A FLORISTIC STUDY OF WEAVER CREEK WETLAND, SANTA ROSA COUNTY, FLORIDA

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A FLORISTIC STUDY OF WEAVER CREEK WETLAND, SANTA ROSA COUNTY, FLORIDA

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A FLORISTIC STUDY OF WEAVER CREEK WETLAND, SANTA

ROSA COUNTY, FLORIDA

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THESIS ABSTRACT

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Courtney R. Holt

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Steepheads (streams that originate from the bases of valley walls) create a unique freshwater wetland habitat. Currently, steepheads are known to exist only in the southeastern United States along the Gulf Coastal Plain. The biology of these habitats is relatively unknown. The objectives of this study were to provide a comprehensive list of vascular plant species in the wetland of Weaver Creek (a steephead stream in Santa Rosa County, Florida), to compare the upstream and downstream reaches of Weaver Creek, and to compile lists of previously reported species from steephead habitats. Fourteen sampling visits over a period of one year (2006-2007) were made to the study site. Every effort was made to cover the entire length of the creek and to collect all species while in flower or fruit. In addition to the species list, species and taxonomic (generic) richness,

evenness (J') and diversity (H') were calculated for the study site. The Jaccard Index (JI) was used to compare the degree of floristic similarity between the upstream and downstream sections of the wetland. Species richness (102 species), evenness (J' = 0.86) and diversity (H' = 3.97) for the entire study site were all relatively high. Taxonomic/generic richness, evenness and diversity were high as well (67 genera, J' = 0.95, H' = 3.98). The degree of community similarity between the upstream and downstream sections of Weaver Creek was very low (JI = 13.33%). Because of this low degree of similarity between the two sections, species and taxonomic richness, evenness and diversity were calculated for each section of the creek to further illustrate the differences between them. The downstream section was both more rich and diverse than the upstream section. However, evenness was slightly greater upstream. This study added 68 species to the list of plants known to occur in steephead habitats. The richness and diversity of the study site illustrate the need for further scientific investigation into steephead habitats. The potential for studying the presence of genetically isolated populations and endemics, as well as rare species, in steepheads provides additional incentive to focus on these habitats.

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INTRODUCTION

Steepheads (also listed as a type of seepage stream by the Florida Natural Areas Inventory [FNAI] [1990]) are little-known habitats found along the southeastern Coastal Plain. They were first described by Sellards and Gunter (1918). The Eglin AFB Steephead Monitoring Plan (2004) defined them as "deep ravines at the headwaters of streams." Means (1975) provided a more detailed definition: "perennially wet, first order stream sources that issue from the base of valley headwalls." The lack of a strict definition of "steephead" speaks to the paucity of intense biological studies of this habitat type.

In contrast to steepheads, gully-eroded ravines are formed by water running over the surface of the land, creating a valley by erosion (Wolfe et al. 1988, Means 1991, Means 2000). Water flow can be heavy at times but is not necessarily constant (Eglin AFB Steephead Monitoring Plan 2004). At the heads of these ravines, the slope is gentle and becomes steeper farther downstream. Due to the scouring action of the water, the ravine appears V-shaped in cross section (Means 2000). Over time, erosion decreases the grade of the slope and causes sediments to enter the stream.

The formation of steepheads is strikingly different from that of gully-eroded ravines and somewhat more complex. Steepheads in the Florida Panhandle are commonly found in (but not limited to) the deep sands of the Citronelle formation as well as in younger sands south of the Cody Scarp, an ancient shoreline (Wolfe et al. 1988,

Enge 1998). Sediments are of Miocene or Pliocene age and are fine- to coarse-grained sand intermixed with gravel (Platt and Schwartz 1990, Means 2000, USGS 2006). These sands contain little clay or silt and were uncovered about two million years ago following the recession of the Gulf of Mexico (Means 1985). Some sources have indicated that these are the only areas in which steepheads occur (Wolfe et al. 1988, Platt and Schwartz 1990, Rasmussen 2004). However, Sheridan et al. (1999) reported on habitats they described as steepheads (although they called them seepage streams) from western Georgia Fall Line sandhills. The vegetational characteristics of steepheads in this area appear very similar to those in Florida.

Steepheads are formed as a stream emerges from beneath the surface and causes the sand above the emergent point to slump. Schumm et al. (1995) referred to the actual water emergence as "spring sapping" rather than seepage erosion because the water discharge is concentrated into specific point sources. This distinction is important in that it explains the difference between seepage slopes (bogs) and steepheads. It was previously thought that water rapidly percolates through the sand until it reaches a confining layer where it is forced out to form the head of the stream (Sellards and Gunter 1918). Resource Consultants and Engineers, Inc. (1994), however, contended that steepheads can form in homogeneous sediments, indicating that an impermeable layer is not necessary for spring formation. Drilling subsequently revealed that there is no hardpan below the bases of some steepheads, providing direct evidence that a hardpan is not required for seepage to occur (Schumm et al. 1995). Howard (1990) suggested that riverine valleys that form in homogeneous sediments are controlled by the slope of the

water table. However, more geologic/hydrologic investigation of steephead formation is needed to fully support this idea.

The erosional processes occurring in steepheads, on the other hand, are fairly well understood. The origin of the steephead migrates farther into the sandhill as erosion occurs (Sharp 1938, Schumm et al. 1995). Over time, the outflow of water carries sand downstream and a U-shaped valley (in cross-section) develops. As the springwater removes sand from the base of the slope, the slope becomes undercut. Eventually, the sand slumps down into the emerging spring water and is carried away, beginning the cycle again and allowing the valley to migrate headward (Means 1991). The rate of headward erosion has been estimated to be about two to five centimeters each century; however, a maximum of 70 centimeters per century has also been suggested (Eglin AFB Steephead Monitoring Plan 2004). According to some sources this natural migration of the head is due in part to surface runoff occurring after fires or clear-cuts in the upland longleaf pine habitats (Schumm et al. 1995, Eglin AFB Steephead Monitoring Plan 2004). Means (2000) reported steephead progression as far as five kilometers into the sand body since the stream's formation. The resultant head of the ravine takes on an amphitheater-like shape, usually slopes down at a 45-degree angle (approximately) and can be up to 35 meters deep.

Abiotic factors in steephead ecosystems differ from those in gully-eroded ravines, allowing for a unique mixture of plant and animal species. Because steephead streams are formed by groundwater that has percolated through deep soils, some studies have suggested that the water remains the same temperature year round, usually between 20°C and 22.2°C. (Wolfe et al. 1988, Chafin et al. 1997). However, Enge (1998) found some

first-order steephead streams to vary by as much as 15°C during the year. More data are needed to determine actual temperature variation.

Because steephead formation is caused by the steady trickle of groundwater through porous substrate, water flow is expected to be fairly constant. Although stream flow is constant from month to month, there is significant variation in water flow from year to year (Schumm et al. 1995). However, steephead streams typically do not run completely dry. Additionally, because the water is filtered through deep layers of sand, it emerges relatively neutral in pH and contains very few pollutants (organic or inorganic), unlike gully-eroded streams, which pick up nutrients and chemicals from a multitude of nonpoint sources such as fields, pastures, roads, and yards (Wolfe et al. 1988, Means 1991). Rainwater is quickly absorbed by the porous sands above steepheads, allowing little opportunity for surface runoff. For these reasons and because ambient temperatures are typically more stable year-round than in the surrounding uplands, steepheads have been said to act as refugia for cool-adapted and stenothermal species (Rasmussen 2004). Such cool-adapted species are present in this otherwise warm region due to the fact that average summer temperatures of the southeastern United States were once nearly 12°C colder than at present (Neill 1957, Watts 1980, Watts et al. 1992). Thus, relict populations of certain species that typically are not found along the Coastal Plain can persist in steepheads (James 1961).

The biogeography of steepheads is also interesting in that there are certain genera with discontinuous distributions between eastern North America and eastern Asia. A number of these groups are found in steepheads and other ravines of the Gulf Coastal Plain (Gray 1875, Li 1952, James 1961). For instance, *Torreya taxifolia* Arn. is located

in ravines of the southeastern U.S. (specifically in northern Florida) and has related species (*T. grandis* Fortune. ex Lindl., *T. fargesii* Franch., *T. jackii* Chun., and *T. nucifera* (L.) Siebold. & Zucc.) in eastern China and Japan (Li 1952).

There seems to be a pattern of fairly constant, undisturbed conditions in steepheads. Although fires are frequent in upland pine forests (every one to three years), they rarely reach into steepheads, creating a drastic distinction between uplands and ravines in this region (Delcourt and Delcourt 1977, Schwartz 1994). The environmental constancy and lack of disturbance may allow for some species that are sensitive to environmental change to thrive within steepheads.

Due to unique abiotic factors, steephead organisms may evolve differences from related forms not occupying steepheads. Because most steepheads are separated from other steepheads by much drier habitats in which many steephead organisms could not survive, populations in isolation may develop genetic differences over time. Environmental characteristics (physical and vegetational) of steepheads are fairly constant within and among drainages into which they flow (Means 1975, Means 1977). Wolfe et al. (1988) proposed that organisms residing in steepheads might be genetically different from regional populations due to founder effects or intense local selection. Some steephead organisms may experience ecological release due to lack of immigration of more competitive species (Wolfe et al. 1988). Currently there is little evidence to support these statements. Means (2000) suggested that the aforementioned evolutionary processes have had a significant effect on species of plethodontid salamanders. Isolation due to sea level changes may have led to a number of speciation events in this region. For most groups of organisms in steepheads little evidence has yet been gathered to

indicate that this is the case. However, endemism has been documented in caddisflies that inhabit ravine systems of northern Florida (Rasmussen 2004). According to Rasmussen (2004), certain species are endemic to ravines (although not steephead ravines specifically) and appear to be associated with habitat type (stream size and ravine type).

Intensive studies have not been performed on the vegetation along steephead streams, but some general information does exist (Means 1985, Chafin et al. 1997). More attention has been focused on the plant diversity of the steephead slopes than on the wetland flora.

The general pattern from the sandhills above the steephead to the stream at the bottom begins with a xeric longleaf pine-scrub oak community surrounding the ravine grading to wetland species below. Historically, *Pinus palustris* Mill. dominated the upland areas. However, many of these areas are now converted into pine plantations and housing developments (Means 1991). Absence of fire has also negatively affected this habitat type by allowing for dense growth of understory species.

On the upper ravine slopes the community becomes a mixture of xeric, deciduous trees. Halfway down the slope, a mesic forest develops, supporting trees typical of a beech-magnolia climax forest. The lower slopes of steepheads are dominated by an evergreen shrub zone, which contains a variety of species, including, in the Apalachicola region, many of Florida's rarest plants, including *Asarum arifolium* Michx., *Croomia pauciflora* (Nutt.) Torr. and *Rhododendron austrinum* (Small) Rehder (Wolfe et al. 1988, Eglin AFB Steephead Monitoring Plan 2004). Kwit et al. (1998) supported this species zonation along the slope but mentioned that the abundances of species change gradually (rather than abruptly) from one zone to the next.

Means (1985) characterized the valley floor of steepheads as a wetland community dominated by *Illicium floridanum* Ellis and *Magnolia virginiana* L. Mosses, liverworts and ferns are also common along the stream. A more recent study by Chafin et al. (1997) reported the presence of three distinct "baygall" plant associations along steephead streams on Eglin Air Force Base. At the head of the stream is the *Illicium floridanum* association. Downstream, the *Cliftonia monophylla* (Lam.) Britt. ex Sarg. association can be found in narrow channels (Chafin et al. 1997). The *Chamaecyparis thyoides* (L.) B.S.P. - *Sphagnum* association is found along wide channels with decreased water velocity (Chafin et al. 1997).

Some wetland plants which are considered to be relatively uncommon are also found in and along steephead streams including *Drosera intermedia* Hayne, *Kalmia latifolia* L., *Macranthera flammea* (Bartr.) Pennnell, *Nuphar advena* (Ait.) Ait. f. subsp. *ulvacea* (Mill. and Standl.) Padgett, *Peltandra sagittifolia* (Michx.) Morong, *Rhododendron austrinum*, *Rhynchospora crinipes* Gale, *Sarracenia leucophylla* Raf., *Sarracenia rubra* Walt., and *Xanthorhiza simplicissima* Marshall (Chafin et al. 1997, U.S. Fish and Wildlife Service 2007). The presence of such species provides further incentive to protect steephead habitats.

In addition to vegetation, animal diversity is also high in these ecosystems. Fairly constant water temperature and continuous flow of steephead streams allows for the survival of rare and sensitive species. The environment is buffered both thermally and chemically, providing a suitable year-round habitat for a number of species (Means 1985).

Constant water flow has obvious implications for the presence of aquatic species diversity. Darters, including the federally endangered Okaloosa darter (*Etheostoma okaloosae* Fowler), bluenose shiners (*Pteronotropis welaka* Evermann & Kendall) and creek chubs (*Semotilus atromaculatus* Mitchill) have been found year-round at the head of steephead streams (Means 1991, Chafin et al. 1997, Florida Fish and Wildlife Conservation Commission 2005, U.S. Fish and Wildlife Service 2007). Organisms along the banks also benefit from the continuous flow. A variety of salamander species are able to survive year-round in the continuously saturated leaf litter (Wolfe et al. 1988, Means 1991, Means 2000). Two notable amphibian species reported to occur in steephead ravines are the pine barrens tree frog (*Hyla andersonii* Baird) and the Florida bog frog (*Rana okaloosae* Moler), both of which are listed as species of special concern (SSC) in Florida (U.S. Fish and Wildlife Service 2007). Hubbell et al. (1956) also suggested that there are orthopterans endemic to such ravines in the Panhandle, although no specific species are mentioned. High water quality allows for survival of pollution-sensitive species. Entrekin et al. (1999) found high invertebrate diversity in all steephead streams studied in southwestern Georgia. In particular, EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa were found, all of which are typically pollution-sensitive organisms.

Because of the rugged terrain of steephead valleys, they are not directly under development or logging pressure. However, the uplands are experiencing degradation in a number of ways. Sites on Eglin Air Force Base are offered some degree of protection, but most steepheads on private land are under threat. Longleaf pine formerly dominated the upland habitat but is being replaced by pine plantations, housing and urban developments, and commercial/industrial developments (Florida Fish and Wildlife

Commission 2005). Fire exclusion has also led to a decline in quality of longleaf pine habitat in the area. Nearby roads contribute to slope disturbance, leading to erosion and siltation (Chafin et al. 1997). Large-scale disturbance of vegetation above a steephead can lead to increased run-off, and, in turn, a rise in stream turbidity (Schumm et al. 1995, Chafin et al. 1997). The Florida Fish and Wildlife Conservation Commission (2004) listed declining water quality as a threat to the habitat.

On Eglin Air Force Base, Chafin et al. (1997) reported additional threats to the health of these ecosystems. They found evidence of direct trash dumping of items such as car parts and paint cans into the streams. Dumping of hazardous wastes in stream watersheds and runoff of fertilizers or biocides from surrounding land have the potential to pollute the shallow ground waters that flow into steephead streams. Invasive species are also a threat to steephead habitats and include feral hogs (*Sus scrofa* L.), Japanese climbing fern (*Lygodium japonicum* (Thunb.) Sw.) and Chinese tallow tree (*Sapium sebiferum* (L.) Roxb.) (Eglin AFB Steephead Monitoring Plan 2004).

Research has only recently begun on steepheads and is still in its preliminary stages, making the need for conservation even greater. Not only are steepheads geologically unique, they also provide stable habitat for a variety of animal and plant species, some of which are found only in these ravines along the Gulf Coastal Plain. Means (1977, 1985) has also proposed that ravine ecosystems in the Panhandle act as paleorefugia (a place where ancient species that are extinct elsewhere persist). Much of this diversity is due to the fact that steepheads are actually a combination of four major ecosystems: an aquatic stream habitat, seepage-slope wetlands, moist beech-magnolia forests, and dry oak-cedar forests (Means 1991). Research is imperative in preserving

this system and protecting it from degradation. With thorough investigation of this habitat, it is probable that more endemic and perhaps undiscovered species will be found.

The objectives of this study were (1) to describe the wetland flora of Weaver Creek steephead from the head of the stream to the foot (its point of entry into Weaver River), (2) to compare the upstream and downstream habitats of Weaver Creek and (3) to compile lists of plant and animal species reported from steephead habitats.

METHODS

The steephead wetland of Weaver Creek was selected for the study based on its large size and accessibility for study. Additionally, Weaver Creek is relatively undisturbed by humans because of its location on Eglin Air Force Base. Permission was obtained from Eglin Air Force Base to conduct this study.

Description of the Study Site

Weaver Creek is located 18.8 km southeast of Milton, Florida on Eglin Air Force Base in Santa Rosa County, Florida (coordinates: 30°30'27.84" N, 86°54'46.95" W) (Figure 1). It is a steephead stream (flowing from south to north) with multiple heads (origin points), all of which are found at the bases of sandhills, and is part of the Yellow River drainage. Elevation on top of the ridge at the head is 33.2 m above sea level (asl). The elevation at the point of origin (base of ridge) is 11.3 m asl. At the point the creek enters Weaver River, the elevation drops to 0.91 m asl. Weaver Creek's total length is 7.18 km (Figure 2), and its depth ranges from a few centimeters at the origin to over three meters deep near its foot. The approximate area of the wetland (area surveyed) is 0.55 km^2. Valley width at the head is approximately 300 m (including the ravine slope) (Figure 3). The steep walls of the ravine at the head decrease the width of wetland habitat to include primarily only the creek itself, which is approximately 70 m wide at the narrowest point. Water depth at the head does not exceed a few centimeters, and the stream channel is relatively narrow. Due to the dense slope and wetland vegetation, the

upstream section of Weaver Creek is more heavily shaded than the downstream portion. At the foot of the stream, the valley is nearly 700 m wide (including the slope) (Figure 3). Downstream, the channel widens and deepens significantly. Thus, the majority of species found downstream are located on soil adjacent to the creek rather than in the stream channel itself. The area surrounding the creek downstream flattens out, creating a wide area (180 m wide) of wetland habitat characterized by constantly saturated soils and increased penetration by sunlight. This section is also heavily shaded by the overstory but contains patches in which the overstory is somewhat thinned, creating light gaps on the forest floor.

In addition to the main stream channel, a side stream (Double Head Branch) was surveyed that originates from Buck Pond (Figure 4). A powerline intersects the stream at one point and creates a short stretch of intense sunlight. The remainder of Double Head Branch is typical of the upstream habitat of Weaver Creek.

According to the Florida Geological Survey (1993), there are two geological formations on which Weaver Creek is situated. The majority of the creek (approximately three-fourths of its length from the head) is on the Citronelle Formation, which is characterized by fine to coarse-grained sands interspersed with gravel, silt and clay (Florida Geological Survey 1993). The remainder of the creek bed is in an area characterized by deposition of alluvium in the Weaver River floodplain. Sands in this section of the creek are very fine to coarse-grained (Florida Geological Survey 1993).

The streambed is composed primarily of sand but is covered with deposits of organic matter in certain areas. Upstream areas of the creek are alluvial, whereas the majority of vegetation downstream grows in nonalluvial mucky areas on either side of the

stream channel. There are, however, pockets of alluvium deposited in the downstream section on which limited vegetation occurs as well. There are two main soil series in the streambed. Near the head of the creek are Lakeland sands (both in the stream and on the surrounding lower slopes) (Weeks et al. 1980). This soil type is on level to sloping (0-30%) terrain and is well drained (Weeks et al. 1980). Downstream portions of the creek contain an association of Dorovan and Pamlico soils, creating a mucky substrate (saturated year round) that has formed via decomposition of plant material (Weeks et al. 1980).

The water is remarkably clear for its entire length, indicating little impact from sediment runoff. Water temperature of the stream (23°C) remained fairly constant during the study period and along its length. This held true even when the air temperature had been near 37.8°C for almost a week. The water is acidic with a pH of 5.6.

Above the ravine at the head of the stream is xeric sandhill habitat into which the ravine is carved. Plant composition of the sandhill above the steephead is drastically different from the slope and wetland vegetation. Dominant overstory trees of the sandhill habitat include *Pinus elliottii* Engelm., *Pinus palustris, Quercus geminata* Small, *Quercus hemisphaerica* Bartr. ex Willd., and some invading *Pinus clausa* (Chapm. ex Engel.) Sarg. Primary understory trees include *Ilex opaca* Ait., *Ilex vomitoria* Ait., *Quercus incana* Bartr., *Quercus laevis* Walt., *Vaccinium corymbosum* L., and *Vaccinium elliottii* Chapm. *Crataegus uniflora* Muenchh., *Diospyros virginiana* L. and *Magnolia grandiflora* L. are occasional in the understory. Other woody plants, vines and herbs common on the sandhill are *Licania michauxii* Prance, *Pteridium aquilinum* (L.) Kuhn, *Satureja coccinea* (Nutt. ex Hook.) Bertol., *Serenoa repens* (Bartr.) Small, *Smilax*

auriculata Walt., and *Vitis rotundifolia* Michx. Ground cover is sparse with scattered clumps of *Aristida stricta* Michx. var. *beyrichiana* (Trin. & Rupr.) D.B. Ward and lichens of the genus *Cladina* (Nyl.) Nyl., particularly *C. evansii* Abbayes.

Near the head, the amount of relief is significant, creating a deep ravine. The ravine contains a variety of plant species, some of which are also found in the upland sandhill or the wetland at the base of the slope. Dominant large trees found on the steep slope are *Magnolia grandiflora* L., *Nyssa sylvatica* Marsh., *Oxydendrum arboreum* (L.) DC., *Quercus nigra* L., and *Quercus phellos* L. Understory slope trees include *Carya glabra* (P. Mill.) Sweet (very few), *Cornus florida* L., *Ilex decidua* Walt., *Ilex opaca, Ilex vomitoria, Magnolia ashei* Weatherby, *Osmanthus americanus* (L.) Benth. & Hook. f. ex Gray, *Ostrya virginiana* (P. Mill.) K. Koch, a few invading *Pinus clausa*, and *Vaccinium corymbosum*. Shrubs and small trees on the slope include *Asimina parviflora* (Michx.) Dunal, *Hamamelis virginiana* L., *Illicium floridanum, Serenoa repens,* and *Vaccinium elliottii*. Common vines and herbs on the slope are *Mitchella repens* L., *Smilax pumila* Walt. and *Vitis rotundifolia*.

Downstream the terrain slopes more gradually. Many sandhill species extend nearly to the creek. The two main overstory trees present are *Pinus palutris* and *Pinus elliottii*. The understory consists primarily of *Quercus incana* Bartr. and *Quercus laevis* Walt. *Acer rubrum* L. begins to appear near the creek. Shrubs of the downstream slope include *Chrysoma pauciflosculosa* (Michx.) Greene, *Ilex glabra* (L.) Gray and *Ilex vomitoria*. The two common vines of the area are *Smilax auriculata* and *Vitis rotundifolia* (which is found near the creek). Ground cover consists primarily of *Aristida stricta* var. *beyrichiana*, *Licania michauxii* and *Pteridium aquilinum*.

Collection Methods

Collections began on 20 August 2006 and were concluded on 18 September 2007. Fourteen visits were made during this period. Collection dates were scheduled in an effort to collect specimens when they were either in flower or fruit. Specific dates are as follows: 20 August 2006, 4 September 2006, 30 September 2006, 19 November 2006, 18 February 2007, 24 February 2007, 3 March 2007, 29 March 2007, 3 May 2007, 1 June 2007, 5 July 2007, 26 July 2007, 11 August 2007, and 18 September 2007. The entire wetland area along the stream was surveyed in an effort to obtain samples of every vascular species present. The wetland was defined as areas in and along the stream with saturated soil and emergent vegetation.

At least one voucher specimen of most species found was deposited in the Freeman Herbarium (AUA) at Auburn University, Auburn, Alabama. Collection of federally protected species and those protected by the state of Florida was avoided. Photographs served as documentation for such species. Taxonomy follows Godfrey and Wooten (1981) unless otherwise noted. Location information of sensitive species was provided to Eglin Air Force Base.

Analysis Methods

Two distinct habitats within the wetland area (upstream and downstream) were described based on floristic composition. Visually, these two habitats are easily discernible based on vegetation present, stream width and relative vegetation density. The transition zone (ecotone) between these two separate habitats was sampled, but the specimens were not used to characterize either of the habitats. Species richness, species evenness, species diversity (the Shannon Index), and community similarity (the Jaccard

Index) were calculated for each section of the creek and for the creek as a whole. Species diversity and evenness were calculated using GW-Basic with the following formulas: $H' = -\Sigma (p_i * \ln(p_i))$ and $J' = H'/\ln(S)$, where H' = diversity, S = number of species, p_i = proportion of species i in total species, and J' = evenness (Ludwig and Reynolds 1988).

Relative abundance values were used to calculate species evenness and diversity. Each species was assigned to one of the following categories: rare (0-5 individuals/colonies), infrequent (6-30 individuals/colonies), occasional (31-100 individuals/colonies), frequent (100-500 individuals/colonies), or abundant (500+ individuals/colonies). In order to measure diversity at the generic level, taxonomic evenness and diversity were also calculated using counts of species within genera instead of individuals within species.

Community similarity between the upstream and downstream sections was determined using the Jaccard Index: JI = j/r x 100, where j = number of species found at both locations and r = number of species unique to either location. The Jaccard Index was chosen for this analysis because it requires only presence-absence data and is not biased even at small sample sizes (Ludwig and Reynolds 1988).

RESULTS

Regarding the wetland floristic composition of Weaver Creek steephead, 102 species were recorded from 67 different genera and 46 families (see annotated list below). Of these, 10 species are listed in Florida as commercially exploited, threatened or endangered. The results of the species richness, evenness and diversity analyses reveal an interesting pattern (Table 1). Generic richness, evenness and diversity follow a similar pattern (Table 2). There is a distinct difference between the floristic composition of the upstream section (reaching approximately 3.40 km downstream from the head) and the downstream section (from 3.40 km from the head to the creek's entry point into Weaver River) of Weaver Creek (Figure 3). This distinction is best illustrated by the low degree of similarity between the two habitats (Table 1). Composition differences between upstream and downstream sections are also well illustrated by the numbers of rare or infrequent species found at each site (Table 1).

Below is a complete list of vascular plant species found in the Weaver Creek wetland along with general location, habitat information, collection numbers, and other significant notes.

PHYLUM LYCOPODIOPHTYA
FAMILY LYCOPODIACEAE

Lycopodium alopecuroides L. – foxtail clubmoss Holt 175

Foxtail clubmoss is rare along the lower portion of Weaver Creek. It is found exclusively in mucky soils alongside the stream beneath openings in the canopy, which allow increased light intensity.

PHYLUM POLYPODIOPHYTA
FAMILY BLECHNACEAE

Lorinseria areolata (L.) T. Moore – netted chain fern Holt 115

Netted chain fern is occasional along Weaver Creek. It is mostly found along the edge of the stream or in very shallow water in the stream itself.

FAMILY THELYPTERIDACEAE

Thelypteris palustris Schott var. *pubescens* (Lawson) Fern. – marsh fern Holt 165

Marsh fern is rare along Weaver Creek. Its habitat is much like that of netted chain fern (moist soils alongside the stream or in shallow areas of the stream itself). North American populations belong to variety *pubescens* (Smith 1993).

FAMILY OSMUNDACEAE

Osmunda cinnamomea L. – cinnamon fern Holt 126

Cinnamon fern is occasional in the upstream section of Weaver Creek. It is found growing in the stream (shallow areas) and along the edges in saturated soil. This species is listed as commercially exploited in Florida (USDA 2007).

PHYLUM PINOPHYTA
FAMILY CUPRESSACEAE

Chamaecyparis thyoides (L.) B.S.P. – Atlantic white cedar Holt 141

Atlantic white cedar is abundant in the lower portion of Weaver Creek. It is found on the wide area of mucky soil bordering the creek. The largest individuals are approximately 22 cm DBH. A few specimens contain growths of vine wicky (*Pieris phyllyreifolia*). Weaver Creek populations fall within the range suggested by Li (1962) for *Chamaecyparis henryae*. Little (1966) considered *C. henryae* a variety. Michener (1993) considered *C. henryae* to simply be a variant of *C. thyoides*, a viewpoint which is adopted here.

Taxodium ascendens Brogn. – pond-cypress Holt 171

Pondcypress is abundant in the lower portion of Weaver Creek along the wide stream banks in mucky, inundated soils. The largest specimens are approximately 24 cm DBH. A number of individuals supported growths of vine wicky (*Pieris phyllyreifolia*). Watson (1983) considered both pond-cypress (*Taxodium ascendens*) and bald-cypress to be subspecies of *Taxodium distichum*. Godfrey (1988) supported the separation of these two into separate species, a view which is followed here.

FAMILY PINACEAE

Pinus elliottii Engelm. var. *elliottii* – slash pine Holt 244

Slash pine is abundant along the entire length of Weaver Creek. It is found growing along the lower slopes and directly adjacent to the creek in upstream sections and in the broad expanse of saturated soil in the downstream portions. Identification of

this variety is based on its known range and the distinctive characteristics of its seedling as compared to *P. elliottii* var. *densa* Little and Dorman.

PHYLUM MAGNOLIOPHYTA
CLASS LILIOPSIDA
FAMILY LILIACEAE

Lilium iridollae Henry – panhandle lily Holt 150

The panhandle lily is frequent along a section in the lower part of Weaver Creek. It grows in a shady expanse of mucky soil adjacent to the stream. The panhandle lily is of conservation concern and, therefore, is listed as G2, S2 and endangered in Florida by FNAI (2007). It is also under consideration for federal protection (Skinner 2002). The population at Weaver Creek appears quite healthy despite the fact it is not located in its typical habitat (open seepage slopes).

FAMILY ARECACEAE

Sabal minor (Jacq.) Pers. – swamp palm Holt 136

Swamp palm is occasional along the creek and can be found growing in shallow water as well as along the banks. The largest specimen found was located in the stream and was approximately 1.5 m tall.

FAMILY POACEAE

Aristida patula Chapm. ex Nash – tall threeawn Holt 217

Tall threeawn is infrequent along the upstream banks of Weaver Creek. It grows in clumps directly adjacent to the stream on very moist soils.

Arundinaria gigantea (Walt.) Walt. ex Muhl – giant cane Holt 167

Giant cane is occasional along Weaver Creek. It can be found growing primarily on the stream bank in moist soil.

Chasmanthium laxum (L.) Yates – slender woodoats Holt 120

Slender woodoats is rare along Weaver Creek. It is found intermittently in small clumps along the bank.

Dichanthelium ensifolium (Baldw. ex Ell.) Gould – cypress witchgrass Holt 214

Cypress witchgrass is rare along Weaver Creek. It is found growing along a small path next to the creek. Godfrey and Wooten (1981) and LeLong (1984) place this species in the genus *Panicum*. Gould and Clark (1978) place it in *Dichanthelium*, which was previously considered a subgenus of *Panicum*. Aliscioni et al. (2003) support the elevation of *Dichanthelium* to genus level based on differences in the chloroplast *ndhF* gene. Additionally, some authors have considered this species a variety of *D. dichotomum* (Gould and Clark 1978). Godfrey and Wooten (1981) kept the species separate (although under the genus *Panicum*), and Aliscioni et al. (2003) support the distinction between the two at the species level. I adopt the viewpoints of elevating the former subgenus to genus and of keeping *D. ensifolium* a separate species from *D. dichotomum*.

FAMILY ARACEAE

Orontium aquaticum L. – golden-club Holt 176

Golden-club is frequent in the lower section of Weaver Creek and is found growing in the stream, both in shallow and deep water. Often, plants are found with their leaves completely submerged. It is more common, though, to find plants with primarily emergent leaves.

Peltandra sagittifolia (Michx.) Morong – spoonflower Holt 148

Spoonflower is occasional along the lower sections of the creek. It is found along the wide bank in mucky, slightly acidic soil, which is occasionally inundated by water, causing small pools to develop. Although not listed by the FNAI, spoonflower populations are monitored by conservation authorities where it occurs (Thompson 2000).

FAMILY BURMANNIACEAE

Apteria aphylla (Nutt.) Barnh. ex Small – nodding-nixie Holt 108

The nodding-nixie is extremely rare (only one specimen found) at the head of the stream. It grows on the lower slope of the ravine in moist soil.

FAMILY CYPERACEAE

Carex atlantica Bailey – Atlantic sedge Holt 211

Atlantic sedge is rare along the lower portion of Weaver Creek. It is found close to the edge of the stream in an area of mucky soil.

Carex elliottii Schwein. & Torr. – Elliott's sedge Holt 209

Elliott's sedge is infrequent along Weaver Creek. It is found close to the edge of the stream in areas of saturated soil.

Carex glaucescens Ell. – clustered sedge Holt 224

Clustered sedge is occasional along Weaver Creek in the downstream portions. It grows in a wide area of saturated soil alongside the stream.

Carex intumescens Rudge – greater bladder sedge Holt 210

Greater bladder sedge is occasional along the downstream section of the creek. It is found growing in a wide area of saturated soil adjacent to the stream.

Dulichium arundinaceum (L.) Britt. – three-way sedge Holt 142

Three-way sedge is frequent in the lower section of Weaver Creek. This species can be found growing in the broad area of saturated soil alongside the stream as well as on islands of vegetation floating in the stream.

Eleocharis elongata Chapm. – slim spikerush Holt 221

Slim spikerush is occasional along the lower section of Weaver Creek. It was found growing in sandy soil in the stream. It is believed that the majority of this species grows with its leaves submerged. It cannot be determined definitely as to whether the submerged plants are also slim spikerush, but the two are found in close proximity, often growing directly next to each other. The submerged leaves are longer and narrower and contain no flowers or fruit. The emergent leaves are easily identifiable by their reproductive structures.

Rhynchospora capitellata (Michx.) Vahl – brownish beaksedge Holt 222

Brownish beaksedge is occasional in the lower section of Weaver Creek and can be found growing along the bank as well as on floating islands of vegetation in the stream itself. Godfrey and Wooten (1981) synonymized *R. leptocarpa* with *R. capitellata*.

Sorrie (2000) suggested that *R. leptocarpa* be distinguished as a separate species. I will adhere to Godfrey and Wooten (1981) on this subject.

Rhynchospora cephalantha Gray – bunched beaksedge Holt 193

Bunched beaksedge is occasional in the lower section of Weaver Creek. It grows most commonly in the area of saturated soil on either side of the stream.

Rhynchospora chalarocephala Fern. & Gale – loosehead beaksedge Holt 185

The loosehead beaksedge is infrequent along Weaver Creek. It is found on the wide expanse of saturated soil bordering the downstream section.

Rhynchospora corniculata (Lam.) Gray – shortbristle horned beaksedge Holt 181

Shortbristle horned beaksedge is rare along Weaver Creek. Its habitat consists of the wide expanse of saturated soil alongside the downstream portion of the creek.

Rhynchospora curtissii Britt. ex Small – Curtiss' beaksedge Holt 174

Curtiss' beaksedge is rare on Weaver Creek. The few specimens found are growing in clumps at the base of pondcypress trees, which are located in the saturated soil beside the creek.

Rhynchospora filifolia Gray – threadleaf beaksedge Holt 233

Threadleaf beaksedge is infrequent along Weaver Creek. This species grows along the edge of the stream in saturated soil.

Rhynchospora glomerata (L.) Vahl – clustered beaksedge Holt 117

Clustered beaksedge is occasional along Weaver Creek. It is found growing along the bank in both upstream and downstream sections of the creek.

Rhynchospora gracilenta Gray – slender beaksedge Holt 155

Slender beaksedge is occasional along Weaver Creek and can be found along the banks of the stream as well as on the saturated soil further into the forested area alongside the stream.

Rhynchospora macra (C.B. Clarke ex Britt.) Small – large beaksedge Holt 172

Large beaksedge is rare along Weaver Creek. This species is found in the broad expanse of saturated soil alongside the stream, usually in areas of greater amounts of sunlight.

Rhynchospora rariflora (Michx.) Ell. – fewflower beaksedge Holt 234

The fewflower beaksedge is rare on Weaver Creek. The plant inhabits vegetation islands in the stream.

Scirpus cyperinus (L.) Kunth – woolgrass Holt 200

Woolgrass is infrequent along a tributary to Weaver Creek (originating from Buck Pond) (Figure 4). The habitat where the specimens are located is disturbed by a powerline road, thus creating an artificially sunny area along a small stretch of the tributary.

Scirpus etuberculatus (Steud.) Kuntze – Canby's bulrush Holt 213

Canby's bulrush is rare along the creek and grows in areas of saturated soil bordering the stream, on vegetation islands in the stream, and in shallow water in the stream. Smith (2002) placed this species in the genus *Schoenoplectus* (Reichenbach) Palla (formerly a subgenus). Godfrey and Wooten (1981) and Wunderlin and Hansen (2004) retained the species in the genus *Scirpus*, a viewpoint which is followed here.

Websteria confervoides (Poir.) S.S. Hooper – algal bulrush Holt 248

Algal bulrush is rare along Weaver Creek. It grows in the lower section of the stream among other vegetation. This is a fairly atypical habitat for algal bulrush, which is usually found in lakes and ponds.

FAMILY ERIOCAULACEAE

Eriocaulon decangulare L. – tenangle pipewort Holt 146

The tenangle pipewort is abundant in the lower section of Weaver Creek. It grows on the wide expanse of saturated soil bordering the creek.

Lachnocaulon beyrichianum Sporl. ex Koern. – southern bogbutton Holt 242

The southern bogbutton is occasional along Weaver Creek and can be found in the wide expanse of saturated soil along the downstream section of the creek.

FAMILY JUNCACEAE

Juncus canadensis J. Gay ex Laharpe – Canadian rush Holt 198

Canadian rush is infrequent in a tributary of Weaver Creek (originating from Buck Pond) (Figure 4). The habitat is disturbed by a powerline road, creating an area of artificially greater sun intensity along the stretch in which this species is found. There are two varieties and two forms proposed to exist, but they do not seem to be biologically distinct (Brooks and Clemants 2000). Therefore, I will leave the identification of this specimen at the species level.

Juncus marginatus Rostk. – grassleaf rush Holt 220

The grassleaf rush is infrequent along the lower portions of Weaver Creek and is found growing only along small paths and clearings next to the creek. This species is

synonymized with a number of different species (Brooks and Clemants 2000). However, I will adhere to Godfrey and Wooten (1981) who use *J. marginatus* (with which three species are synonymized – *J. aristulatus* Michx, *J. biflorus* Ell. and *J. longii* Fern.).

Juncus polycephalus Michx. – manyhead rush Holt 240

The manyhead rush is infrequent along Weaver Creek. It grows primarily on floating islands of vegetation in the stream but also inhabits the very edge of the stream bank where mucky soil is present.

Juncus tenuis Willd. – path rush Holt 207

Path rush is rare along Weaver Creek. The only specimens encountered were found growing on a small path next to the stream in compacted, moist soil.

Juncus trigonocarpus Steud. – redpod rush Holt 139

Redpod rush is infrequent along a tributary of Weaver Creek (originating from Buck Pond) (Figure 4). The habitat in which this species is found is disturbed by a powerline road, creating an artificially sunny stretch along the tributary. It grows along the raised bank of the tributary.

FAMILY NARTHECIACEAE

Lophiola aurea Ker Gawl. – golden-crest Holt 218

Golden-crest is frequent in the lower section of Weaver Creek. It is present in a wide area of saturated soil that borders the creek. More specifically, it is found primarily in patches of greater sunlight within the broad areas of mucky soil. Godfrey and Wooten (1981) referred to this species as *L. americana* and synonymize *L. aurea* with it. Fernald (1921) recognizes these as two distinct species (*L. aurea* being the southeastern species),

a viewpoint which is adopted here. Family placement of golden-crest is not well resolved as this time. It has traditionally been placed in Haemodoraceae (Robertson 1976, Godfrey and Wooten 1981). Ambrose (1985) placed the species in Liliaceae; Wunderlin and Hansen (2004) suggested an affinity with Nartheciaceae; Simpson (1983) placed the species in Tecophiliaceae. I will adhere to the idea that golden-crest be placed in the Nartheciaceae based on morphological similarities to other species of that family.

FAMILY ORCHIDACEAE

Platanthera blephariglottis (Willd.) Lindl. var. *conspicua* (Nash) Luer - white fringed orchid Holt 245

The white fringed orchid is rare along Weaver Creek and grows in the wide expanse of saturated soil in the downstream sections of the creek. Godfrey and Wooten (1981) placed this species in the genus *Habenaria*. However, I will follow Sheviak (2002) in placing it in the genus *Platanthera*. Additionally, Godfrey and Wooten (1981) did not recognize the variety listed. Therefore, I will follow Sheviak (2002), Wunderlin and Hansen (2004) and USDA (2007) in listing the specimens at Weaver Creek as variety *conspicua*.

Platanthera cristata (Michx.) Lindl. – crested fringed orchid Holt 109

The crested fringed orchid is infrequent along the length of Weaver Creek. It is found growing in both the upper and lower reaches of the creek along the bank. Soil on which it grows is moist. Godfrey and Wooten (1981) placed this species in the genus *Habenaria*; however, I will follow Sheviak (2002) in placing it in the genus *Platanthera*. This species is listed as threatened in Florida (USDA 2007).

FAMILY SMILACACEAE

Smilax laurifolia L. – bamboo briar Holt 208

Bamboo briar is abundant throughout the length of Weaver Creek.

Smilax smallii Morong – lanceleaf greenbriar Holt 125

Lanceleaf greenbriar is abundant along the length of Weaver Creek.

FAMILY SPARGANIACEAE

Sparganium americanum Nutt. – burr reed Holt 151

Burr reed is infrequent along the creek. It grows on the vegetation islands along the edges of the downstream portions of the creek.

FAMILY XYRIDACEAE

Xyris fimbriata Ell. – fringed yelloweyed grass Holt 170

Fringed yelloweyed grass is occasional in the lower portion of Weaver Creek. It grows on the broad expanse of saturated soil that borders both sides of the creek as well as on the vegetation islands within the stream.

Xyris smalliana Nash. – Small's yelloweyed grass Holt 147

Small's yelloweyed grass is occasional along the lower section of the creek and grows in mucky soil along the banks of the creek as well as on the vegetation islands in the stream channel.

CLASS MAGNOLIOPSIDA
FAMILY NYMPHAEACEAE

Nuphar advena (Ait.) Ait. f. subsp. *ulvacea* (Mill. and Standl.) Padgett – spatterdock Holt 152

Spatterdock is occasional in the lower portion of Weaver Creek. It grows both in the main stream and in side streams found along the broad flat areas bordering the main stream. Beal (1956) and Godfrey and Wooten (1981) considered all North American taxa in the genus *Nuphar* to be subspecies of *Nuphar luteum*. Wiersema and Hellquist (1997) suggested that Gulf coast populations of *N. ulvacea* (due to much intergradation) be listed as a subspecies of *N. advena*, a viewpoint which is adopted here.

Nymphaea odorata Ait. subsp. *odorata* – fragrant water-lily Holt 182

Fragrant water lily is infrequent along Weaver Creek and is found growing along the downstream portions in the stream itself as well as in side streams that contain sufficient amounts of water. The subspecies rank is assigned here based on Wiersema and Hellquist (1997).

FAMILY MAGNOLIACEAE

Magnolia grandiflora L. – southern magnolia

Southern magnolia is abundant in the upper section of Weaver Creek and is found growing on the stream banks. It also can be found growing abundantly on the steephead slopes. The largest individual is approximately 18 cm DBH.

Magnolia virginiana L. – sweet-bay Holt 106

Sweet-bay is abundant in the upper section of Weaver Creek and occasional in the lower section. Specimens are found growing in shallow water in the stream as well as on the lower slope and stream bank. The largest specimen is approximately 15 cm DBH.

FAMILY LAURACEAE

Persea palustris (Raf.) Sarg. – swamp red bay Holt 105

Swamp red bay is occasional in the upper reaches of the creek. Individuals grow mostly in shallow waters near the head.

FAMILY ILLICIACEAE

Illicium floridanum Ellis – Florida anise Holt 194

Florida anise is abundant in the upper portion of Weaver Creek and grows in shallow areas of the stream, along the bank, and on the lower slope.

CLASS ROSOPSIDA
FAMILY HAMAMELIDACEAE

Hamamelis virginiana L. – witch hazel Holt 127

Witch hazel is infrequent along the upper section of Weaver Creek. Its typical habitat includes the moist, sandy soils on the banks of the stream.

FAMILY MYRICACEAE

Myrica cerifera L. – wax-myrtle Holt 102

Wax-myrtle is abundant in the upper section of Weaver Creek. It can also infrequently be found growing in the lower portion of the creek. Typically, it grows in shallow areas of the stream itself (on sandy soils). In downstream areas, it is found in the broad expanse of mucky soil bordering the stream.

Myrica heterophylla Raf. – evergreen bayberry Holt 128

Evergreen bayberry is occasional along the upper portions of Weaver Creek. It grows in shallows areas of the stream (on sandy soils). Wunderlin and Hansen (2004) referred to this species as *M. caroliniensis* Mill. However, I will adhere to Godfrey and Wooten (1981) in calling it *M. heterophylla*.

Myrica inodora Bartr. – odorless wax-myrtle Holt 130

Odorless wax-myrtle is infrequent along the upper portions of Weaver Creek. Much like the above two species, it grows in shallow areas of the creek. Additionally, it is rarely found along the lower section of the creek in the areas of mucky soil bordering the creek.

FAMILY CLUSIACEAE

Hypericum brachyphyllum (Spach) Steud. – coastal plain St. John's wort Holt 154

Coastal plain St. John's wort is infrequent along Weaver Creek. It grows on areas of mucky soil bordering the creek.

Hypericum fasciculatum Lam. – peelbark St. Johnswort Holt 228

Peelbark St. John's wort is infrequent along Weaver Creek. It is found inhabiting islands of vegetation growing in the stream.

FAMILY SARRACENIACEAE

Sarracenia leucophylla Raf. – whitetop pitcherplant Holt 145

The whitetop pitcherplant is occasional along Weaver Creek. It grows in the wide expanse of mucky substrate that borders the downstream portions of the creek. According to FNAI (2007), its global and state ranks are G3 and S3, respectively. It is also listed as endangered in Florida by FNAI (2007).

Sarracenia psittacina Michx. – parrot pitcherplant Holt 191

The parrot pitcherplant is occasional along lower Weaver Creek. It grows in the wide expanse of mucky substrate alongside the creek. The parrot pitcherplant is listed as threatened in Florida (USDA 2007).

Sarracenia pupurea L. – purple pitcherplant Holt 195

The purple pitcherplant is occasional along Weaver Creek. Its habitat consists of a broad area of saturated soil alongside the stream. Naczi et al. (1999) considered populations of purple pitcherplant in northwestern Florida, southern Alabama, southwestern Georgia, and southeastern Mississippi to be *S. rosea*. However, I will adhere to Godfrey and Wooten (1981) and Cheek et al. (1997) in retaining the species under its original name. This species is listed as threatened in Florida (USDA 2007).

Sarracenia rubra Walt. – red pitcherplant Holt 149

The red pitcherplant is occasional along Weaver Creek. It grows in the same general area as the other *Sarracenia* species found at the study site – wet mucky soils bordering the stream. Godfrey and Wooten (1981) acknowledged the large amount of taxonomic studies completed in the decade prior to publishing their work. However they chose to remain with the original classification and not acknowledge any subspecies, a

view which is followed here. The red pitcherplant is listed as G4, S3, and threatened in Florida (FNAI 2007).

FAMILY DROSERACEAE

Drosera capillaris Poir. – pink sundew Holt 189

Pink sundew is occasional along lower Weaver Creek and grows in areas of saturated soil.

Drosera intermedia Hayne – water sundew Holt 158

The water sundew is infrequent along lower Weaver Creek. Its habitat consists of a wide expanse of mucky soil on either side of the stream. FNAI (2007) lists the water sundew as G5, S3, and threatened in Florida.

FAMILY CYRILLACEAE

Cliftonia monophylla (Lam.) Britt. ex Sarg. – black titi Holt 143

Black titi is frequent in the upper section of Weaver Creek. It grows both along the banks of the stream in moist soil as well as in shallow water in the stream.

Cyrilla racemiflora L. – white titi Holt 103

White titi is abundant in the upper section of Weaver Creek. Its habitat includes both the stream (shallow water) and the edges of the banks.

FAMILY ERICACEAE

Gaylussacia mosieri Small – woolly huckleberry Holt 206

Woolly huckleberry is rare along the lower section of Weaver Creek. It grows in mucky soil that extends over a broad area away from the stream.

Lyonia lucida (Lam.) K. Koch – fetterbush Holt 123

Fetterbush is present along the entire length of Weaver Creek. It is abundant in the upper portion of the creek and grows in the stream and along the edge. Downstream, it is frequent, though not abundant, and grows in a wide area of saturated soil bordering the stream.

Oxydendrum arboreum (L.) DC. – sourwood Holt 135

Sourwood is occasional in the upper section of Weaver Creek. It is found growing in the stream and along the edge in moist soil.

Pieris phyllyreifolia (Hook.) DC. – vine wicky Holt 179

Vine wicky is occasional on Weaver Creek. It grows under the bark of *Taxodium ascendens* and *Chamaecyparis thyoides* with its roots in saturated soil at the base of the trees. Up to 60 emergences on one individual of *T. ascendens* were counted. Many emergences may represent only one individual of the species.

Rhododendron viscosum (L.) Torr. – swamp azalea Holt 204

Swamp azalea is present throughout the length of Weaver Creek. Upstream, it is frequent within the stream in shallow water and along the banks in moist soil. Downstream, swamp azalea becomes more occasional and grows along the moist banks of the stream (usually in greater sunlight). It does not appear on the mucky substrate in the downstream areas dominated by pondcypress and Atlantic white cedar.

Vaccinium corymbosum L. – highbush blueberry Holt 118

Highbush blueberry is occasional on Weaver Creek. It grows in moist soil along the banks of the stream in addition to lower slopes of the ravine.

Vaccinium elliottii Chapm. – Elliott's blueberry Holt 124

Elliott's blueberry is frequent in the upper portion of Weaver Creek. It grows primarily in shallow water in the stream or on moist soil along the banks. Wunderlin and Hansen (2004) have synonymized this species with *V. corymbosum*. However, Godfrey and Wooten (1981), Munoz and Lyrene (1985) and Uttal (1987) consider these separate species, a conclusion to which I will adhere.

FAMILY SAXIFRAGACEAE

Itea virginica L. – Virginia willow Holt 104

Virginia willow is abundant in the upper section of Weaver Creek. It grows in shallow areas of the stream. Family placement of this species is uncertain. Wunderlin and Hansen (2004) place it in Iteaceae, USDA (2007) places it in Grossulariaceae and Godfrey and Wooten (1981) place it in Saxifragaceae. I will follow Godfrey and Wooten until further taxonomic research has been completed.

FAMILY CELASTRACEAE

Euonymus americanus L. – strawberry bush Holt 156

Strawberry bush is rare along Weaver Creek. It was found growing on the bank of the stream in sandy moist soil.

FAMILY AQUIFOLIACEAE

Ilex coriacea (Pursh) Chapm. – large gallberry Holt 162

Large gallberry is abundant in the upper portion of Weaver Creek. It grows in shallow water in the stream as well as along the banks in moist soil.

Ilex glabra (L.) Gray – gallberry Holt 215

Gallberry is frequent in the upper portion of Weaver Creek. It is found growing in shallow water in the stream and along the bank in moist soil.

Ilex opaca Ait. var. *opaca* – American holly Holt 101

American holly is abundant in the upper portion of Weaver Creek. It grows from the stream up to mid-slope on the ravine.

Ilex vomitoria Ait. – yaupon Holt 116

Yaupon is occasional along Weaver Creek. It is found along the banks of the stream and lower slopes of the ravine in sandy soil. Downstream, it grows on the edges of the mucky areas of soil that border the creek in slightly less saturated soil.

FAMILY POLYGALACEAE

Polygala brevifolia Nutt. – littleleaf milkwort Holt 169

Littleleaf milkwort is infrequent along Weaver Creek and is found growing in the broad expanse of saturated soil bordering the downstream sections of the creek.

Polygala hookeri Torr. & Gray – Hooker's milkwort Holt 230

Hooker's milkwort is infrequent along the downstream section of Weaver Creek. It grows in the broad expanse of saturated soil on either side of the creek.

FAMILY FABACEAE

Strophostyles helvola (L.) Ell. – trailing fuzzybean Holt 227

Trailing fuzzybean is rare along Weaver Creek. This vine is not typically considered to be a wetland species. At the study site, it is found growing in the

downstream section in a depression in moist soil. The area in which trailing fuzzybean is found is adjacent to an area of disturbance (a dirt road that crosses Weaver Creek).

FAMILY ROSACEAE

Aronia arbutifolia (L.) Nieuwl. – red chokeberry Holt 246

Red chokeberry is rare along Weaver Creek. The few specimens found were in the downstream section growing in the creek bed in shallow water.

FAMILY VITACEAE

Vitis rotundifolia Michx. – muscadine Holt 133

Muscadine is frequent along the length of Weaver Creek. In upstream areas, it grows on a variety of trees and shrubs located in the stream as well on the banks and lower slopes of the ravine. Downstream it grows on a multitude of species as well along the banks and in the broad expanse of mucky soil present on either side of the stream.

FAMILY MELASTOMATACEAE

Rhexia petiolata Walt. – fringed meadowbeauty Holt 197

Fringed meadowbeauty is infrequent along a tributary to Weaver Creek (originating from Buck Pond) (Figure 4). The area of the tributary in which this species is found is disturbed by a powerline, creating a short stretch of uncharacteristically intense sunlight.

FAMILY ONAGRACEAE

Ludwigia maritima Harper – seaside primrose-willow Holt 219

Seaside primrose-willow is rare along Weaver Creek. It is found in a disturbed area along the bank from which most of the overstory has been removed by human action, providing ample sunlight. The soil is moist and very sandy.

FAMILY CORNACEAE

Cornus florida L. – flowering dogwood Holt 129

Flowering dogwood is rare in the wetland of Weaver Creek. However, one specimen was found growing along the bank in the upstream section of the creek in moist, sandy soil. This location is odd considering flowering dogwood is not typically a wetland species.

Cornus foemina Mill. – swamp dogwood Holt 160

Swamp dogwood is occasional on Weaver Creek. It is found growing along the bank of the stream in very moist, sandy soils.

Nyssa biflora Walt. – swamp tupelo Holt 144

Swamp tupelo is occasional along the stream. Its habitat consists of a broad area of saturated soil on either side of the stream.

FAMILY CAPRIFOLIACEAE

Viburnum nudum L. – possumhaw Holt 114

Possumhaw is abundant in the upper section of Weaver Creek. It is found most commonly growing in shallow waters in the creek on sandy soil.

FAMILY RUBIACEAE

Mitchella repens L.- partridgeberry Holt 122

Partridgeberry is infrequent near the head of Weaver Creek. It grows on moist, sandy substrate on the bank/lower slope of the ravine.

FAMILY OLEACEAE

Osmanthus americanus (L.) Benth. & Hook. f. ex Gray – American olive Holt 205

American olive is frequent in the upper section of Weaver Creek. It grows along the bank as well as in the stream. Although Godfrey and Wooten (1981) call it *O. americana*, it appears *O. americanus* is more widely used.

FAMILY BIGNONIACEAE

Bignonia capreolata L. – crossvine Holt 107

Crossvine is infrequent on the upper section of Weaver Creek along the bank and in the stream.

FAMILY LENTIBULARIACEAE

Pinguicula primuliflora Wood and Godfrey – southern butterwort Holt 188

The southern butterwort is rare along the lower section of Weaver Creek. Its habitat along the stream consists of mucky soil in areas with a significant amount of sun due to openings in the canopy. FNAI (2007) lists the species as G3G4, S3 and FNAI endangered in Florida.

Utricularia cornuta Michx. – horned bladderwort Holt 226

Horned bladderwort is rare along the lower section of Weaver Creek. It grows along the broad area of saturated soil on either side of the creek. Typically, it is found growing near the edge of the stream.

Utricularia gibba L. – humped bladderwort Holt 186

Humped bladderwort is rare along Weaver Creek and grows in the broad area of saturated soil along the creek. The few specimens are located in areas of greater sunlight caused by openings in the canopy.

FAMILY ASTERACEAE

Balduina uniflora Nutt. – oneflower honeycombhead Holt 243

Oneflower honeycombhead is occasional along the lower portions of Weaver Creek. It is found in saturated soil alongside the creek.

Bidens laevis (L.) B.S.P. – smooth beggarticks Holt 168

Smooth beggarticks is rare along the lower portion of Weaver Creek. It is found growing in the broad expanse of saturated soil alongside the creek near the edge of the forested area.

Compilation of Previously Reported Steephead Species

In addition to my personal observations, I have compiled comprehensive lists of species reported in the literature to occur in steepheads. Plant species found within steepheads are listed in Tables 3 and 4. The reported floristic composition of the uplands surrounding steepheads can be found in Table 5. In comparison to previous studies, 68 species found during this study had not been previously reported from steepheads. The

majority of these unreported species (52 species) are found exclusively downstream at Weaver Creek.

A list of steephead fauna was also compiled (Table 6). There are extensive lists of herpetofauna and invertebrate families provided by Enge (2005) and Entrekin et al. (1999), respectively. Please refer to these papers for further detail regarding herpetofauna and invertebrates of steepheads.

DISCUSSION

As a whole, Weaver Creek appears to have a high degree of species and generic diversity compared to other wetland habitats. Much of this diversity is due to the distinction between the floristic communities found along the stream – one upstream and the other downstream. The change from upstream to downstream is somewhat gradual; there is no distinct line at which the two sections can be delineated. Some species were located throughout the study site, but the majority of species were unique to one section or the other. The two sections consist of very different habitat, a fact which helps to explain the low degree of floristic similarity between the communities. Upstream, the wetland is more heavily shaded due in large part to the slope vegetation. Downstream, the slope is very gradual, so no additional overstory is created by the slope vegetation. There, only one canopy layer provides shade, creating a habitat with greater light intensity which allows for the growth of many of the small herbaceous species found exclusively downstream. These herbaceous species, nearly half of which are rare or infrequent at the study site, increase the richness and diversity (both species and generic) of the downstream section. However, because the majority of individuals downstream are one of two species, either *Chamaecyparis thyoides* or *Taxodium ascendens*, the evenness of the downstream section is slightly less than that of the upstream section. Even though evenness is one aspect of diversity, the difference in evenness between the two stream sections does not seem to be great enough to have

much of an effect on the diversity of each section. On the steep slope upstream, numerous canopy layers exist and shade the wetland to a greater extent, limiting the growth of a wide variety of small herbaceous species (and, thus, decreasing richness). Species and generic evenness, however, is slightly greater upstream because there are a greater number of dominant species/genera, only about one-fifth of which are rare or infrequent.

Furthermore, the greater water depth downstream allows for the growth of floating vegetation islands, which occur along the edges of the stream. These islands are dominated primarily by *Dulichium arundinaceum, Eleocharis elongata, Eriocaulon decangulare, Orontium aquaticum,* and *Xyris* spp. They are relatively large in size, reaching up to approximately 8-10 m in length and 2-3 m wide. Upstream, the minimal water depth and extensive shading seem to have prohibited the formation of vegetation islands.

Finally, the soils upstream and downstream are drastically different, as described previously. Loose, sandy, well-drained soil composes the majority of the substrate upstream. Downstream soils contain a large amount of decomposing material and are very mucky with a noticeably finer texture. These soils remain saturated year-round. Upstream soils are moist year-round but do not hold as great a volume of water as downstream soils.

As a result of these variations in habitat, each section of the creek is characterized by different dominant species. Near the head of Weaver Creek, the wetland is dominated by *Cyrilla racemiflora, Ilex coriacea, Ilex opaca, Illicium floridanum*, *Itea virginica, Lyonia lucida, Magnolia grandiflora, Magnolia virginiana, Myrica cerifera,* and

Viburnum nudum. The foot of the stream is dominated primarily by *Chamaecyparis thyoides* and *Taxodium ascendens*. Both sections of the creek contain an abundance of *Pinus elliottii*. The drastic difference in dominant vegetation and the low degree of community similarity strongly support the classification of these two habitats of Weaver Creek as highly distinct.

There are a number of notable species found in Weaver Creek steephead that have not been previously mentioned in the literature. In total, 67% of the vascular plant species found in this study were not noted by previous authors. The majority of these newly reported steephead species (76%) reside exclusively in the downstream portion. Most of the previous authors have focused heavily on slope vegetation and, to a lesser extent, wetland area near the head of a steephead creek. Focusing on both the wetland habitat of the steephead and the downstream section of Weaver Creek led to this increase in diversity recorded. Because the downstream habitat is drastically different, it is not a surprise that many species have not been accounted for in previous studies. Although it may not have been considered typical steephead habitat in previous studies, it is useful to include the downstream section in steephead studies in order to gain a broader understanding of the entire stream system. Including the vegetation near the foot of the stream adds a new dimension to the floristics of steephead wetlands and adds 72% of the overall species richness.

Weaver Creek appears to have a relatively high degree of species richness, evenness and diversity when compared to other wetlands of similar size. Other wetland systems that have a similar hydrologic regime (constant water levels) appear to have species richness values comparable to those of Weaver Creek. For instance, herbaceous

plant species richness of pine savannas in southern Louisiana was similar to that of Weaver Creek wetland (140 species in 1 km^2) (Keddy et al. 2006). In this study I found 102 species in 0.55 km^2.

However, there have been studies in other wetland types that report greater species richness than was found at Weaver Creek. For instance, Kirkman and Sharitz (1994) reported the presence of 105 species in only 0.025 km^2 in Carolina bay wetlands in South Carolina. However, other research on Carolina bays has shown a lower species richness and/or diversity compared to Weaver Creek (Tyndall et al. 1990, Mulhouse et al. 2005). In the case of Carolina bays in particular, greater variation in hydroperiod (among bays) could be the underlying cause of this divergence in species richness/diversity between studies. Carolina bays have a wide range of sizes, which can affect their hydroperiod since water levels are heavily dependent upon rainfall and rates of evapotranspiration (Kirkman and Sharitz 1994). Differences in hydroperiod would create significant differences in floristic composition. Regarding the differences in richness/diversity between Carolina bays and Weaver Creek steephead, it is important to note the drastic difference in hydrologic regime between these two wetland types. As mentioned above, most Carolina bays do not maintain a constant water level. Steephead water levels remain fairly constant year round due to seepage from the sandhill at the head of the stream. This factor most likely plays a significant role in determining the richness and diversity of the systems. It may be that only Carolina bays with nearly constant water levels approach the diversity of steephead wetlands.

Wetlands that are alluvial throughout and in which water levels are not constant appear to have richness levels below those of Weaver creek. Brandt et al. (2003) found a

species richness value of 19 over an area of 0.2 km^2 and an evenness of 0.68 (using the Jaccard Index) in tree islands in Everglades National Park, FL. Although their study area was slightly smaller than the wetland of Weaver Creek, the authors determined (prior to the study) that the area sampled was sufficiently large to provide an accurate estimate of species richness. In a study of bottomland hardwood-*Pinus taeda* forest only 71 vascular plant species were recorded over an area of 9 km^2 (Grell et al. 2005). Diversity of this bottomland forest (mean H' = 1.68) was also much lower than that of Weaver Creek (Grell et al. 2005).

Tidal wetlands also appear to be much less species rich than Weaver Creek. Morzaria-Luna et al. (2004) found only 13 species in a salt marsh within a study area of 0.54 km^2 (nearly the size of the wetland of Weaver Creek). The intertidal zone of Boston Harbor Islands National Park contained only 15 species in an area approximately 3.66 km^2 (Bell et al. 2005). It is not surprising that tidal wetlands have a lower species richness considering the water level fluctuation and salinity of these habitats.

Comparisons in this study were based only on a survey of one steephead wetland. Investigation of a large number of steepheads would be extremely beneficial. There would likely be a great number of species found in other steephead wetlands that were not found in this study. Other steepheads contain habitat types (within the steephead wetland) that are not present at Weaver Creek. For instance, close to the head of a few steephead streams there are open marshy areas which contain islands of herbaceous species, many of which are not present at Weaver Creek (personal observation). The upstream area of Weaver Creek does not contain the large openings necessary for such islands to develop. Although Weaver Creek is a fairly typical, undisturbed steephead,

there is inherent variation in floristic composition among steephead habitats (despite relatively consistent abiotic factors) regarding floristic composition. More intensive field surveys among a number of steepheads would provide a much more complete picture of the true diversity of steephead wetlands.

Future research should be aimed at faunal diversity in steepheads, as well. Herpetological fauna has been the most extensively studied thus far, but the use of steepheads as refugia by rare herpetofauna should be investigated further because of obvious conservation implications. Invertebrate diversity research would also be beneficial since very little work has been completed on this topic. The array of invertebrate taxa found in steepheads is almost entirely unknown.

Emphasis on wetland research has grown over the past few decades, but steepheads remain relatively unknown even within the scientific community. The variety of plant species found at Weaver Creek and the fact that two very distinct communities are found over a relatively small area support the idea that steepheads are indeed unique wetland systems and worthy of scientific focus. Many steephead wetlands are unaffected by human development because of their topography and/or location. However, human development will eventually put pressure on steepheads as well. Thus, concentrating research on steepheads while they are in a relatively pristine state is of great importance. Cataloguing the unique aspects of these habitats may ultimately lead to their preservation. Because of high diversity, community distinction, and their importance as paleorefugia, preservation of these habitats is critical in helping to protect a large number of species.

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Figure 1. Map of the western Florida panhandle with the location of Weaver Creek noted. Coordinates: 30°30'27.84" N, 86°54'46.95" W.

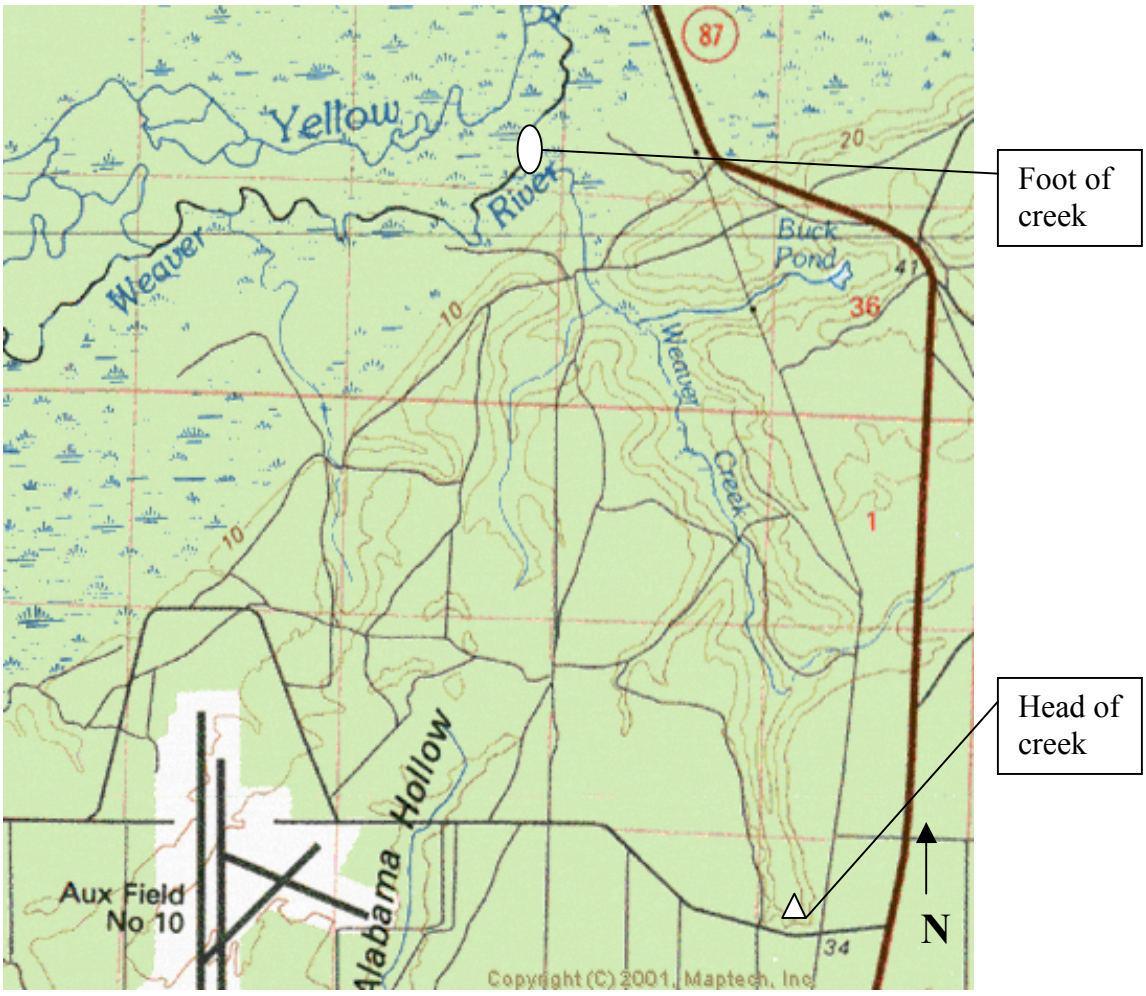

Figure 2. Topographic map of Weaver Creek showing point of origin and point of entry into Weaver River.

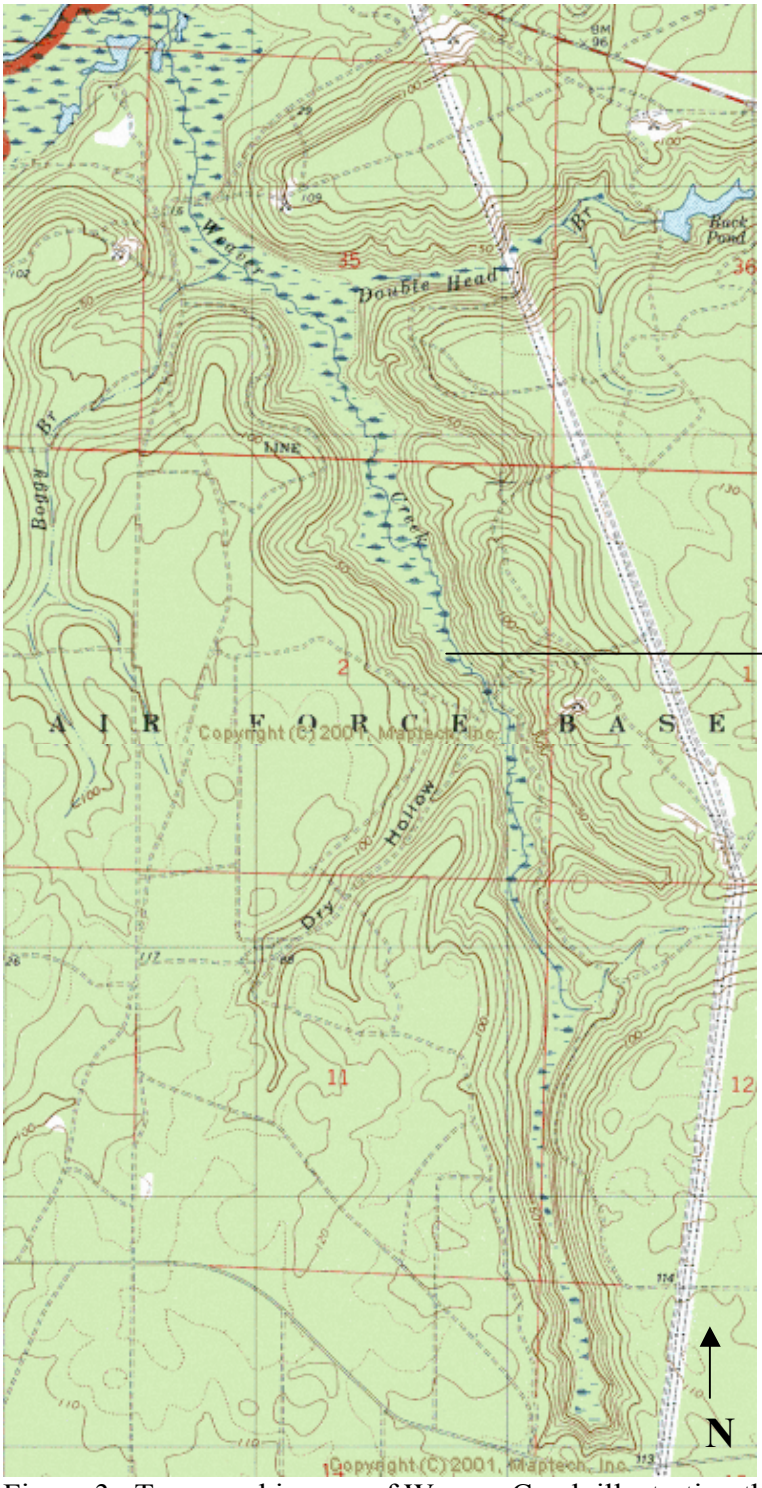

Figure 3. Topographic map of Weaver Creek illustrating the difference in width between upstream and downstream sections. The point of delineation is only approximate due to the fact that the stream becomes gradually wider downstream.

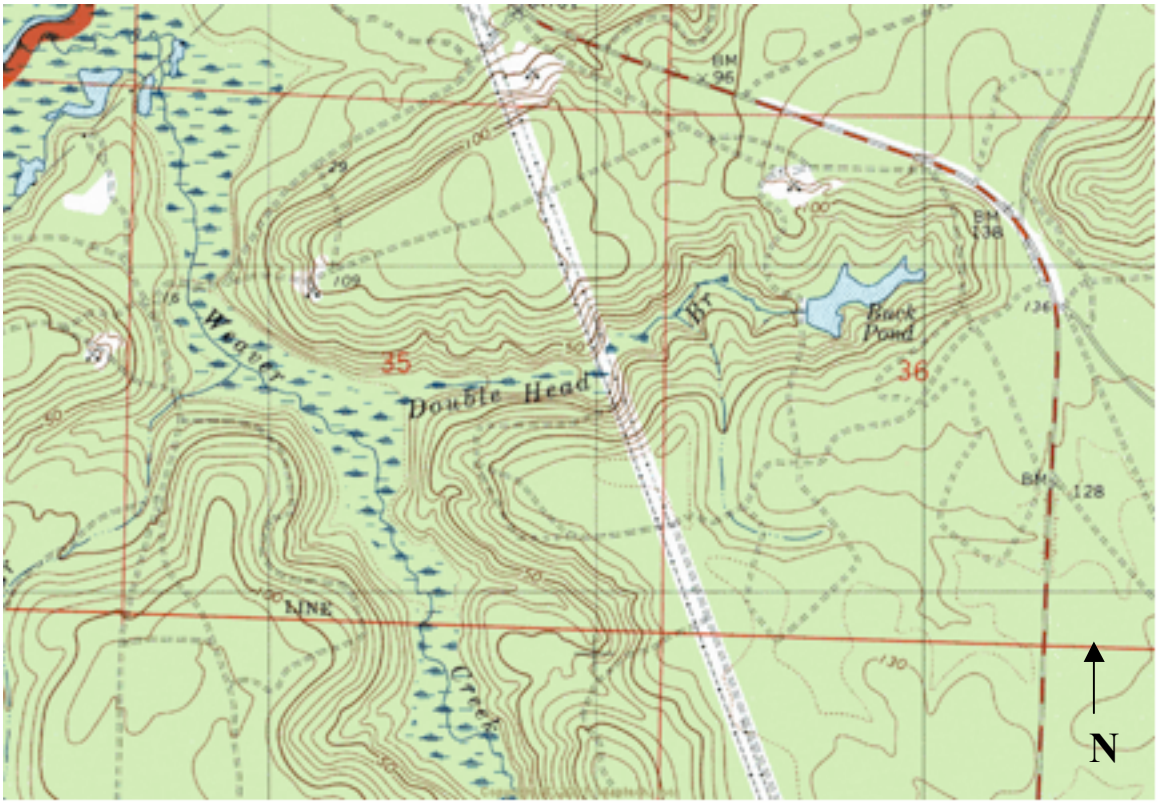

Figure 4. Topographic map of Buck Pond collection site. The powerline along which the stream was sampled is shown as a dashed line with dots interspersed. The point at which the powerline crosses Double Head Branch was the center of the sampling area.

Table 1. Species richness (with number of species unique to each section in parentheses), evenness and diversity (the Shannon Index) of both the upstream and downstream sections of Weaver Creek as well as the entire length of the creek. Community similarity (the Jaccard Index) between upstream and downstream sections is also given. The last column is included to illustrate the numbers of species that occurred in rare (0-5) or infrequent (6-30) abundance categories with percentages of total species per section in parentheses.

	Richness (S)	**Evenness (J')**	**Diversity (H')**	**Similarity (JI)**	**Rare/ Infrequent Species**
Upstream	41 (29)	0.88	3.28	13.33%	9 (22%)
Downstream	73 (61)	0.84	3.61		35 (48%)
Entire Creek	102	0.86	3.98	--	44 (43%)

Table 2. Taxonomic (generic) richness (with number of genera unique to each site in parentheses), evenness and diversity (the Shannon Index) of upstream and downstream portions along with the entire length of the creek.

	Richness	**Evenness (J')**	**Diversity (H')**
Upstream	34 (25)	0.97	3.43
Downstream	43 (34)	0.93	3.49
Entire Creek	67	0.95	3.98

Table 3**:** Summary of vascular plant species reported to occur in steepheads. The table is organized by position within the steephead (upper slope, middle to lower slope, and wetland). Source information is provided for each species as well.

FAMILY	**UPPER SLOPE**	**MID/LOWER SLOPE**	**WETLAND**
Aceraceae		*Acer rubrum* (Clewell 1981)	*Acer rubrum* (Enge 1998)
Apiaceae			*Hydrocotyle umbellata* (Enge 1998)
Aquifoliaceae	*Ilex opaca* (Enge 1998, Kwit et al. 1998) *Ilex vomitoria* (Enge 1998)	*Ilex coriacea* (Enge 1998, Kwit et al. 1998) *Ilex opaca* (Enge 1998, Kwit et al. 1998, Eglin AFB Steephead Monitoring Program 2004) *Ilex vomitoria* (Enge 1998)	*Ilex coriacea* (Enge 1998) *Ilex opaca* (Enge 1998)
Araceae			*Orontium aquaticum* (SAIC 2006) *Peltandra sagittifolia* (Chafin et al. 1997, SAIC 2006)
Aristolochiaceae		*Hexastylis arifolia* (Wolfe et al. 1988)	*Hexastylis arifolia* (U.S. Fish and Wildlife Service 2007)
Betulaceae	*Ostrya virginiana* (Enge 1998)	*Carpinus caroliniana* (Enge 1998) *Ostrya virginiana* (Wolfe et al. 1988, Enge 1998, Kwit et al. 1998)	
Blechnaceae			*Woodwardia virginica* (Enge 1998)
Caprifoliaceae	*Viburnum dentatum* (Enge 1998)		
Clethraceae			*Clethra alnifolia* (Enge 1998)
Cornaceae	*Cornus florida* (Clewell 1981, Enge 1998)	*Cornus florida* (Enge 1998) *Nyssa sylvatica* (Enge 1998)	*Nyssa biflora* (Means 1975, Clewell 1981) *Nyssa sylvatica* (Enge 1998)
Cupressaceae	*Juniperus silicicola* (Enge 1998)		*Chamaecyparis thyoides* (Chafin et al. 1997)
Cyperaceae			*Eleocharis* spp. (SAIC 2006) *Rhynchospora crinipes* (Chafin et al. 1997)

FAMILY	UPPER SLOPE	MID/LOWER SLOPE	WETLAND
Cyrillaceae			*Cliftonia monophylla* (Clewell 1981) *Cyrilla racemiflora* (Clewell 1981, Enge 1998)
Droseraceae			*Drosera intermedia* (SAIC 2006, U.S. Fish and Wildlife Service 2007)
Dryopteridaceae			*Onoclea sensibilis* (Enge 1998)
Ebenaceae	*Diospyros virginiana* (Clewell 1981)		
Ericaceae	*Kalmia latifolia* (Kwit et al. 1998) *Oxydendrum arboreum* (Kwit et al. 1998) *Vaccinium arboreum* (Clewell 1981, Enge 1998, Kwit et al. 1998)	*Kalmia latifolia* (Wolfe et al. 1988, Enge 1998, Kwit et al. 1998, Eglin AFB Steephead Monitoring Plan 2004) *Lyonia lucida* (Wolfe et al. 1988, Eglin AFB Steephead Monitoring Plan 2004) *Oxydendrum arboreum* (Clewell 1981, Kwit et al. 1998) *Rhododendron austrinum* (Wolfe et al. 1988) *Vaccinium arboreum* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004)	*Kalmia latifolia* (Enge 1998, U.S. Fish and Wildlife Service 2007) *Lyonia lucida* (Enge 1998) *Oxydendrum arboreum* (Clewell 1981) *Rhododendron austrinum* (U.S. Fish and Wildlife Service 2007)
Euphorbiaceae		*Sebastiana fruticosa* (Enge 1998)	
Fabaceae	*Cercis canadensis* (Enge 1998)	*Cercis canadensis* (Enge 1998)	

FAMILY	UPPER SLOPE	MID/LOWER SLOPE	WETLAND
Fagaceae	*Fagus grandifolia* (Kwit et al. 1998) *Quercus alba* (Clewell 1981, Kwit et al. 1998) *Quercus hemisphaerica* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Kwit et al. 1998, Eglin AFB Steephead Monitoring Plan 2004) *Quercus incana* (Enge 1998) *Quercus laevis* (Clewell 1981) *Quercus laurifolia* (Enge 1998) *Quercus nigra* (Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004) *Quercus stellata* (Clewell 1981) *Quercus virginiana* (Clewell 1981)	*Fagus grandifolia* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Kwit et al. 1998, Eglin AFB Steephead Monitoring Plan 2004) *Quercus alba* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Kwit et al. 1998) *Quercus hemisphaerica* (Clewell 1981, Enge 1998, Kwit et al. 1998) *Quercus laurifolia* (Enge 1998) *Quercus michauxii* (Wolfe et al. 1988, Enge 1998) *Quercus nigra* (Wolfe et al. 1988)	
Hamamelidaceae	*Hamamelis virginiana* (Enge 1998)	*Liquidambar styraciflua* (Enge 1998)	*Liquidambar styraciflua* (Enge 1998)
Illiciaceae		*Illicium floridanum* (Enge 1998, Kwit et al. 1998)	*Illicium floridanum* (Means 1975, Clewell 1981, Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004, U.S. Fish and Wildlife Service 2007)
Juglandaceae	*Carya glabra* (Clewell 1981, Wolfe et al. 1988, Enge 1998) *Carya tomentosa* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004)	*Carya pallida* (Clewell 1981) *Carya tomentosa* (Clewell 1981)	
Lauraceae		*Persea borbonia* (Clewell 1981, Enge 1998)	*Persea borbonia* (Clewell 1981, Enge 1998)
Liliaceae			*Lillium iridollae* (SAIC 2006)

FAMILY	UPPER SLOPE	MID/LOWER SLOPE	WETLAND
Magnoliaceae	*Magnolia grandiflora* (Kwit et al. 1998)	*Magnolia ashei* (Wolfe et al. 1988) *Magnolia grandiflora* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Kwit et al. 1998, Eglin AFB Steephead Monitoring Plan 2004) *Magnolia pyramidata* (Wolfe et al. 1988) *Magnolia virginiana* (Enge 1998)	*Liriodendron tulipifera* (Means 1975) *Magnolia virginiana* (Means 1975, Clewell 1981, Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004)
Myricaceae			*Myrica cerifera* (Enge 1998)
Nymphaeaceae			*Nuphar lutea* subsp. *ulvacea* (Chafin et al. 1997, SAIC 2006)
Oleaceae	*Osmanthus americanus* (Clewell 1981, Enge 1998, Kwit et al. 1998)	*Osmanthus americanus* (Clewell 1981, Enge 1998, Kwit et al. 1998)	*Osmanthus americanus* (Clewell 1981)
Pinaceae	*Pinus glabra* (Clewell 1981, Kwit et al. 1998)	*Pinus glabra* (Clewell 1981, Wolfe et al. 1988, Enge 1998, Kwit et al. 1998)	*Pinus glabra* (Enge 1998)
Potamogetonaceae			*Potamogeton* spp. (SAIC 2006)
Ranunculaceae			*Xanthorhiza simplicissima* (U.S. Fish and Wildlife Service 2007)
Rosaceae	*Amelanchier arborea* (Clewell 1981) *Crataegus marshallii* (Enge 1998) *Prunus americana* (Enge 1998)	*Prunus caroliniana* (Enge 1998)	
Sarraceniaceae			*Sarracenia leucophylla* (Chafin et al. 1997, SAIC 2006) *Sarracenia rubra* (Chafin et al. 1997, U.S. Fish and Wildlife Service 2007, SAIC 2006)
Saururaceae		*Saururus cernuus* (Enge 1998)	*Saururus cernuus* (Enge 1998)
Scrophulariaceae			*Bacopa monnieri* (Enge 1998) *Macranthera flammea* (U.S. Fish and Wildlife Service 2007)

FAMILY	UPPER SLOPE	MID/LOWER SLOPE	WETLAND
Stemonaceae		*Croomia pauciflora* (Wolfe et al. 1988)	
Symplocaceae	*Symplocos tinctoria* (Enge 1998)	*Symplocos tinctoria* (Enge 1998)	
Taxaceae		*Taxus floridana* (Wolfe et al. 1988, Enge 1998) *Torreya taxifolia* (Wolfe et al. 1988)	
Theaceae		*Stewartia malacodendron* (Wolfe et al. 1988)	
Tiliaceae	*Tilia heterophylla* (Clewell 1981, Enge 1998)	*Tilia heterophylla* (Clewell 1981)	
Verbenaceae	*Callicarpa americana* (Enge 1998)		
Vitaceae	*Vitis rotundifolia* (Enge 1998)	*Vitis rotundifolia* (Enge 1998)	

Table 4: Plant species reported from steepheads with no specific location information. Some are repeated from Table 1 if listed by a different source than in Table 3. Reference information is provided for each species.

FAMILY	SPECIES
Anacardiaceae	*Toxicodendron radicans* (Clewell 1981, Enge 1998)
Annonaceae	*Asimina parviflora* (Clewell 1981)
Aquifoliaceae	*Ilex coriacea* (Clewell 1981) *Ilex opaca* (Clewell 1981)
Araceae	*Colocasia esculenta* (Enge 1998)
Araliaceae	*Aralia spinosa* (Clewell 1981)
Arecaceae	*Sabal minor* (Enge 1998)
Aristolochiaceae	*Aristolochia serpentaria* (Clewell 1981) *Hexastylis arifolia* (Clewell 1981, Means 1985)
Ascelpiadaceae	*Matalea alabamensis* (Eglin AFB Steephead Monitoring Program 2004)
Betulaceae	*Ostrya virginiana* (Clewell 1981)
Bignoniaceae	*Bignonia capreolata* (Clewell 1981)
Blechnaceae	*Woodwardia areolata* (Enge 1998)
Bromeliaceae	*Tillandsia usneoides* (Clewell 1981)
Caprifoliaceae	*Sambucus canadensis* (Enge 1998) *Viburnum nudum* (Clewell 1981, Enge 1998)
Celastraceae	*Euonymus americanus* (Clewell 1981)
Cornaceae	*Cornus foemina* (Enge 1998)
Cupressaceae	*Juniperus silicicola* (Clewell 1981)
Cyperaceae	*Carex baltzellii* (Eglin AFB Steephead Monitoring Program 2004)
Dioscoreaceae	*Dioscorea quaternata* (Clewell 1981)
Dryopteridaceae	*Athyrium filix-femina* (Enge 1998) *Dryopteris ludoviciana* (Enge 1998) *Polystichum acrostichoides*
Ericaceae	*Epigaea repens* (Means 1985) *Leucothoe racemosa* (Clewell 1981) *Oxydendrum arboreum* (Enge 1998) *Rhododendron austrinum* (Eglin AFB Steephead Monitoring Program 2004) *Vaccinium fuscatum* (Clewell 1981)
Euphorbiaceae	*Sapium sebiferum* (Eglin AFB Steephead Monitoring Plan 2004) *Sebastiana fruticosa* (Clewell 1981)
Fabaceae	*Cercis canadensis* (Clewell 1981)
Fagaceae	*Quercus arkansana* (Eglin AFB Steephead Monitoring Program 2004)
Grossulariaceae	*Itea virginica* (Clewell 1981, Enge 1998)
Hydrangeaceae	*Hydrangea arborescens* (Means 1985)
Juglandaceae	*Carya ovata* (Entrekin et al. 1999)

FAMILY	SPECIES
Lamiaceae	*Calamintha dentata* (Clewell 1981) *Conradina glabra* (Clewell 1981)
Lauraceae	*Sassafras albidum* (Clewell 1981)
Liliaceae	*Lilium iridollae* (Means 1991) *Lilium superbum* (Clewell 1981) *Trillium underwoodii* (Enge 1998)
Loganiaceae	*Gelsemium sempervirens* (Clewell 1981)
Lygodiaceae	*Lygodium japonicum* (Eglin AFB Steephead Monitoring Plan 2004)
Magnoliaceae	*Liriodendron tulipifera* (Enge 1998) *Magnolia ashei* (Eglin AFB Steephead Monitoring Program 2004) *Magnolia pyramidata* (Enge 1998, (Eglin AFB Steephead Monitoring Program 2004)
Oleaceae	*Chionanthus virginicus* (Clewell 1981)
Orchidaceae	*Goodyera pubescens* (Means 1985)
Osmundaceae	*Osmunda cinnamomea* (Enge 1998)
Pinaceae	*Pinus taeda*
Poaceae	*Arundinaria gigantea* (Enge 1998)
Ranunculaceae	*Actaea pachypoda* (Means 1985) *Clematis reticulata* (Clewell 1981)
Rosaceae	*Crataegus uniflora* (Clewell 1981)
Rubiaceae	*Mitchella repens* (Clewell 1981, Enge 1998)
Sapotaceae	*Bumelia lanuginosa* (Clewell 1981)
Smilacaceae	*Smilax* spp. (Enge 1998) *Smilax bona-nox* (Clewell 1981) *Smilax pumila* (Clewell 1981)
Staphyleaceae	*Staphylea trifolia* (Means 1985)
Stemonaceae	*Croomia pauciflora* (Means 1985)
Styracaceae	*Halesia diptera* (Clewell 1981) *Styrax grandifolia* (Clewell 1981)
Symplocaceae	*Symplocos tinctoria* (Clewell 1981)
Taxaceae	*Taxus floridana* (Clewell1981, Means 1985) *Torreya taxifolia* (Means 1985)
Theaceae	*Stewartia malacodendron* ((Eglin AFB Steephead Monitoring Program 2004)
Ulmaceae	*Celtis tenuifolia* (Clewell 1981) *Ulmus floridana* (Enge 1998)
Verbenaceae	*Callicarpa americana* (Clewell 1981)
Violaceae	*Viola* spp. (Enge 1998)
Vitaceae	*Parthenocissus quinquefolia* (Enge 1998) *Vitis rotundifolia* (Enge 1998)

Table 5**:** Vascular plant species reportedly located in uplands (sandhills) surrounding steepheads. Reference information is provided as well for each species.

FAMILY	**SPECIES**
Agavaceae	*Yucca filamentosa* (Enge 1998)
Chrysobalanaceae	*Licania michauxii* (Enge 1998)
Ericaceae	*Vaccinium arboreum* (Enge 1998) *Vaccinium myrsinites* (Enge 1998)
Loganiaceae	*Gelsemium sempervirens* (Enge 1998)
Fagaceae	*Quercus geminata* (Enge 1998) *Quercus incana* (Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004) *Quercus laevis* (Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004) *Quercus laurifolia* (Enge 1998) *Quercus margaretta* (Enge 1998) *Quercus marilandica* (Wolfe et al. 1988) *Quercus virginiana* (Wolfe et al. 1988, Enge 1998)
Pinaceae	*Pinus clausa* (Enge 1998) *Pinus elliottii* (Enge 1998) *Pinus palustris* (Wolfe et al. 1988, Enge 1998, Eglin AFB Steephead Monitoring Plan 2004)
Smilacaceae	*Smilax* spp. (Enge 1998)

Table 6**:** Fauna reported from steepheads. Reference information is provided for each species.

FAMILY	SPECIES
Invertebrates	
Acrididae	*Melanoplus apalachicolae* (Chafin et al. 1997)
Baetiscidae	*Baetisca becki* (Florida Fish and Wildlife Conservation Commission 2004) *Baetisca laurentina* (Florida Fish and Wildlife Conservation Commission 2004) *Baetisca rogersi* (Florida Fish and Wildlife Conservation Commission 2004)
Behningiidae	*Dolania americana* (Chafin et al. 1997)
Cambaridae	*Cambarus pyronotus* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Procambarus rathbunae* (Florida Fish and Wildlife Conservation Commission 2005) *Procambarus rogersi expletus* (Florida Fish and Wildlife Conservation Commission 2005)
Cordulegastridae	*Cordulegaster sayi* (Florida Fish and Wildlife Conservation Commission 2005)
Ctenizidae	*Cyclocosmia torreya* (Chafin et al. 1997)
Gyrinidae	*Spanglerogyrus albiventris* (Epler 2005)
Leptoceridae	*Oecetis parva* (Florida Fish and Wildlife Conservation Commission 2005)
Lestidae	*Lestes inaequalis* (Florida Fish and Wildlife Conservation Commission 2005)
Sericostomatidae	*Agarodes ziczac* (Florida Fish and Wildlife Conservation Commission 2005)
Fish	
Cyprinidae	*Pteronotropis hypselopterus* (FNAI 1990) *Pteronotropis welaka* (Chafin et al. 1997) *Semotilus atromaculatus* (Wolfe et al. 1988, FNAI 1990) *Semotilus thoreauianus* (Florida Fish and Wildlife Conservation Commission 2004)
Ictaluridae	*Noturus leptacanthus* (FNAI 1990)
Percidae	*Etheostoma edwini* (FNAI 1990) *Etheostoma okaloosae* (Means 1991, Chafin et al. 1997, Eglin AFB Steephead Monitoring Program 2004, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005, SAIC 2006) *Etheostoma parvipinne* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Percina nigrofasciata* (FNAI 1990)
Amphibians	
Amphiumidae	*Amphiuma pholeter* (Means 1977, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005)
Hylidae	*Hyla andersonii* (Means and Longden 1976, Chafin et al. 1997, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005, U.S. Fish and Wildlife Service 2007)

FAMILY	SPECIES
Plethodontidae	*Desmognathus apalachicolae* (Wolfe et al. 1988, Means 1991, Means 2000, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Desmognathus auriculatus* (Means 1974, Means 1975, Wolfe et al. 1988, FNAI 1990, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Desmognathus cf. conanti* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Desmognathus fuscus* (Means 1974) *Desmognathus fuscus conanti* (Means 1975, Wolfe et al. 1988, Means 2000) *Desmognathus monticola* (Means 1974, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Eurycea bislineata* (Means 1975, Wolfe et al. 1988, FNAI 1990) *Eurycea chamberlaini* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Eurycea cirrigera* (Means 2000) *Eurycea cf. quadridigitata* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Hemidactylium scutatum* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Pseudotriton montanus* (FNAI 1990) *Pseudotriton ruber* (Means 1975, Wolfe et al. 1988, Means 2000) *Pseudotriton ruber* subsp. *vioscai* (FNAI 1990)
Proteidae	*Necturus alabamensis* (FNAI 1990)
Ranidae	*Rana clamitans* subsp. *clamitans* (FNAI 1990) *Rana okaloosae* (Wolfe et al. 1988, Chafin et al. 1997, Means 1991, Eglin AFB Steephead Monitoring Program 2004, Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005, U.S. Fish and Wildlife Service 2006, U.S. Fish and Wildlife Service 2007)
Reptiles	
Chelydridae	*Macroclemys temminckii* (Chafin et al. 1997)
Colubridae	*Farancia erytrogramma* (FNAI 1990) *Nerodia taxispilota* (FNAI 1990) *Storeria occipitomaculata* (FNAI 1990)
Kinosternidae	*Sternotherus minor* (FNAI 1990)
Scincidae	*Eumeces anthracinus* (Chafin et al. 1997)
Viperidae	*Agkistrodon contortrix contortrix* (Chafin et al. 1997)
Birds	
Accipitridae	*Elanoides forficatus* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005)

FAMILY	SPECIES
Ardeidae	*Butorides virescens* (Florida Fish and Wildlife Conservation Commission 2004) *Egretta caerulea* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005)
Parulidae	*Seiurus motacilla* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005)
Mammals	
Molossidae	*Eumops glaucinus* (Florida Fish and Wildlife 2004) *Nyctinomops macrotis* (Florida Fish and Wildlife Conservation Commission 2004)
Mustelidae	*Lutra canadensis lataxina* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005)
Vespertilionidae	*Corynorhinus rafinesquii* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Eptesicus fuscus* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Lasiurus borealis* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Lasiurus cinereus* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Lasiurus intermedius* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Lasiurus seminolus* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Myotis austroriparius* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Myotis grisescens* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005) *Pipistrellus subflavus* (Florida Fish and Wildlife Conservation Commission 2004, Florida Fish and Wildlife Conservation Commission 2005)