pine trees will suffice in small wetlands. Very small pine trees and wax myrtle likely would be killed by the next inundation or fire. If the marsh is large, there are hundreds of invading slash pine trees or wax myrtle, and/or the dbh of the woody vegetation is too large then a bush hog or shredder may be more suitable.

As part of the restoration of a hydrologically modified wetland on GRWMA, approximately 12 ha of willow and wax myrtle were successfully treated using a shredder followed by the reintroduction of fire into the wetland basin (J. Ellenberger, GRMWA, pers. com.). On AWMA, where heavily encroached titi swamps were also impacted by hummocks and old push piles, a low ground pressure track hoe and dozer combination was used to remove the titi and thick organic material down to the mineral soil. The herbaceous vegetation response was variable but generally positive (M. Wilbur, AWMA, pers. com.). In severely disturbed wetlands with dense shrub encroachment Martin and Kirkman (2009) successfully used an industrial mower to remove all small saplings (up to 10 cm dbh) from wetland basins. Large trees can be removed by hand or girdled. Spot herbicide may be necessary on some tree species to prevent re-sprouting (Martin and Kirkman 2009).

All mechanical and herbicide treatments must be conducted when the wetland is completely dry to minimize soil damage and rut formation and to reduce the risk of herbicide entering the aquatic system. We were unable to locate any sufficient references that unequivocally show herbicides are safe in wetlands. We did find references related to the toxicity of herbicides to amphibians (Berrill et al. 1994, Cheek et al. 1999, Relyea 2005a, Relyea 2005b) as well as the long-term persistence of herbicides in soil (Bell 1997). Herbicide treatments should be selected as a last resort and used with extreme caution. Some general guidelines to follow include: minimizing non-target vegetation spread, using chemicals only on one patch of the site at a time and evaluating the impact, conducting treatments when the wetland during the dry season when the wetland is completely dry and not expected to hydrate, and using the chemical with the least impact. We found 3 publications that may be useful if herbicide is selected as a management tool: Langeland 2006, Ferrell et al. 2006, Langeland et al. 2009.

We encountered 27 wetlands (31%) on CRWMA impacted by some degree of woody encroachment. The largest concern (26% of the affected wetlands) was related to brush rings. Large trees established within marshes, encroaching small slash pine trees, and a dense midstory also were encountered.

Restoration Prioritization

Because resources are finite, not all recommended restoration actions can be employed immediately. Ultimately, the prioritization of wetland restoration is up to the land manager and their objectives, resource availability, and logistical constraints. However, we provide here some general ideas to assist managers in prioritizing restoration of wetlands:

- Conduct biological surveys for rare species, particularly amphibians and other species dependent on ephemeral wetlands. Prioritize restoration actions based on the results of these surveys (i.e. feral hog control or other aggressive actions).
- Prioritize the filling of ditches that are either permanent or connect to permanent water sources over the filling of ephemeral ditches that connect to ephemeral water sources.

- Address woody encroachment in marshes before swamps because succession and subsequent exclusion of marsh habitat can happen relatively quickly.
- Consider resources required and condition of the uplands

Database

In addition to this report, a shapefile was provided that includes all the wetlands inventoried on the property. The shapefile includes an attribute table with fields associated with the following information:

- Wetland ID
- Wetland type
- Basin area
- Hydroperiod
- Canopy coverage (%)
- Dominant canopy species
- Midstory coverage (%)
- Dominant midstory species
- Herbaceous coverage (%)
- Dominant herbaceous species
- Herbaceous distribution
- Wetland concerns
- Upland community type
- Upland conditions

This database provides a quick reference for land managers to not only locate ephemeral wetlands on each property, but to know wetland attributes associated with each location and spatially identify major wetland concerns (ex. Figure 4).

Wetland Characterizations and Descriptions

The following pages provide photographs and descriptions of the 88 ephemeral wetlands assessed on CRWMA. The MUs are organized numerically. The wetland nomenclature uses the MU number and the wetland number. For example, 74-03 is the third wetland inventoried in MU 74. Additional photographs were provided on the accompanying CD.

Wetland ID: 08-01

Description: This wetland is a 0.1 ha highly ephemeral marsh. A few large slash pine trees have established in the wetland interior. The tree canopy covers 5-25% of the wetland basin. There is no midstory cover. Maidencane densely grows throughout the wetland, and covers >75% of the wetland basin. The encroaching pine trees and dense maidencane likely are a result of a lack of fire in the wetland. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Herbaceous density, Woody encroachment

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed. Pine trees in the wetland interior could be hand-removed when the wetland is dry.

Wetland ID: 09-01

Description: This wetland is a 0.6 ha ephemeral marsh. There is no tree canopy or midstory cover. A diverse array of maidencane, sedges/grasses, and emergent vegetation grow throughout the wetland, and cover >75% of the basin. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 09-02

Description: This wetland is a 0.1 ha ephemeral marsh. There is no tree canopy or midstory cover. Sedges/ grasses grow throughout the wetland, and cover >75% of the basin. A MU boundary/fireline bisects the south end of the wetland. The boundary line separates properties managed by 2 public agencies. There is a road on the other side of the fireline with associated ditches. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): MU boundary/fireline, Road, Roadside ditch, Upland condition

Restoration Action Recommended: Re-route the MU boundary/fireline into the uplands and out of the wetland if feasible. If the road cannot be re-routed, fill the roadside ditch where it is adjacent to the wetland. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 09-03

Description: This wetland is a 0.3 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows thick throughout the wetland, and covers >75% of the basin. A private property boundary fence bisects the middle of the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): Herbaceous density, Upland condition

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 11-01

Description: This former wetland is a 2.4 ha highly ephemeral forested swamp. It was logged and has since succeeded to a hardwood forest, likely due to ditching and the historic draining of the property. Maple, pine, sweet gum, and oak trees cover >75% of the area and smilax grows over most vegetation. Herbaceous cover is sparse. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are oldfield and food plot communities.

Wetland Concern(s): Ditching, Upland condition

Restoration Action Recommended: Fill the nearby ditches. We cannot ascertain the ecological character of this wetland before it was altered. Therefore, as a conservative approach, we recommend monitoring the wetland over time to see if filling the nearby ditches restores the wetland hydrology. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 11-02

Description: This wetland is a 1.0 ha highly ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by wax myrtle, fetterbush, and buttonbush, and covers 25-50% of the wetland. Maidencane and fern grow throughout the wetland, and cover >75% of the basin. The wetland is surrounded by almost impenetrable grapevine and blackberry covered vegetation. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are oldfield and food plot communities.

Wetland Concern(s): Woody encroachment, Upland condition

Restoration Action Recommended: Periodic fire through and around the wetland would reduce the dense brush ring. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 12-01

Description: This wetland is a 0.5 ha highly ephemeral forested swamp. Cypress, gum, and bay trees dominate the canopy, and cover >75% of the wetland. The midstory is dominated by wax myrtle, and covers 25-50% of the wetland. Maidencane and sedges/grasses grow throughout the wetland, and cover >75% of the basin. This wetland was most likely a cypress dome before the cypress trees were logged. The wetland is surrounded by a dense thicket. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): Upland condition, Woody encroachment

Restoration Action Recommended: The thick brush ring surrounding this wetland needs to be thinned. Periodic fire in and around the wetland should reduce the dense woody vegetation, but this wetland also is a good candidate for experimental, mechanical brush ring removal. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 12-02

Description: This wetland is a 0.8 ha highly ephemeral forested swamp. Gum and pine trees dominate the canopy, and cover > 75% of the wetland. The midstory is dominated by wax myrtle, and covers 5-25% of the wetland. Maidencane and fern grow in scattered patches, and cover 25-50% of the wetland basin. Historically, this wetland likely was a cypress dome. The cypress were logged, the uplands drained for cattle grazing, and the resulting desiccation allowed gum and pine trees to colonize. On its current tract, the wetland will succeed to a hardwood forest and no longer function as a wetland. The wetland is ringed in thick brush. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 12-03a

Description: This wetland is a 0.3 ha highly ephemeral forested swamp. Gum, maple, and pine trees dominate the canopy, and cover 51- 75% of the wetland basin. The midstory is dominated by wax myrtle, and cover 5-25% of the wetland. Sedges/grasses and fern grow in scattered patches, and cover 50-75% of the basin. This swamp is located on the northeastern end of what historically was a 300m long, continuous cypress wetland strand and that now is separated into 3 wetlands. The wetland is ringed in thick brush. There are ditches on the east and south sides of the wetland. This wetland likely was a cypress swamp. The cypress were logged, the uplands drained for cattle grazing, and the resulting desiccation allowed gum and pine to colonize. The uplands currently are an oldfield community.

Wetland Concern(s): Ditching, Upland condition

Restoration Action Recommended: Fill the ditches to restore the wetland's hydrology. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 12-03b

Description: This wetland is a 0.4 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane, rush, and pickerelweed grow throughout the wetland, and cover >75% of the basin. This wetland is located in the center of what historically was a 300m long, continuous cypress wetland strand and that now is separated into 3 wetlands. The cypress were logged, the uplands drained for cattle grazing, and presently the area is open and herbaceous. The uplands currently are an oldfield community.

Wetland Concern(s): Herbaceous density, Upland condition

Restoration Action Recommended: This wetland is the most functional part of the 3-part wetland system. Monitor herbaceous density; provide custom burn treatments if needed. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 12-03c

Description: This wetland is a 0.7 ha ephemeral forested swamp. Maple and gum trees dominate the canopy, and cover >75% of the wetland. The midstory is dominated by wax myrtle and palm, and covers 5-25% of the wetland. Grasses and fern grow in scattered patches, and cover 25-50% of the basin. This wetland is located on the southwestern side of what historically was a 300m long, continuous cypress wetland strand and that now is separated into 3 wetlands. The cypress were logged, the uplands drained for cattle grazing, and the resulting desiccation allowed hardwoods and pine trees to colonize. The uplands currently are an oldfield community.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 15-01

Description: This wetland is a 0.3 ha ephemeral marsh. There is no tree canopy cover. The midstory is dominated by wax myrtle and *Baccharis*, and covers 5-25% of the wetland. Maidencane and broomsedge grow throughout the wetland, and cover >75% of the basin. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): Herbaceous density, Upland condition

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 15-02

Description: This wetland is a 0.4 ha ephemeral forested swamp. Gum trees dominate the canopy, and cover >75% of the wetland. There is little midstory cover. Grasses and fern are sparse in the wetland, and cover 5-25% of the basin. The wetland floor is covered in leaf and pine litter. An old ditch appears to be eroded enough that it does not drain the wetland. Our site visit occurred during a drier period so this should be verified during the rainy season. A virtually impenetrable thicket of shrub, blackberry, and smilax ring the pond. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are an oldfield community.

Wetland Concern(s): Ditching, Upland condition, Woody encroachment

Restoration Action Recommended: Periodic fires in the area immediately adjacent to the wetland would reduce the thick shrubs and vines. If the ditch functions to drain the wetland, the ditch should be filled. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 23-01

Description: This wetland is a 0.6 ha highly ephemeral forested swamp. Bay and palm trees dominate the canopy, cover >75% of the wetland. The midstory is dominated by wax myrtle, and covers 50-75% of the wetland. Muscadine grape densely covers vegetation. The wetland ground surface is predominately covered in leaf litter with very little herbaceous cover. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are mesic flatwoods.

Wetland Concern(s): Upland condition, Woody encroachment

Restoration Action Recommended: Periodic fire would reduce the thick shrub layers. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 24-01

Description: This wetland is a 0.7 ha ephemeral marsh. There is no tree canopy cover. The midstory is dominated by buttonbush, and covers 5-25% of the wetland. Maidencane, smartweed, and rush grow throughout the wetland, and cover >75% of the basin. An old ditch runs up to a berm 90m to the south of the wetland. The ditch was filled adjacent to the wetland and no longer appears to be functioning. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and oldfield communities.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 24-02

Description: This wetland is a 1.4 ha highly ephemeral forested swamp. This wetland likely was a cypress dome. The cypress were logged, the uplands drained for cattle grazing, and the resulting desiccation allowed gum trees to colonize. Gum trees dominate the canopy, and cover >75% of the wetland. There is little to no midstory cover. Maidencane and rush grow throughout, and cover 50-75% of the basin. A ditch and fireline encircle 3/4 of the pond. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and oldfield communities.

Wetland Concern(s): Ditching, Fireline, Upland condition

Restoration Action Recommended: Fill the ditch around the wetland. If the fireline surrounding the wetland is necessary and cannot be rerouted further into the uplands, monitor the wetland to ensure it regularly burns. If not, intentional burning of the wetland basin and vegetation surrounding the basin may be needed in the future. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 24-03

Description: This wetland is a 0.7 ha ephemeral marsh. There is no tree canopy cover. The midstory is dominated by buttonbush, and covers 5-25% of the wetland. Maidencane and rush densely grow throughout the wetland, and cover >75% of the basin. A barbed wire fence runs through the center of the wetland. There is some evidence of cattle traffic. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and oldfield communities.

Wetland Concern(s): Cattle, Herbaceous density, Upland condition

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 24-04

Description: This wetland is a 0.6 ha ephemeral forested swamp. Gum and maple trees dominate the canopy, and cover 50-75% of the wetland. The midstory is dominated by wax myrtle and willow, and covers 50-75% of the wetland. Maidencane and smartweed grow in scattered patches, and cover 25-50% of the basin. The wetland is ringed in thick brush. An old barbed wire fence runs through the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are grazed oldfield, planted pine, and mesic flatwoods communities.

Wetland Concern(s): Upland condition, Woody encroachment

Restoration Action Recommended: The almost impenetrable thick brush surrounding this wetland needs to be thinned. Periodic fire should reduce the dense woody vegetation, but this wetland also is a good candidate for experimental, mechanical brush ring removal. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 24-05

Description: This wetland is a 0.1 ha highly ephemeral marsh. There is no tree canopy or midstory cover. Small pine trees are encroaching into the wetland, but cover <5% of the basin. Maidencane grows throughout the wetland, and covers >75% of the basin. The wetland is ringed in a brushy thicket. There is a ditch/fireline along the north side of the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and mesic flatwoods communities.

Wetland Concern(s): Ditching, Fireline, Upland condition, Woody encroachment

Restoration Action Recommended: Fill the ditch to restore the wetland's hydrology. If the fireline is necessary, monitor the wetland to ensure it regularly burns. If not, intentional burning of the wetland basin and vegetation surrounding the basin may be needed in the future. Monitor the pine trees that are encroaching into the wetland to ensure they do not get established. Pine saplings can be hand-chopped if needed in the future. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 25-01

Description: This wetland is a 0.8 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows throughout the wetland, and covers >75% of the basin. A portion of the wetland is enclosed by a rectangular barbed wire fence. There is evidence of cattle in the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 26-01

Description: This wetland is a 0.5 ha ephemeral forested swamp. Gum and pine trees dominate the canopy, and cover >75% of the wetland. The midstory is comprised of various shrubs, and covers 25-50% of the wetland. Maidencane, *Sphagnum*, and fern grow throughout the wetland, and cover 50-75% of the basin. A ditch drains the wetland to the south and the wetland shows effects of long-term desiccation. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands are a mix of pasture, food plot, and planted longleaf pine communities.

Wetland Concern(s): Ditching, Upland condition

Restoration Action Recommended: Fill the ditch to restore the wetland's hydrology. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 29-01

Description: This wetland is a 0.2 ha highly ephemeral marsh. Several gum trees ring the pond edge and a few saplings are growing in the pond center. The trees provide <5% cover. There is no midstory cover. Maidencane and rush are grow throughout the wetland, and cover >75% of the basin. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 29-02

Description: This wetland is a 0.3 ha ephemeral marsh. A few gum trees grow around the wetland edge, but cover <5% of the wetland. There is no midstory cover. Maidencane and rush grow throughout the wetland, and cover >75% of the basin. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Needed: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 29-03

Description: This wetland is a 0.3 ha ephemeral. There is no tree canopy. A clump of willow shrubs grow in the wetland center, and covers 5-25% of the basin. Sawgrass and fern grow throughout the wetland, and cover >75% of the basin. There is evidence of cattle grazing in the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Needed: Periodic fire within the wetland basin should reduce the thick sawgrass and encourage the growth of other species. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 33-01

Description: This wetland is a 0.6 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows throughout the wetland, and covers >75% of the basin. A dike road bisects the west end of the pond. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and mesic flatwoods communities.

Wetland Concern(s): Road, Upland condition

Restoration Action Recommended: The wetland appears to be in relatively good condition despite the road. Removal of the road may cause more damage than benefit so mechanical manipulation here is not recommended. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 33-02

Description: This wetland is a 1.3 ha ephemeral forested swamp. Maple, gum and pine trees dominate the canopy, and cover >75% of the wetland. The midstory is dominated by fetterbush and *Vaccinium*, and covers 5-25% of the wetland. Sawgrass grows in scattered patches, and covers 5-25% of the basin. Thick brush surrounds the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are grazed, mesic flatwoods.

Wetland Concern(s): Upland condition, Woody encroachment

Restoration Action Recommended: Periodic fire around the wetland edge would reduce the thick brush. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 34-01

Description: This wetland is a 0.7 ha highly ephemeral marsh. There is no tree canopy or midstory cover. Maidencane and smartweed grow throughout the wetland, and cover >75% of the basin. There is evidence of grazing in the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 34-02

Description: This wetland is a 0.6 ha ephemeral mixed swamp. Pine trees dominate the canopy, and cover 5-25% of the wetland. The midstory is dominated by wax myrtle and willow, and covers 25-50% of the wetland. Maidencane and rush grow throughout the wetland, and cover >75% of the basin. This wetland is either man-made or man-enhanced and there is a berm on the east side. We saw cattle in the wetland basin on the day of our visit. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Berm, Cattle, Upland condition

Restoration Action Recommended: The berm could be removed to restore the natural hydrology of this area. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 34-03

Description: This wetland is a 0.2 ha highly ephemeral marsh. There is no tree canopy or midstory cover. Maidencane and broomsedge grow throughout the wetland, and cover >75% of the basin. A MU boundary/dirt road runs along the north end of the wetland. Cattle trails lead into and around the pond. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 35-01

Description: This wetland is a 0.4 ha highly ephemeral forested swamp. Gum trees dominate the canopy, and cover >75% of the wetland. There is minimal midstory cover. Grasses and ferns grow throughout the wetland, cover >75% of the basin. Historically, a ditch drained the wetland and desiccated the swamp. The ditch has been filled in an effort to restore the wetland's hydrology. Cattle trails lead into and around the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: Action has already been taken to reduce pond desiccation by filling the drainage ditch. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 35-02

Description: This wetland is a 0.6 ha highly ephemeral forested swamp. Gum and pine trees dominate the canopy, and cover >75% of the wetland. There is minimal midstory cover. Maidencane, grasses, and ferns grow in scattered patches, and cover 25-50% of the basin. Historically, a ditch drained the wetland and desiccated the swamp. The ditch has been filled in an effort to restore the wetland's hydrology. Cattle trails lead into and around the wetland. The adjacent uplands were ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are a pasture community.

Wetland Concern(s): Cattle, Upland condition

Restoration Action Recommended: Action has already been taken to reduce pond desiccation by filling the drainage ditch. In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 36-01

Description: This wetland is a 0.3 ha ephemeral forested swamp. Black gum trees dominate the canopy and a few large pine trees grow in the wetland center. The tree canopy covers >75% of the wetland. There is minimal midstory cover. Grasses and lizard's tail ring the wetland edge, and cover 25-50% of the basin. The adjacent uplands have been ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture, food plot, and river bottomland communities.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 36-02

Description: This wetland is a 0.2 ha ephemeral forested swamp. Black gum trees dominate the canopy, and cover 25-50% of the wetland. There is no midstory cover. Maidencane, grasses, and lizardtail grow throughout the wetland, and cover 50-75% of the basin. The adjacent uplands have been ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and river bottomland communities.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 36-03

Description: This wetland is a 0.2 ha highly ephemeral forested swamp. Black gum trees dominate the canopy, and cover 5-25% of the wetland. Shrubs were mechanically removed from the west side of the wetland. There is minimal midstory cover. Maidencane and smartweed grow throughout the wetland, and cover >75% of the basin. The adjacent uplands have been ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are grazed oldfield and food plot communities.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 36-04

Description: This wetland is a 0.4 ha ephemeral marsh. Black gum trees grow in a ring around the wetland edge, and cover 25-50% of the wetland. There is no midstory cover. Maidencane, grasses, and smartweed grow throughout the wetland, and cover >75% of the basin. The adjacent uplands have been ditched, drained, and logged to provide grazing habitat for cattle. The uplands currently are pasture and food plot communities.

Wetland Concern(s): Upland condition

Restoration Action Recommended: In order to restore the full ecological function of this wetland, the uplands would need to be restored.

Wetland ID: 40-01

Description: This wetland is a 0.2 ha semi-permanent man-made marsh. There is no tree canopy or midstory cover. Maidencane and *Sphagnum* grow in a ring the edge of the wetland, and cover 50-75% of the basin. The wetland has an open water center with lily pads. A 2 m tall earthen berm surrounds the wetland. The adjacent uplands are fire-suppressed mesic flatwoods.

Wetland Concern(s): Berm

Restoration Action Recommended: The berm may serve as a barrier to small animal movement into and out of the wetland. The berm could be removed to reduce the barrier potential. However, the remote nature of this wetland may prevent this from being logistically feasible and the pond appears to be functioning as a healthy ephemeral wetland.

Wetland ID: 52-01

Description: This wetland is a 0.3 ha highly ephemeral forested swamp. Young cypress and pine trees cover >75% of the wetland. Grasses and fern grow throughout the wetland, and cover >75% of the wetland basin. An MU boundary/fireline runs along the northwest side of the wetland. There is a ditched canal along the opposite side of the fireline (i.e. not proximal to the wetland). Feral hog damage is minimal. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Feral hog damage, MU boundary/fireline

Restoration Action Recommended: Monitor the wetland to ensure more severe damage does not occur in the future. Move the MU boundary into the uplands and away from the wetland. If moving the boundary is not feasible, monitor the wetland to ensure it regularly burns. If not, intentional burning of the wetland basin and vegetation surrounding the basin may be needed in the future.

Wetland ID: 53-01

Description: This wetland is a 0.3 ha ephemeral marsh. A cluster of gum and pine trees cover 5-25% of the wetland. There is no midstory cover. There are thick patches of maidencane throughout the wetland. The herbaceous vegetation covers >75% of the basin. A major road (SR 19) is located on the east side of the wetland. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Road

Restoration Action Recommended: In order to restore the hydrology of this wetland and the larger wetland system, the road would have to be removed. Recognizing that this road is now a permanent attribute to the landscape, we do not recommend any action relating to the road. The wetland could be monitored to ensure it is not affected by run-off or other impacts.

Wetland ID: 54-01

Description: This wetland is a 0.4 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows thick throughout the wetland, and covers >75% of the basin. Feral hog damage is present, but not severe. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Feral hog damage, Herbaceous density

Restoration Action Recommended: Periodic fire within the wetland basin would reduce the thick maidencane and encourage the growth of other species. The feral hog damage is minimal but should be monitored to ensure more severe damage does not occur in the future. This wetland is part of a cluster of wetlands impacted by feral hog damage. If feral hog activity continues to be a problem in this area, this wetland would be a candidate for more aggressive action.

Wetland ID: 59-01

Description: This wetland is a 1.0 ha ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 5-25% of the wetland. The midstory is dominated by wax myrtle, fetterbush, and buttonbush, and covers 25-50% of the wetland. Maidencane grows thick throughout the wetland, and covers >75% of the basin. The adjacent uplands are mesic flatwoods. The topography is undulating with old, but deep, plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Herbaceous density

Restoration Action Recommended: Periodic fire within the wetland basin should reduce the thick maidencane and encourage the growth of other species.

Wetland ID: 60-01

Description: This wetland is a 1.2 ha ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by wax myrtle and fetterbush, and covers 50-75% of the wetland. Sphagnum, grasses, and ferns are extensive throughout, cover >75% of the basin. Dense shrubs ring the outer edge of the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old, but deep, plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Woody encroachment

Restoration Action Recommended: The thick brush ring surrounding this wetland needs to be thinned. Periodic fire should reduce the woody vegetation, but this wetland also is a good candidate for experimental, mechanical brush ring removal.

Wetland ID: 60-02

Description: This wetland is a 1.9 ha ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by wax myrtle and fetterbush, and covers 50-75% of the wetland. Maidencane, sphagnum, and fern grow throughout the wetland, and cover >75% of the basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 61-01


Description: This wetland is a 0.3 ha highly ephemeral marsh. Slash pine trees are beginning to colonize the wetland basin. There is no tree canopy or midstory cover. Maidencane, grasses, and sedges grow throughout the wetland, cover >75% of the basin. An MU boundary/fireline runs along the east edge of the wetland. Feral hog damage is extensive. Push piles are present along the western edge of the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old, but deep, plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, MU boundary/fireline, Push piles, Woody encroachment

Restoration Action Recommended: Monitor this wetland to ensure more damage does not occur in the future. This wetland is part of a cluster of wetlands impacted by feral hog damage. If feral hog activity continues to be a problem in this area, this wetland would be a candidate for more aggressive action. Re-route the fireline into the uplands and away from the wetland. Hand-chop pines out of the wetland if inundation or fire does not kill them within the next year or two. The push piles are not extensive but they could be flattened to restore more natural conditions to the wetland.

Wetland ID: 61-02

Description: This wetland is a 0.3 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows throughout the wetland, and covers >75% of the basin. Feral hog damage is present, but not severe. The adjacent uplands are mesic flatwoods. The topography is undulating with old, but deep, plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, Herbaceous density

Restoration Action Recommended: Monitor this wetland to ensure more severe damage does not occur in the future. This wetland is part of a cluster of wetlands impacted by feral hog damage. If feral hog activity continues to be a problem in this area, this wetland would be a candidate for more aggressive action. Periodic fire within the wetland basin should reduce the thick maidencane and encourage the growth of other species.

Wetland ID: 62-01

Description: This wetland is a 0.5 ha highly ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 5-25% of the wetland. The midstory is dominated by fetterbush, wax myrtle, and buttonbush, and covers 50-75% of the wetland. Sedges/grasses and fern grow in scattered patches, and cover 25-50% of the wetland basin. This wetland appears to be suffering from long-term dryness due to drought and/or land use practices. The adjacent uplands are mesic flatwoods and a food plot.

Wetland Concern(s): Woody encroachment

Restoration Action Recommended: The thick brush surrounding the wetland center needs to be reduced. Periodic fire should reduce the woody vegetation, but this wetland also is a good candidate for experimental, mechanical brush ring removal.

Wetland ID: 63-01

Description: This wetland is a 0.2 ha ephemeral marsh. Gum and pine trees dominate the canopy and cover 5-25% of the wetland. There is no midstory cover. Maidencane grows throughout the wetland, and covers >75% of the basin. A property boundary fireline bisects the northern edge of the wetland. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Herbaceous density, Property boundary/fireline

Restoration Action Recommended: Periodic fire within the wetland basin should reduce the thick maidencane and encourage the growth of other species. If possible, re-route the property boundary into the uplands and away from the wetland.

Wetland ID: 64-01

Description: This wetland is a 0.9 ha ephemeral forested swamp. Cypress and pine trees dominate the canopy, and cover 50-75% of the wetland. The midstory is dominated by wax myrtle, and covers 5-25% of the wetland. Maidencane and other grasses grow throughout the wetland, and cover 25-50% of the basin. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 65-01

Description: This wetland is a 1.7 ha ephemeral marsh. Cypress and pine trees grow around the wetland edge, and cover 25-50% of the basin. The midstory is dominated by wax myrtle and fetterbush, and covers 25-50% of the wetland. Maidencane and sawgrass grow throughout the wetland, and cover >75% of the basin. A drainage ditch on the west side of the wetland has allowed upland woody plants to encroach into the wetland. The adjacent uplands are mesic flatwoods with thickly stocked pine trees.

Wetland Concern(s): Ditching, Herbaceous density, Woody encroachment

Restoration Action Needed: Fill the ditch. Monitor herbaceous density; provide custom burn treatments if needed. Hand-chop the encroaching young pine trees in the wetland interior. Periodic fire should reduce the encroaching shrubs.

Wetland ID: 65-02

Description: This wetland is a 0.5 ha highly ephemeral mixed swamp. Cypress and large slash pine trees dominate the canopy, and cover 50-75% of the wetland. The midstory is dominated by wax myrtle, and covers 25-50% of the wetland. Sedges and grasses grow throughout the wetland, and cover >75% of the basin. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 65-03

Description: This wetland is a 2.0 ha ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by wax myrtle, and covers 25-50% of the wetland. A few pine trees are beginning to colonize the wetland basin. Maidencane grows thick throughout the wetland, and covers >75% of the basin. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Herbaceous density, Woody encroachment

Restoration Action Recommended: This wetland appears to be a recovering cypress dome. The wetland could be monitored and treated with periodic fire to ensure the young pine trees do not establish and the thick maidencane is reduced. If the pine trees become established, they could be hand-chopped from the wetland basin.

Wetland ID: 68-01

Description: This wetland is a 1.2 ha semi-permanent marsh. It has an open, herbaceous center and is ringed with cypress and other woody vegetation. Cypress trees cover 25-50% of the basin. The midstory is dominated by fetterbush, gallberry, and *Smilax*, and covers 5-25% of the wetland. Fern grow throughout the wetland, and cover >75% of the basin. Snags stand along the east side of the wetland. A wildfire burned through this management unit in August of 2006, and completely removed encroaching woody vegetation from the wetland. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 69-01

Description: This wetland is a 0.7 ha ephemeral marsh. There is no tree canopy cover. Wax myrtle grows in a ring around the wetland center, and covers 5-25% of the wetland. Maidencane grows throughout the wetland, and covers >75% of the basin. The adjacent uplands are wet flatwoods with densely stocked pine trees.

Wetland Concern(s): Herbaceous density

Restoration Action Recommended: Monitor herbaceous density and shrub ring; provide custom burn treatments if needed.

Wetland ID: 69-02

Description: This wetland is a 0.2 ha ephemeral marsh. Pine trees grow around the wetland edge, and cover 5-25% of the basin. There is no midstory cover. Maidencane and other grasses grow throughout the wetland, and cover >75% of the basin. A MU boundary/fireline bisects the north side of the wetland and another MU boundary/fireline flanks the east side. Old feral hog damage is evident in the wetland. The adjacent wetlands are mesic flatwoods.

Wetland Concern(s): Feral hog damage, MU boundary/fireline

Restoration Action Recommended: Monitor this wetland to ensure more damage does not occur in the future. Re-route the MU boundary into the uplands and away from the wetland. If the boundary cannot be re-routed, monitor the wetland to ensure it regularly burns. If not, custom burning of the wetland basin and vegetation surrounding the basin may be needed in the future.

Wetland ID: 70-01

Description: This wetland is a 0.4 ha ephemeral marsh. Gum and pine trees grow around the edge of the wetland, and cover 5-25% of the wetland. The midstory is dominated by wax myrtle, and covers 5-25% of the wetland. Maidencane and fern grow throughout the wetland, and cover >75% of the basin. Old stumps in the adjacent wet flat provide evidence of historical logging. The adjacent uplands are a mix of mesic and wet flatwoods.

Wetland Concern(s): Herbaceous density

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed.

Wetland ID: 70-02

Description: This wetland is a 0.2 ha ephemeral marsh. There is no significant tree canopy or midstory cover, although a few young pine trees grow scattered in the wetland basin. Maidencane grows thick throughout the wetland, and covers >75% of the basin. Old stumps in the adjacent wet flat provide evidence of historical logging. The adjacent uplands are a mix of mesic and wet flatwoods.

Wetland Concern(s): Herbaceous density

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed.

Wetland ID: 71-01

Description: This wetland is a 1.5 ha semi-permanent mixed swamp. Cypress, bay, and pine trees dominate the canopy, and cover >75% of the wetland. The midstory is dominated by fetterbush and bay saplings, and covers >75% of the wetland. There is sparse herbaceous cover. An MU boundary/fireline bisects the northwest side of the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old, but deep, plowlines created by the Florida Department of Forestry.

Wetland Concern(s): MU boundary/fireline, Woody encroachment

Restoration Action Recommended: The fireline is not a major concern but the wetland should be monitored to ensure the fireline does not prevent burning of the wetland basin and vegetation surrounding the basin. Periodic fires would reduce the thick woody vegetation.

Wetland ID: 71-02

Description: This wetland is a 0.3 ha highly ephemeral marsh. A few large slash pines are growing within the wetland, but prove <5% canopy cover. There is no midstory cover. Sedges, grasses, and ferns are extensive throughout, and cover >75% of the wetland basin. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 71-03

Description: This wetland is a 0.4 ha ephemeral marsh. Black gum trees ring the wetland edge, and cover 25-50% of the wetland. The midstory is dominated by wax myrtle, and covers 5-25% of the wetland. Maidencane, sphagnum, and fern grow throughout the wetland, and cover >75% of the basin. An old ditch is located in the uplands on the north side. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 71-04

Description: This wetland is a 0.5 ha ephemeral marsh. Gum and pine trees dominate the canopy, and cover 5-25% of the wetland. There is no midstory layer. Maidencane grows throughout the wetland, and covers >75% of the basin. The adjacent uplands are mesic flatwoods that are managed with prescribed fire.

Wetland Concern(s): Herbaceous density

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed.

Wetland ID: 73-01

Description: This wetland is a 0.8 ha ephemeral marsh. Cypress and pine trees dominate the canopy, and cover 5-25% of the wetland. There is no midstory cover. Maidencane grows throughout the wetland, and covers >75% of the basin. There is light feral hog damage around the wetland edge. We observed mechanical restoration activity in the uplands that extended to the wetland edge. The adjacent uplands are mesic flatwoods that are managed with mechanical treatment and prescribed fire.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: Monitor this wetland to ensure more severe damage does not occur in the future.

Wetland ID: 73-02

Description: This wetland is a 4.5 ha semi-permanent mixed swamp. Cypress and bay trees dominate the canopy, and cover >75% of the wetland. The midstory is dominated by fetterbush, and covers >75% of the wetland. There is little to no herbaceous vegetation. Recent restoration activity was conducted in the uplands and up to wetland edge to rehabilitate a large fireline constructed by Florida Department of Forestry during the 2006 wildfire. It appears the wetland was not completely dry and there are ruts and deep holes surrounding the wetland. The adjacent uplands are mesic flatwoods that are managed with mechanical treatment and prescribed fire.

Wetland Concern(s): Vehicular damage, Woody encroachment

Restoration Action Recommended: The ruts and deep holes will heal over time. Periodic fires should reduce the thick shrub layer.

Wetland ID: 74-01

Description: This wetland is a 0.7 ha ephemeral forested swamp. Cypress and pine trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by fetterbush and wax myrtle, and covers 5-25% of the wetland. Maidencane, *Sphagnum*, and fern grow throughout the wetland, and cover >75% of the basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 74-02

Description: This wetland is a 1.0 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows throughout the wetland, and covers >75% of the basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 74-03

Description: This wetland is a 1.1 ha ephemeral marsh. There is no tree canopy. A thick patch of shrubs grows on the south and southwest periphery of the wetland, but covers <5% of the wetland. Maidencane grows thick throughout the wetland, and covers >75% of the basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): Herbaceous density

Restoration Action Recommended: Monitor herbaceous density; provide custom burn treatments if needed.

Wetland ID: 75-01

Description: This wetland is a 6.3 ha semi-permanent mixed swamp. Cypress and pine trees dominate the canopy, and cover >75% of the wetland. The midstory is dominated by fetterbush, and covers >75% of the wetland. Sedges and grasses grow in scattered patches, and cover 5-25% of the wetland basin. The brush surrounding this wetland is tall and very thick. The adjacent uplands are mesic flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Woody encroachment

Restoration Action Recommended: The thick brush ring surrounding this wetland needs to be thinned. Periodic fire should reduce the dense woody vegetation, but this wetland also is a good candidate for experimental, mechanical brush ring removal.

Wetland ID: 76-01

Description: This wetland is a 0.1 ha highly ephemeral marsh. Slash pines have established in the wetland, and cover 25-50% of the basin. There is no midstory layer. Maidencane and redroot grow throughout the wetland, and covers 25-50% of the wetland basin. Feral hog damage is severe and mostly concentrated through the center of the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, Woody encroachment

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted by severe feral hog damage and should be considered for more aggressive action. Remove pine trees from the wetland interior.

Wetland ID: 76-02

Description: This wetland is a 0.2 ha highly ephemeral marsh. Slash pine trees have established in the wetland, and cover 25-50% of the wetland. There is no midstory layer. Maidencane and *Sphagnum* grow throughout, and cover >75% of the wetland basin. Old and new feral hog damage is evident. The adjacent uplands are mesic flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, Woody encroachment

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted by severe feral hog damage and should be considered for more aggressive action. Remove pine trees from the wetland interior.

Wetland ID: 76-03

Description: This wetland is a 01. ha highly ephemeral marsh. Slash pine trees have established in the wetland, and cover 25-50% of the wetland. There is no midstory layer. Redroot and *Xyris* grow throughout the wetland, and cover 50-75% of the basin. The feral hog damage is severe and distributed throughout the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, Woody encroachment

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted by severe feral hog damage and should be considered for more aggressive action. Remove pine trees from the wetland interior.

Wetland ID: 76-04

Description: This wetland is a 0.1 ha highly ephemeral marsh. Slash pine trees have established in the wetland, and cover 5-25% of the wetland. There is no midstory layer. Maidencane, *Sphagnum*, and redroot grow throughout the wetland, and cover 50-75% of the basin. Feral hog damage is distributed throughout the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, Woody encroachment

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted by severe feral hog damage and should be considered for more aggressive action. Remove pine trees from the wetland interior.

Wetland ID: 76-05

Description: This wetland is a 0.4 ha highly ephemeral marsh. A few slash pines have established in the wetland, but provide less than 5% canopy cover. There is no midstory layer. Slash pine seedlings are beginning to establish in the wetland basin. *Sphagnum*, sedges, grasses, and redroot grow throughout the wetland, and cover 50-75% of the basin. The feral hog damage is severe and is distributed throughout the wetland. The adjacent uplands are mesic flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage, Woody encroachment

Restoration Action Needed: This wetland is part of a cluster of wetlands impacted by severe feral hog damage and should be considered for more aggressive action. Monitor the encroaching pine seedlings to ensure they do not get established. Pine saplings can be hand-chopped if needed in the future.

Wetland ID: 76-06

Description: This wetland is a 1.1 ha semi-permanent mixed swamp surrounded by mesic flatwoods. Cypress trees dominate the canopy, and cover 50-75% of the wetland basin. The midstory is dominated by fetterbush and smilax, and covers 50-75% of the wetland. Maidencane is sparse, and covers 5-25% of the wetland basin. An old fireline encircles the pond. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): Fireline

Restoration Action Recommended: Allow vegetation to reestablish in the old fire break and monitor the wetland to ensure it regularly burns. When burning this management unit, custom burning of the wetland basin and vegetation surrounding the basin may be needed if the old fire break acts as a barrier.

Wetland ID: 76-07

Description: This wetland is a 1.6 ha semi-permanent forested swamp. Cypress trees grow in a ring around an herbaceous marsh center. The tree canopy covers 25-50% of the wetland basin. Fetterbush and wax myrtle grow in a ring around the wetland, and cover 5-25% of the wetland. Maidencane grows throughout the wetland, and covers 50-75% of the basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 77-01

Description: This wetland is 0.7 ha semi-permanent mixed swamp. Cypress trees dominate the canopy, and cover 50-75% of the wetland. The midstory is dominated by wax myrtle and fetterbush, and covers 25-50% of the wetland. Maidencane grows in scattered patches and covers 5-25% of the wetland basin. This cypress dome is ringed with a thick shrub layer. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): Woody encroachment

Restoration Action Recommended: Periodic, growing-season burns around the edge of the wetland should reduce the thick shrub layer.

Wetland ID: 77-02

Description: This wetland is 0.9 ha ephemeral marsh. There is no tree canopy or midstory cover. Maidencane grows in a ring around the open-water center, and covers 50-75% of the wetland basin. Feral hog damage is minor and concentrated around the wetland edge. The adjacent uplands are scrubby flatwoods.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 77-03

Description: This wetland is a 0.4 ha highly ephemeral marsh. There is no tree canopy or midstory cover. Maidencane and other grasses grow throughout the wetland, and cover >75% of the basin. Vegetation is now growing in old feral hog ruts and rootings. The adjacent uplands are a mix of mesic and scrubby flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 77-04

Description: This wetland is a 0.9 ha highly ephemeral marsh. Slash pine trees dominate the canopy, and cover 5-25% of the wetland. There is no midstory cover. Maidencane, *Sphagnum*, and redroot grow throughout the wetland, and cover >75% of the basin. Old feral hog damage is extensive throughout the wetland, although vegetation has recovered. The adjacent uplands are a mix of mesic and scrubby flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 77-05

Description: This wetland is a 0.3 ha ephemeral forested swamp. Cypress trees dominate the canopy, and cover 50-75% of the wetland. The midstory is dominated by wax myrtle, and covers 5-25% of the wetland. Maidencane grows throughout the wetland, and covers >75% of the basin. The adjacent uplands are scrubby flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): None

Restoration Action Recommended: None

Wetland ID: 78-01

Description: This wetland is 1.3 ha semi-permanent mixed swamp. Cypress trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by wax myrtle and fetterbush, and covers 25-50% of the wetland. Sedges, grasses, and pickerel weed grow throughout the wetland, and cover 50-75% of the basin. Cypress stumps indicate historical logging within the wetland. A minimal amount of feral hog damage is present. This cypress pond has a high diversity of herbaceous and woody vegetation, especially on the east side of the pond. The adjacent uplands are scrubby flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 78-02

Description: This wetland is a 0.6 ha highly ephemeral marsh. There is minimal canopy cover and no midstory cover. Maidencane, other grasses, and *Sphagnum* grow throughout the wetland, and cover >75% of the basin. Feral hog damage is severe. The adjacent uplands are scrubby flatwoods. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 78-03

Description: This wetland is a 0.1 ha highly ephemeral marsh. There is no tree canopy or midstory cover. Grasses and ferns grow throughout the wetland, and cover >75% of the basin. Feral hog damage is minor. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 78-04

Description: This wetland is a 1.1 ha highly ephemeral marsh. Slash pine trees cover 25-50% of the wetland. There is no midstory layer. *Sphagnum*, grasses, and redroot grow throughout the wetland, and cover >75% of the basin. Old and new feral hog damage is evident and severe to moderate in extent. The adjacent uplands are scrubby flatwoods.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action. The pine trees could be removed from the wetland interior.

Wetland ID: 78-05

Description: This wetland is a 0.2 ha highly ephemeral marsh. There is no tree canopy or midstory cover. *Sphagnum* and ferns grow throughout the wetland, and cover >75% of the basin. Feral hog damage is deep and extensive. The adjacent uplands are scrubby flatwoods.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 78-06

Description: This wetland is a <0.1 ha highly ephemeral marsh. There is no tree canopy or midstory cover. Grasses and redroot grow throughout the wetland, and cover >75% of the basin. Vegetation is now growing in old feral hog ruts and rootings. The adjacent uplands are scrubby flatwoods.

Wetland Concern(s): Feral hog damage

Restoration Action Recommended: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 78-07

Description: This wetland is a 0.2 ha highly ephemeral marsh. Slash pine trees cover 25-50% of the wetland. The midstory is dominated by gallberry, and covers 5-25% of the wetland. Grasses and fern grow throughout the wetland, and cover 50-75% of the basin. Feral hog damage eliminated the vegetation in the center of the wetland. The adjacent uplands are wet flatwoods.

Wetland Concern(s): Feral hog damage

Restoration Action Needed: This wetland is part of a cluster of wetlands impacted to varying degrees by feral hog damage. These wetlands should be monitored for changes in feral hog activity. If damage becomes more severe or more widespread, the area should be considered for more aggressive action.

Wetland ID: 80-01

Description: This wetland is a 0.7 ha semi-permanent mixed swamp. Cypress trees dominate the canopy, and cover 50-75% of the wetland. The dense midstory layer is dominated by fetterbush and smilax, and covers >75% of the wetland. There is no herbaceous cover. The adjacent uplands are wet flatwoods with thick underbrush. The topography is undulating with old plowlines created by the Florida Department of Forestry.

Wetland Concern(s): Woody encroachment

Restoration Action Recommended: Although this wetland was recently burned, the shrub layer remains tall and dense. Periodic fire should reduce this thick midstory layer.

Wetland ID: 80-02

Description: This wetland is a 0.2 ha highly ephemeral wetland. Slash pine trees dominate the canopy, and cover 50-75% of the basin. There is no midstory layer. *Sphagnum* and redroot grow throughout the wetland, and cover >75% of the basin. Old and new feral hog damage covers the entire wetland basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): Feral hog damage, Woody encroachment

Restoration Action Recommended: Both feral hogs and the pine canopy are excluding herbaceous vegetation growth. This wetland is part of a cluster of wetlands impacted by severe feral hog damage and should be considered for more aggressive action. The pine trees around the wetland could be thinned during the next upland thinning operation.

Wetland ID: 80-03

Description: This wetland is a 0.4 ha ephemeral mixed swamp. Cypress trees dominate the canopy, and cover 25-50% of the wetland. The midstory is dominated by fetterbush and wax myrtle, and covers 25-50% of the wetland. *Sphagnum*, fern, and pickerelweed grow throughout the wetland, and cover >75% of the basin. Thick shrubs encircle the edges of the wetland. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): Woody encroachment

Restoration Action Recommended: Periodic fire, particularly around the wetland edge, would reduce the thick shrub layer.

Wetland ID: 80-04

Description: This wetland is a 0.6 ha ephemeral marsh. There is no tree canopy or midstory layer. Maidencane grows throughout the wetland, and covers >75% of the basin. The adjacent uplands are mesic flatwoods.

Wetland Concern(s): None

Restoration Action Recommended: None

REFERENCES

REFERENCES

Belden, R., and W. Frankenberger. 1977. Management of feral hogs in Florida – past, present, and future. *In* G. W. Wood, editor. Research and management of wild hog populations: proceedings of a symposium. Belle W. Baruch Forest Science Institute of Clemson University, Georgetown, South Carolina, USA.

Bell, C. E. 1997. Using arsenal for brushy species control. California Exotic Pest Plant Council Symposium Proceedings, Concord, CA.

Berrill, M., S. Bertram, L. McGillvray, M. Kolohon, and B. Pauli. 1994. Effects of low concentrations of forest-use pesticides on frog embryos and tadpoles. Environmental Toxicology and Chemistry 13(4): 657-664.Bishop, D. C., and C. A. Haas. 2005. Burning trends and potential negative effects of suppressing wetland fires on flatwoods salamanders. Natural Areas Journal 25(3): 290-294.

Blood, E. R., J. S. Phillips, D. Calhoun, and D. Edwards. 1997. The Role of the Floridan Aquifer in Depressional Wetlands Hydrodynamics and Hydroperiod. Pages 273-279 *in* K. J. Hatcher, editor. Proceedings of the 1997 Georgia Water Resources Conference, Athens, USA.

Brennan, L. A., R. T. Engstrom, W. E. Palmer, S. M. Hermann, G. A. Hurst, L. W. Burger, and C. L. Hardy. 1998. Whither wildlife without fire? Trans. 63rd North American Wildlife and Natural Resources Conference: 402-414.

Cheek, A. O., C. F. Ide, J. E. Bollinger, C. V. Rider, and J. A. McLachlan. 1999. Alteration of leopard frog (*Rana pipens*) metamorphosis by the herbicide acetochlor. Archives of Environmental Contamination and Toxicology 37(1): 70-77.

Choquenot, D., J., McIlroy, J., and T. Korn. 1996. Managing vertebrate pests: feral pigs. Bureau of Resource Sciences. Australian Government Publishing Service, Canberra, AUS.

Comer, P., K. Goodin, A. Tomaino, G. Hammerson, G. Kittel, S. Menard, C. Nordman, M. Pyne, M. Reid, L. Sneddon, and K. Snow. 2005. Biodiversity values of geographically isolated wetlands in the United States. NatureServe, Arlington, Virginia, USA.

Cox, J., R. Kautz, M. Maclauglin, and T. Gilbert. 1994. Closing the gaps in Florida's wildlife habitat conservation system. Office of Environmental Services, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida, USA.

Dodd, C. K., Jr. 1992. Biological diversity of a temporary pond herpetofauna in north Florida sandhills. Biodiversity and Conservation 1: 125-142.

Dodd, C. K., Jr., and B. G. Charest. 1988. The herpetofaunal community of temporary ponds in north Florida sandhills: species composition, temporal use, and management implications. Pages 87-97 *in* R. C. Szaro, K. E. Severson, and D. R. Patton, technical coordinators. Proceedings of the symposium management of reptiles, amphibians, and small mammals in North America. U.S. Forest Service General Technical Report RM-166

Enge, K. M., and K. N. Wood. 2000. A herpetofaunal survey of Chassahowitzka Wildlife Management Area, Hernando County, Florida. Herpetological Natural History 7(2): 117-144.

Engeman, R. M., A. Stevens, J. Allen, J. Dunlap, M. Daniel, D. Teague, and B. Constantin. 2007. Feral swine management for conservation of an imperiled wetland habitat: Florida's vanishing seepage slopes. Biological Conservation 134: 440-446.

Ewel, K. C. 1990. Swamps. Pages 281-323 *in* R. L. Myers and J. J. Ewel, editors. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida, USA.

Ferrell, J., Langeland, K., and B. Sellers. 2006. Herbicide application techniques for woody plant control. Document SS-AGR-260, Center for Aquatic and Invasive Plants, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Ferriter, A., D. Thayer, B. Nelson, T. Richards, and D. Girardin. 1997. Management in Water Management Districts. Pages 317-325 *in* D. Simberloff, D. C. Schmitz, and T. C. Brown, editors. Strangers in paradise: impact and management of nonindigenous species in Florida. Island Press, Washington, D.C., USA.

Florida Fish and Wildlife Conservation Commission (FWC). 2005. Florida's Wildlife Legacy Initiative. Florida's Comprehensive Wildlife Conservation Strategy. Tallahassee, Florida, USA.

Forrester, D. J. 1991. Parasites and diseases of wild mammals in Florida. University of Presses in Florida, Gainesville, Florida, USA.

Franz, R., C. K. Dodd Jr., and C. Jones. 1988. *Rana areolata aesopus* Florida gopher frog Movement. Herpetological Review 19(2): 33.

Franz, R., and L. L. Smith. 1999. Distribution and status of the striped newt and Florida gopher frog in peninsular Florida. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida, USA.

Frost, C. C. 2006. History and future of the longleaf pine ecosystem. Pages 9-42 *in* S. Jose, E. J. Jokela, and D. L. Miller, editors. The longleaf pine ecosystem – ecology, silviculture, and restoration. Springer, U.S.A.

Gibbs, J. P. 1993. Importance of small wetlands for the persistence of local populations of wetland-associated animals. Wetlands 13(1): 25-31.

Gibbons, J. W. 2003. Terrestrial habitat: a vital component for herpetofauna of isolated wetlands. Wetlands 23(3): 630-635.

Greenberg, C. H., A. Storfer, G. W. Tanner, and S. G. Mech. 2003. Amphibians using isolated, ephemeral ponds in Florida longleaf pine uplands: population dynamics and assessment of monitoring methodologies. Final Report to Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida, USA.

Hart, R., and J. R. Newman. 1995. The importance of isolated wetlands to fish and wildlife in Florida. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.

Hone, J., and B. Atkinson. 1983. Evaluation of fencing to control feral pig movement. Wildlife Research 10: 499-505.

Hipes, D. 2003. Field surveys for flatwoods salamander on under-surveyed publicly owned lands in Florida. Florida Natural Areas Inventory, Tallahassee, Florida, USA.

Jensen, D. B., and D. J. Vosick. 1994. Introduction. *In* D. C. Schmitz and T. C. Brown, editors. An assessment of invasive non-indigenous species in Florida's public lands. Technical Report TSS-94-100. Florida Department of Environmental Protection, Tallahassee, Florida, USA.

Jensen, J. B., and S. C. Richter. 2005. *Rana capito* (Le conte, 1855). Pages 536-538 *in* M. Lannoo, editor. Amphibian declines: The conservation status of United States species. University of California Press, Berkley, California, USA.

Johnson, S. A. 2001. Life history, ecology, and conservation genetics of the striped newt (*Notophthalmus perstriatus*). Ph.D Dissertation, University of Florida, Gainesville, FL.

Johnson, S. A. 2003. Orientation and migration distances of a pond-breeding salamander. Salamandridae, *Notophthalmus perstriatus*. Alytes 21: 3-22.

Jolley, D. B. 2007. Reproduction and herpetofauna depredation of feral pigs at Fort Benning, Georgia. Master of Science Thesis, Auburn University, Auburn, Georgia, USA.

Killian, G., L. Miller, J. Rhyan, and H. Doten. 2006. Immunocontraception of Florida feral wwine with a single-dose GnRH vaccine. American Journal of Reproductive Immunology 55: 378-384.

Kushlan, J. A. 1990. Freshwater marshes. Pages 324-363 *in* R. L. Myers and J. J. Ewel, editors. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida, USA.

LaClaire, L. V. 1992. Ecology of temporary ponds in north-central Florida. Thesis, University of Florida, Gainesville, Florida, USA.

LaClaire, L. V., and R. Franz. 1990. Importance of isolated wetlands in upland landscapes. Pages 9-15 *in* M. Kelly, editor. The role of aquatic plants in Florida's lakes and rivers. Proceedings of the 2nd Annual Meeting, Florida Lake Management Society, Orlando, Florida, USA.

Langeland, K. A. 2006. Safe use of glyphosate-containing products in aquatic and upland natural areas. Document SS-AGR-104, Center for Aquatic and Invasive Plants, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Langeland, K. A., Ferrell, J. A., Sellers, B., Macdonald, G. E., and R. K. Stocker. 2009. Control of nonnative plants in natural areas of Florida. 2009. Document SP 242, Center for Aquatic and Invasive Plants, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Lannoo, M. (ed.). 2005. Amphibian declines: the conservation status of United States species. University of California Press, Berkeley, CA.

Layne, J. N. 1997. Nonindigenous mammals. Pages 157-186 *in* D. Simberloff, D. C. Schmitz, and T. C. Brown, editors. Strangers in paradise: impact and management of nonindigenous species in Florida. Island Press, Washington, D.C., USA.

Lipscomb, D. J. 1989. Impacts of feral hogs on longleaf pine regeneration. Southern Journal of Applied Forestry 13: 177-181.

Maffei, M. D. 1997. Management in National Wildlife Refuges. Pages 267-274 *in* D. Simberloff, D. C. Schmitz, and T. C. Brown, editors. Strangers in paradise: impact and management of nonindigenous species in Florida. Island Press, Washington, D.C., USA.

Martin, K. L. and L. K. Kirkman. 2009. Management of ecological thresholds to re-establish disturbance-maintained herbaceous wetlands of the south-eastern USA. Journal of Applied Ecology 46: 906-914.

Means, D. B. 1996. Longleaf pine forest, going, going,… Pages 210-229 *in* M. B. Davis, editors. Eastern old growth forests. Island Press, Washington, DC.

Means, D. B. 2007. Life cycles, dispersal, and critical habitat utilization of vertebrates dependent upon small isolated water bodies in the Munson Sandhills and Woodville Karst Plain, Leon County, Florida. Coastal Plains Institute, Tallahassee, Florida, USA.

Means, D. B., C. K. Dodd, Jr., S. A. Johnson, and J. G. Palis. 2004. Amphibians and fire in longleaf pine ecosystems: response to Schurbon and Fauth. Conservation Biology 18(4): 1149-1153.

Means, D. B., and R. C. Means. 1998. Distribution of the striped newt (*Notophthalmus perstriatus*) and gopher frog (*Rana capito*) in the Munson Sandhills of the Florida Panhandle. Coastal Plains Institute, Tallahassee, Florida, USA.

Means, D. B., and J. Travis. 2007. Declines in ravine-inhabiting dusky salamanders of the southeastern US Coastal Plain. Southeastern Naturalist 6(1): 83-96.

Means, R.P.M. 2008. Management Strategies for Florida's Ephemeral Ponds and Ephemeral Pond-Breeding Amphibians. Final Report to the Florida Fish and Wildlife Conservation Commission. Coastal Plains Institute, Tallahassee, Florida, USA.

Moler, P. E., and R. Franz. 1987. Wildlife values of small, isolated wetlands in the southeastern Coastal Plain. Pages 234-241 *in* R.R. Odum, K.A. Riddleberger, and J.C. Ozier, editors. Proceedings of the third southeast nongame and endangered wildlife symposium. Georgia Department of Natural Resources, Atlanta, Georgia, USA.

Mushinsky, H. R. 1985. Fire and the Florida sandhill herpetofaunal community: with special attention to responses of *Cnemidophorus sexlineatus*. Herpetologica 41(3): 333-342.

Palis, J. G. 1997. Distribution, habitat, and status of the flatwoods salamander (*Ambystoma cingulatum*) in Florida, USA. Herpetological Natural History 5(1): 53-65.

Platt, W. J. 1999. Southeastern pine savannas. Pages 23-51 *in* R. C. Anderson, J. S. Fralish and J. Baskin, editors. The savanna, barren, and rock outcrop communities of North America. Cambridge University Press, Cambridge, England.

Printiss, D., and D. Hipes. 1999. Rare amphibian and reptile survey of Eglin Air Force Base, Florida. Florida Natural Areas Inventory, Tallahassee, Florida, USA.

Printiss, D., and D. Hipes. 2000. Flatwoods salamander survey and habitat evaluation of Eglin Air Force Base, Hurlburt Field, and Tyndall Air Force Base. Florida Natural Areas Inventory, Tallahassee, Florida, USA

Printiss, D., and D. Hipes. 2001. Flatwoods salamander survey of St. Marks National Wildlife Refuge, Florida. Florida Natural Areas Inventory, Tallahassee, Florida, USA.

Randall, J. M., R. R. Lewis III, and D. R. Jensen. 1997. Ecological restoration. Pages. 205–219 i*n* D. Simberloff, D. C. Schmitz, and T. C. Brown, editors. Strangers in paradise: impact and management of nonindigenous species in Florida. Island Press, Washington, DC., USA.

Relyea, R. A. 2005a. The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. Ecological Applications 15(2): 618-627.

Relyea, R. A. 2005b. The lethal impact of roundup on aquatic and terrestrial amphibians. Ecological Applications 15(4): 118-1124.

Ripley, R., and D. Printiss. 2005. Management plan for flatwoods salamander populations on National Forests in Florida. The Nature Conservancy Northwest Florida Program, Bristol, Florida, USA.

Robbins, L. E., and R. L. Myers. 1992. Seasonal effects of prescribed burning in Florida: a review. Tall Timbers Research Station, Tallahassee, Florida, USA.

Robertson, K. M., and T. E. Ostertag. 2004. Problems with Schurbon and Fauth's test of effects of prescribed burning on amphibian diversity. Conservation Biology 18(4): 1154-1155.

Roznik, E. A. 2007. Terrestrial ecology of juvenile and adult gopher frogs (*Rana capito*). Masters Thesis, University of Florida, Gainesville, Florida, USA.

Scheffers, B. R., J. B. C. Harris, and D. G. Haskell. 2006. Avifauna associated with ephemeral ponds on the Cumberland Plateau, Tennessee. Journal of Field Ornithology 77(2): 178-183.

Schurbon, J. M., and J. E. Fauth. 2003. Effects of prescribed burning on amphibian diversity in a southeastern U.S. National Forest. Conservation Biology 17(5): 1338-1349.

Semlitsch, R. D. 2000. Size does matter: the value of small isolated wetlands. National Wetlands Newsletter: 5-13.

Semlitsch, R. D. 2003. Conservation of pond-breeding amphibians. Pages 8-23 *in* R.D. Semlitsch (editor). Amphibian conservation. Smithsonian Books, Washington D.C.

Semlitsch, R. D., D. E. Scott, J. H. K. Pechmann, and J. W. Gibbons. 1996. Structure and dynamics of an amphibian community: evidence from a 16-year study of a natural pond. Pages 217-248 *in* M. L. Cody and J. Smallwood, editors. Long-term studies of vertebrate communities. Academic Press, New York, New York, USA.

Semlitsch, R. D., and J. R. Bodie. 1998. Are small, isolated wetlands expendable? Conservation Biology: 1129-1133.

Semlitsch, R. D., and J. B. Jensen. 2001. Core habitat, not buffer zone. National Wetlands Newsletter 23(4): 5-11.

Stoddard, H. L. 1931. The bobwhite quail: its habits, preservation, and increase. Charles Scribner's Sons, New York, New York, USA.

Tiner, R. W., H. C. Bergquist, G. P. DeAlessio, and M. J. Starr. 2002. Geographically isolated wetlands: a preliminary assessment of their characteristics and status in selected areas of the United States. U.S. Fish and Wildlife Service, Northeast Region, Hadley, Massachusetts, USA.

US Department of Agriculture/Animal and Plant Health Inspection Service, US Department of Agriculture/Forest Service, and Department of Interior/Bureau of Land Management. 1997.

Animal damage control program final environmental impact statement (revised). USDA/Animal and Plant health Inspection Service. Washington, D.C.

Vtorov, I. P. 1993. Feral pig removal: effects on soil microarthropods in a Hawaiian rain forest. Journal of Wildlife Management 57: 875-880.

Wade, D., J. Ewel, and R. Hofstetter. 1980. Fire in South Florida ecosystems. US Forest Service General Technical Report No. SE-17. Southeast Forest Experiment Station, Asheville, North Carolina, USA.

Whitney, E., D. B. Means, and A. Rudloe. 2004. Priceless Florida: natural ecosystems and native species. Pineapple Press, Inc, Sarasota, Florida, USA

Williams, D. D. 1987. The ecology of temporary waters. Blackburn Press, New Jersey, USA

Appendix A. Wetland Survey Form.

Management Area:_____ Date:_____ Wetland ID:_____ Photos:_____

Wetland Basin Assessment

Wetland Type:
___Marsh ___Shrub swamp ___ Forested swamp ___Mixed swamp
___Altered ___Other:

Basin area:_____

Hydroperiod: ___Highly Ephemeral ___Ephemeral ___Semi-Perm

% Canopy Cover:
___<5% ___5-25% ___25-50% ___50-75% ___>75%

Dominant Canopy:
___N/A ___Cypress ___Gum ___Pine ___Cypress/gum
___Holly ___Cypress/pine ___Cypress/holly ___Gum/pine ___Gum/holly
___Holly/pine ___Other:

Sub-canopy Cover:
___<5% ___5-25% ___25-50% ___50-75% ___>75%

Dominant Sub-canopy:
___N/A ___Wax Myrtle ___Willow ___Titi ___Buttonbush ___Fetterbush
___Gallberry ___Holly ___Other:

% Herbaceous Cover:
___<5% ___5-25% ___25-50% ___50-75% ___>75%

Dominant Herbaceous Groundcover:
___N/A ___Maidencane ___Sphagnum ___Rush ___Sedge/Grass
___Sawgrass ___Emergents ___Fern ___Redroot ___Other:

Herbaceous Distribution:
___Sparse ___Ring around edge ___ Scattered patches ___Throughout ___Other:

Wetland Restoration Concerns:
___Hog damage ___Logging ___Slash ___Ditching ___Woody Encroachment
___Choked w/herb. ___Fireline ___Cattle ___Invasive Species ___Push Piles
___Bedding ___Desiccation ___Vehicular ___Other:

Comments:

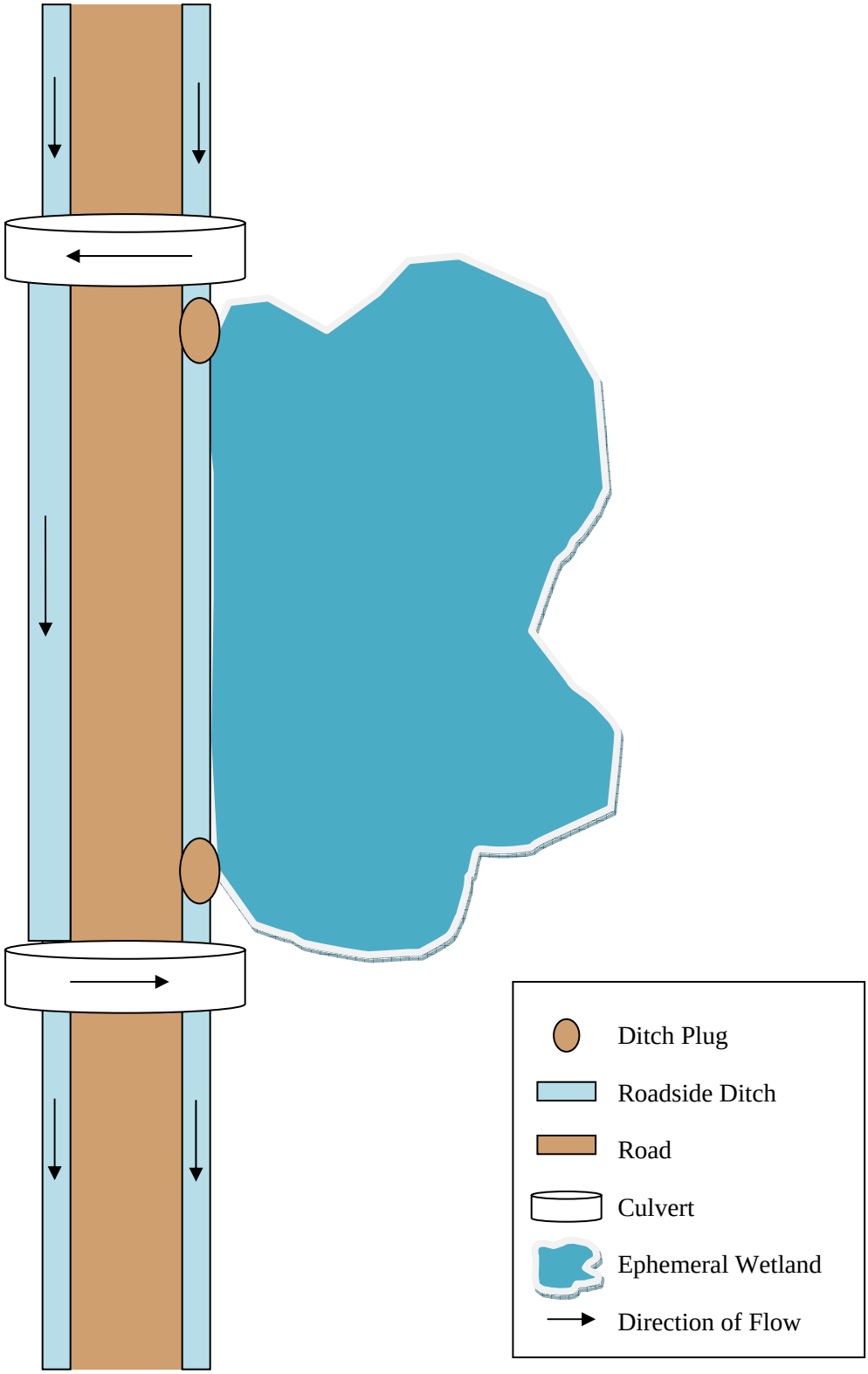
Upland Assessment

Surrounding Community Type:
___Mesic flatwoods ___Wet flatwoods ___Scrubby flatwoods ___Upland pine forest
___ Wet prairie ___Pasture ___Old field ___Sandhill ___Other:

Upland Condition:
___Fire suppressed ___Has burned ___Old bedding ___Pine plantation
___Hog damage ___Invasive species ___Grazing ___Other:

Comments:

Appendix B. Suggested method to break connectivity between an ephemeral wetland and tangent roadside ditch. This method is recommended as an experimental approach to restore the hydrology of wetlands connected to permanent ditches.



Appendix C. Scientific names of common plants encountered during this project, listed alphabetically by common name.

Bahia grass	*Paspalum notatum*
Black gum	*Nyssa sylvatica*
Broomsedge	*Andropogon sp.*
Buttonbush	*Cephalanthus occidentalis*
Cogongrass	*Imperata cylindrica*
Cordgrass	*Spartina sp.*
Corkwood	*Leitneria floridana*
Dog fennel	*Eupatorium capillifolium*
Fetterbush	*Lyonia lucida*
Gallberry	*Ilex glabra* (short gallberry), *Ilex tomentosa* (tall gallberry)
Hackberry	*Celtis sp.*
Japanese climbing fern	*Lygodium japonicum.*
Laurel oak	*Quercus laurifolia*
Lizard's tail	*Saururus cernuus*
Loblolly bay	*Gordonia lasianthus*
Maidencane	*Panicum hemitomon*
Muscadine grape	*Vitis rotundifolia*
Myrtle-leaved holly	*Ilex myrtifolia*
Persimmon	*Diospyros virginiana*
Pickerelweed	*Pontederia cordata*
Pond cypress	*Taxodium ascendens*
Redroot	*Lachnanthes caroliniana*
Sawgrass	*Cladium jamaicense*
Sand pine	*Pinus clausa*
Slash pine	*Pinus elliottii*
Smartweed	*Polygonum hydropiperoides*
St. Johns wort	*Hypericum spp.*
Sweet gum	*Liquidambar styraciflua*
Sweet bay magnolia	*Magnolia virginiana*
Titi	*Cliftonia monophylla* (black titi), *Cyrilla racemiflora* (swamp titi),
Torpedograss	*Panicum repens*
Wax myrtle	*Myrica cerifera*