Wetlands of Coastal Georgia

Results of the National Wetlands Inventory and Landscape-level Functional Assessment

October 2012

Cover Photo: Blackbeard Island NWR Salt Marsh (Courtesy of GA DNR)

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Introduction

Coastal Georgia was among the first areas in the nation to be inventoried by the National Wetlands Inventory Program (NWI) of the U.S. Fish and Wildlife Service (FWS or Service). That early wetland mapping work was done in cooperation with the Georgia Department of Natural Resources (DNR) in the late 1970s, and though it was not widely distributed, it was instrumental in formulating NWI procedures. In the late 1980s the NWI was again conducted for coastal Georgia, and the results of the inventory were published in the form of hardcopy 1:24,000 scale maps that were later digitized to be used as a data layer in geographic information systems (GIS) applications. A history of the NWI in the area is included in this report. Much change has occurred since the 1980s inventory and the original mapping is no longer relevant for most of the coastal counties, especially in areas where development activity and natural coastal geophysical processes have taken place.

Remote sensing technology has advanced considerably since the early mapping was conducted; better quality aerial imagery is increasingly available and geospatial technology has evolved to make desktop interpretation of digital imagery possible. These advances allow production of a more comprehensive inventory with both improved detection (i.e., more wetlands identified) and better classification detail. The NWI also created additional descriptors for landscape position, landform, water flow path, and waterbody type (LLWW descriptors) to expand wetland classification. The enhanced classification, referred to as NWI+, allows for more detailed classification of types that can be used to perform a preliminary assessment of functions for wetlands in the region. Recognizing this, the Coastal Resources Division (CRD) of the DNR, utilizing a grant from the U.S. Environmental Protection Agency and in cooperation with FWS, elected to update the NWI for the six coastal counties: Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden.

This document reports on the methods and the findings of the updated and enhanced wetland inventory. It includes information on wetland status (e.g., acreage of different wetland types) and a preliminary functional assessment of wetlands. The functional assessment highlights wetlands that are predicted to perform eleven functions at significant levels and includes thematic maps showing the location of these wetlands.

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History of the National Wetlands Inventory in Coastal Georgia

The DNR has a relationship with the NWI that dates back to the 1970s. The NWI update described in this report is the third iteration of the NWI for coastal Georgia. With ever-improving mapping techniques, each wetlands inventory has been of greater detail and precision.

When the NWI became operational in 1976, coastal Georgia was among the first places where mapping and classifying wetlands on a regional scale using the new Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979), then in the working draft stage of completion, was attempted. The initial coastal Georgia NWI effort took place from 1977 through 1979. The DNR's Game and Fish Division, Coastal Fisheries Section (under contract to the FWS) provided the photo-interpretation and field checking of the wetland delineations that were provided to the FWS for map production. The study area for the project extended from the South Carolina state border southward to the Florida border and westward from the ocean about 30 miles. Photo-interpreters from the Coastal Protection Section delineated wetlands that they were able to observe through ten-power stereoscopes directly on to mylar overlays attached to color infrared (CIR) or black and white aerials varying in scale from 1:76,000 to 1:130,000, taken from 1973 to 1978. Wetlands were classified only to the system, subsystem, and class level. The minimum size of wetlands delineated was between 5 and 20 acres. The wetland maps produced from these delineations were at a scale of 1:100,000. The maps were not widely distributed and were used primarily as a source of information for an atlas associated with Ecological Characterization of the Sea Island Coastal Region of South Carolina and Georgia Vol. III, Biological Features of the Characterization Area (Sandifer 1980), prepared by the Biological Services Program of the FWS.

During the 1980s, interest in wetland management and regulation increased. With encouragement from natural resource managers, the NWI started production of large-scale wetland maps from stereoscopic photo-interpretation of high altitude aerial photographs. Optical devices called zoom transfer scopes were used to match the wetland delineations with U.S. Geological Survey (USGS) 1:24,000 scale quadrangle base maps and produce hardcopy wetland maps at 1:24,000. In addition to increasing the scale of the wetland maps, the level of classification detail was also improved. Wetlands were now being classified in accordance with the Cowardin et al. (1979) classification system to the subclass level, including water regime modifiers and special modifiers where they could be observed from the aerial photographs or where collateral information was available.

Significant in the production of improved wetland maps by the NWI was the development of the National High Altitude Program (NHAP) for the acquisition of consistent and systematic aerial photography coverage of the United States. The program, begun in 1978, enabled federal agencies to combine funds to acquire aerial photography to support a wide range of uses. The Department of the Interior, especially USGS and the FWS, was a regular contributor to the program. Under direction of the USGS, the program simultaneously acquired 1:80,000-scale panchromatic and 1:58,000-scale CIR positive images. NHAP acquired aerial photography from 1980 to 1987.

Coastal Georgia, because of its high density of wetlands, continued to be a priority for the NWI. In the mid-1980s, with the availability of high quality NHAP color infrared imagery taken in March of 1983 and February of 1984, the NWI undertook a second inventory of the area. Using a photo-interpretation and drafting contractor, Martel Laboratories in St. Petersburg, Florida, wetlands were again identified through ten-power stereoscopic analysis and delineated on clear mylar overlays attached to the NHAP CIR images. The late winter, leaf-off, NHAP imagery, proved to be an excellent wetland mapping data source. The minimum size of wetlands delineated ranged from one acre for high contrast features such as farm ponds to five acres for most vegetated wetland types. The identification and classification of wetlands from the imagery was supported by the use of collateral information including USGS topographic maps, Natural Resources Conservation Service (NRCS) Soil Surveys, and other ecoregional documentation, along with limited ground truth acquisition. Once the delineations were completed and reviewed by the FWS, they were transferred optically (using zoom transfer scopes) to fit the corresponding 1:24,000-scale USGS topographic base maps. The draft maps, showing the wetland delineations and classifications, were then distributed upon request to interested parties for review, a number of which participated with the FWS in field checking the maps. Based on comments returned to the FWS, the maps were edited and prepared for final distribution. These procedures were standard practice for the NWI for nearly two decades.

The 1980s version NWI maps for Georgia were well received by wetland managers, regulators, and others involved in land planning and management. In the early 1990s, the Georgia Geological Survey became a distribution center for the NWI, copying and mailing maps to users upon request, facilitating their wide application. Shortly thereafter, the use of NWI was institutionalized in the tax code by the Georgia Department of Revenue by making any area of a landowner’s property shown as wetland by the NWI as eligible for a Conservation Use Assessment for Environmentally Sensitive Property. In 2000, the Georgia Department of Community Affairs developed guidelines for preparation of local wetlands ordinances that incorporated the use of the NWI in the planning and development process (See Figure 1).

In the late 1990s, GIS technology was advancing rapidly. Natural resources professionals were finding GIS tools invaluable for their work. Recognizing this, the Environmental Protection Division of the DNR partnered with the NWI by funding the digitization of the 1980s version hard-copy NWI maps, which the FWS posted on their website, making them internet-accessible. Partnerships like this helped make the NWI one of the first standardized data layers broadly available to GIS users.

By the mid-2000s, the landscape of coastal Georgia had changed considerably since the previous NWI period. The value of wetlands was much better understood and interest in their sound management had increased significantly. Also the NWI had developed techniques to expand wetland classification to include hydrogeomorphic-type descriptors that significantly increased the descriptive information about mapped wetlands and allowed NWI data to be used to produce a preliminary landscape-level assessment of wetland functions. In 2008, as a result of these factors, the Coastal Resources Division of the Department of Natural Resources, in cooperation with the FWS, elected to utilize grant funding from the U.S. Environmental Protection Agency to update and enhance the NWI data for coastal Georgia.

This report provides an overview of the process of updating the NWI for the six coastal counties, the results of the NWI, as well as the process and results of enhancing the NWI and conducting a preliminary landscape-level assessment of wetland functions for the area.

Figure 1. Georgia Department of Community Affairs (GDCA) guidelines for preparation of local wetlands ordinances as published on the GDCA website in September 2000. This version of the guidelines is provided as historical reference only. Contact information contained in the guidelines may no longer be current.

WETLANDS: GUIDELINES

Step One: Identify and Map

A local government does not need to start from scratch to create a wetlands map. This information has already been produced. National Wetlands Inventory (NWI) maps, as they are called, are available in both digital (computer) and paper format.

A. Obtain the wetlands map.

1. The paper maps can be obtained by calling either of the following:

Division of Natural Resources Georgia Natural Heritage Program 2117 U.S. Highway 278 SE Social Circle, Georgia 30025 Phone: 770.918.6411	OR	Georgia Geologic Survey Room 4063 19 Martin Luther King Jr. Dr. SW Atlanta, GA 30334-9004 (404) 657-6127 FAX: 404-657-8379

2. The digital maps are available on the World Wide Web at www.nwi.fws.gov. Some areas of the state have been digitally mapped and are available for downloading.

B. Create a wetlands map.

An RDC or local government can create a map using available data.

1. Find the selected area on your Digital Ortho Quadrangle (DOQ) CD. Use this data as your base. [*Every RDC has a CD containing DOQs for their region. This data is broken down by County.]*
2. Download the Department of Transportation (DOT) road data at www.GIS.state.ga.us. *[This can be found within this website by going to 'clearinghouse', 'data library', 'browse data', 'theme search'.]* If your RDC has its own road system data this can also be used. Overlay this data on the DOQ base map.
3. Download the National Wetlands Inventory Maps from www.nwi.fws.gov./download.htm. All of these maps will be available on DCA's website soon. Overlay this data on the DOQ base map.

C. Review the wetlands map.

Review the maps to see if there are wetlands in the city or county's jurisdiction (Call DCA for assistance if necessary.) If wetlands are present within the jurisdiction, local wetland protection criteria must be adopted.

Step Two: Design and Prepare Ordinance

- Wetland protection requires coordination with the U.S. Army Corps of Engineers for review of projects that may require a Section 404 Permit. For more information regarding this regulatory program, go to www.sas.usace.army.mil/permit.htm or call the Savannah District Regulatory Branch at 1.800.448.2402 or 912.652.5995.

- Review the Rules for Environmental Criteria (Rule 391-3-16-.03) and think about which local regulations or procedures should trigger the wetland review process. The Rules are available from DCA's website (http://www.dca.state.ga.us/planning/ocp_rules/envtoc.html) or by calling the DCA Office of Coordinated Planning Division at 404-679-5279 or email to esmith@dca.state.ga.us. Also refer to *Designing, Implementing, and Enforcing* a local ordinance for additional information. In the absence of other regulations, you may need a stand-alone ordinance.

- **Design a coordination process.** Incorporate provisions into your regulations that require builders and developers to submit proposed projects for wetlands review. If it appears that wetlands are present on the proposed development site, the applicant should submit the project to the U.S. Army Corps of Engineers for a jurisdictional wetlands determination and possibly a 404 permit. No local permit must be issued on a project that appears to contain wetlands until a determination has been made by the Corps of Engineers on whether jurisdictional wetlands exist on the site.

  Decide who will have the *responsibility* at the local level of comparing the sites of proposed projects to wetlands maps and referring projects that appear to contain wetlands to the Corps.

  1. If there **are no** jurisdictional wetlands on site, the local government permitting process can proceed.

  2. If there **are** jurisdictional wetlands on the site that will be disturbed by the proposed development, the applicant must first obtain a wetlands alteration permit from the Corps of Engineers.

     > *Sending every developer to the Corps for a determination would needlessly overburden the Corps staff resources and delay the developers local permitting process. Therefore, it is important for the local government to compare a project to a "wetlands map" and if the project appears to be near or within a wetland area then the developer needs to consult with the U.S. Army Corps of Engineers before issuance of any local permit.*

Step Three: Local Legal Review
Prepare the ordinance and have the city/county attorney review the draft ordinance prior to its adoption. This review should focus on ensuring that the local government is not violating the rights of developers and property owners, which can lead to expensive lawsuits.

Step Four: Submit to DCA for Review
All local governments must submit their environmental ordinances to the DCA for review and approval. The local government can submit directly to DCA or to the RDC. DCA prefers the ordinance to be in draft form when submitted but this is not required.

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Study Area

The study area is composed of Georgia's six coastal counties, each with direct access to the Atlantic Ocean. They are, from north to south: Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden Counties. The counties cover a land area of approximately 3,159 square miles and represent about 5.5 percent of the State of Georgia (Figure 2). County acreages used in this study are based on the 2006 United States Census Bureau, Geography Division, TIGER/Line Shapefiles.

Figure 2. Study Area.

Overview of NWI's Wetland Definition and Classification System[1]

Since some readers may be unfamiliar with the Service's wetland definition and classification system and this system serves as the foundation for this report, an introduction to the definition and classification is presented here. Other readers may simply proceed to the next section of this report on page 19. Idealized wetland plant community descriptions for coastal Georgia with typical NWI classifications are included in Appendix B.

Wetland Definition

Conceptually, wetlands usually lie between the better drained, rarely flooded uplands and the permanently flooded deep waters of lakes, rivers, and coastal embayments. Wetlands include the variety of marshes, bogs, swamps, shallow ponds, and bottomland forests that occur throughout the country. They usually form in upland depressions or along rivers, lakes and coastal waters in areas subject to periodic flooding. Some wetlands, however, occur on slopes where they are associated with groundwater seepage areas or drainageways.

For mapping wetlands, the Service defines wetlands as follows:

> "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year." (Cowardin et al. 1979)

This definition emphasizes three key attributes of wetlands: (1) hydrology - the degree of flooding or soil saturation, (2) wetland vegetation (hydrophytes), and (3) hydric soils. All areas considered wetland must have enough water at some time during the year to stress plants and animals not adapted for life in water or saturated soils. Most wetlands have hydrophytes and hydric soils present, yet many are nonvegetated (e.g., tidal mudflats). Wetlands typically fall within one of the following four categories: (1) areas with both hydrophytes and hydric soils (e.g., marshes, swamps, and bogs), (2) areas without hydrophytes, but with hydric soils (e.g., farmed wetlands), (3) areas without soils but with hydrophytes (e.g., seaweed-covered rocky shores), and (4) periodically flooded areas without soil and without hydrophytes (e.g., gravel bars and tidal mudflats). All wetlands must be periodically saturated or covered by shallow water during the growing season, whether or not hydrophytes or hydric soils are present. Effectively drained hydric soils that are no longer capable of supporting hydrophytes due to a major change in hydrology are not considered wetland. Areas with effectively drained hydric soils are, however, good indicators of historic wetlands, which may be suitable for restoration.

[1] This chapter was derived nearly verbatim from Tiner (2010).

The Service does not generally include permanently flooded deep water areas as wetland, although nontidal shallow waters (ponds) are classified as wetland. Instead, these deeper waterbodies are defined as deepwater habitats, since water, not air, is the principal medium in which dominant organisms live. Along the coast in tidal areas, the deepwater habitat begins at the extreme spring low tide level. In nontidal freshwater areas, this habitat starts at a depth of 6.6 feet (2 meters [m]) because the shallow water areas are often vegetated with emergent wetland plants.

Wetland Classification

For the NWI, wetlands were classified following the Service's official wetland classification: Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). This classification system has also been adopted as the federal wetland classification standard by the Federal Geographic Data Committee. The following discussion represents a simplified overview of the Service's wetland classification system. Since some of the more technical points have been omitted from this discussion, readers are advised to refer to the official classification document (Cowardin et al. 1979) when attempting to classify a wetland and should not rely solely on this overview.

The Service's wetland classification system is hierarchical or vertical in nature, proceeding from general to specific, as noted in Figure 3 and Appendix A. In this approach, wetlands are first defined at a rather broad level - the *system*. The term *system* represents "a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors." Five systems are defined: marine, estuarine, riverine, lacustrine, and palustrine. The marine system generally consists of the open ocean and its associated high-energy coastline, while the estuarine system encompasses salt and brackish marshes, nonvegetated tidal shores, and brackish waters of coastal rivers and embayments. Freshwater wetlands and deepwater habitats fall into one of the other three systems: riverine (rivers and streams), lacustrine (lakes, reservoirs, and large ponds), or palustrine (e.g., marshes, bogs, swamps, and small shallow ponds). Thus, at the most general level, wetlands can be defined as either marine, estuarine, riverine, lacustrine or palustrine (Figure 3).

Each system, with the exception of the palustrine, is further subdivided into *subsystems*. The marine and estuarine systems both have the same two subsystems, which are defined by tidal water levels: (1) subtidal - continuously submerged areas and (2) intertidal - areas alternately flooded by tides and exposed to air. Similarly, the lacustrine System is separated into two systems based on water depth: (1) littoral - wetlands extending from the lake shore to a depth of 6.6 feet (2 m) below low water or to the extent of nonpersistent emergents (e.g., arrowheads, pickerelweed, or spatterdock) if they grow beyond that depth and (2) limnetic - deepwater habitats lying beyond the 6.6 feet (2 m) mark at low water. By contrast, the riverine system is further defined by four subsystems that represent different reaches of a flowing freshwater or lotic system: (1) tidal - water levels subject to tidal fluctuations for at least part of the growing season, (2) lower perennial - permanent, flowing waters with a well-developed floodplain, (3) upper perennial - permanent, flowing water with very little or no floodplain development, and (4) intermittent - channel containing nontidal flowing water for only part of the year.

Figure 3. Wetland and deepwater habitat classification hierarchy (Cowardin et al. 1979).

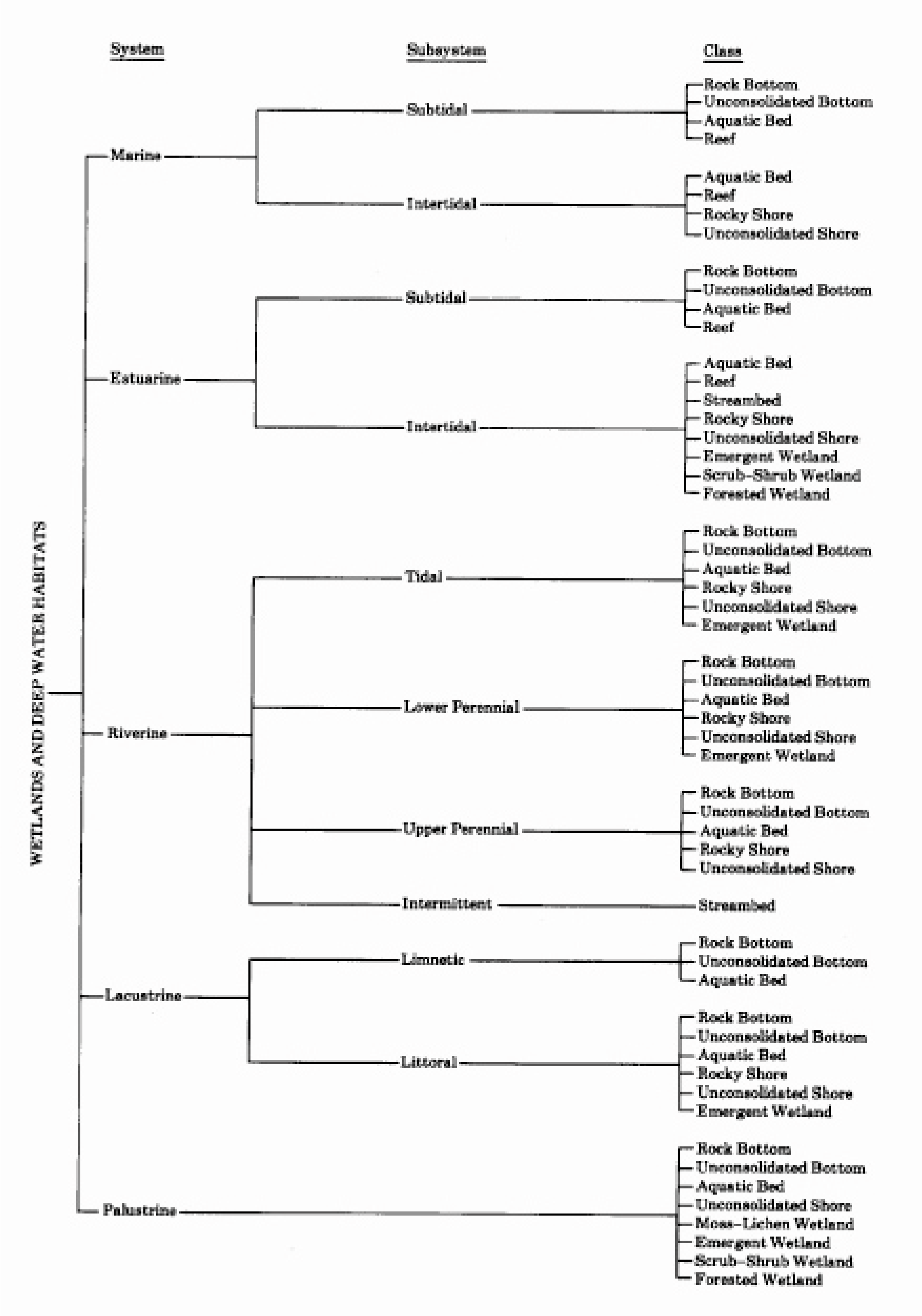
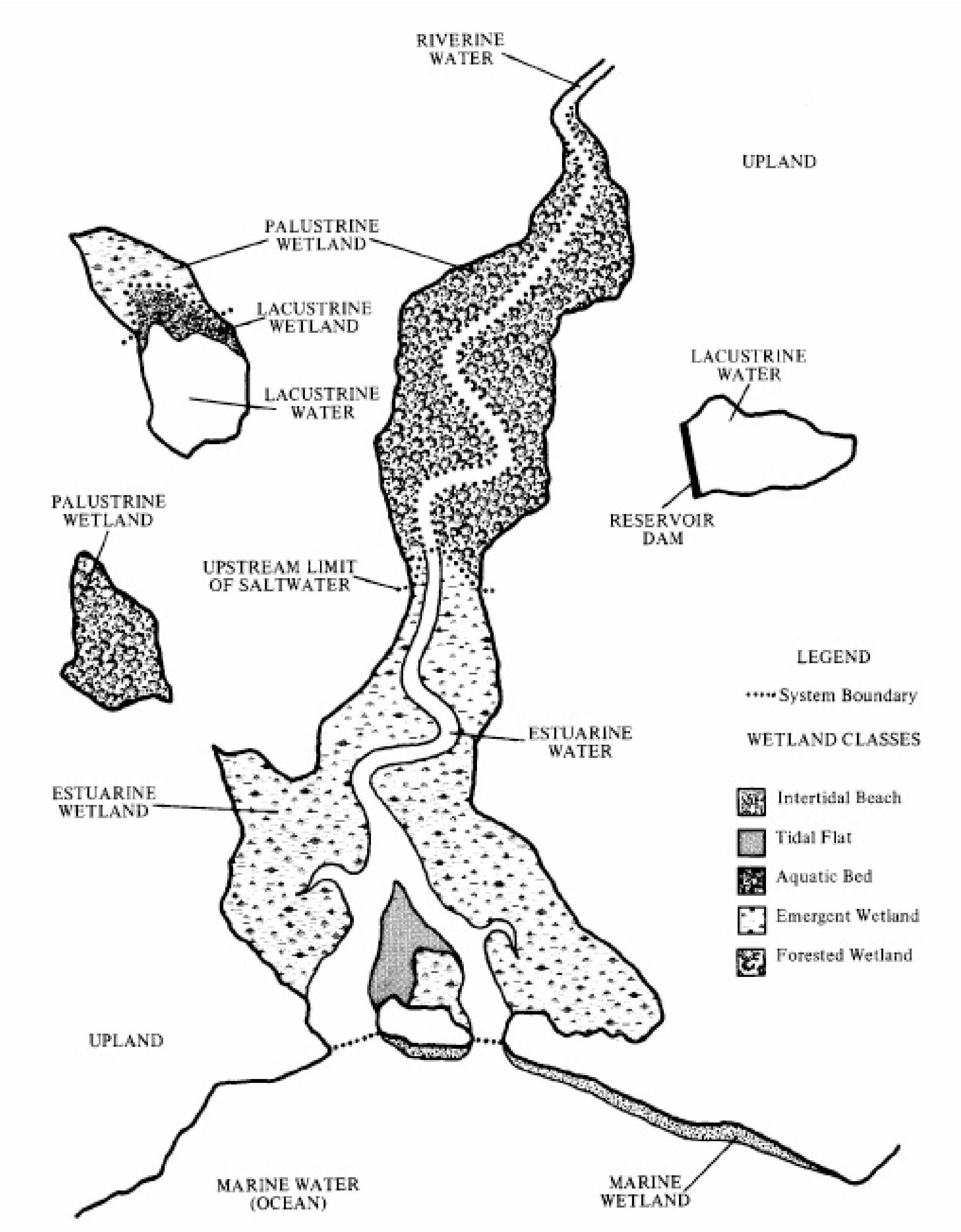


Figure 4. Schematic drawing showing positions and types of wetlands on the landscape.



The next level - *class* - describes the general appearance of the wetland or deepwater habitat in terms of the dominant vegetative life form or the nature and composition of the substrate, where vegetative cover is less than 30% (Table 1). Of the 11 classes, five refer to areas where vegetation covers 30% or more of the surface: Aquatic Bed, Moss-Lichen Wetland, Emergent Wetland, Scrub-Shrub Wetland, and Forested Wetland. The remaining six classes represent areas generally lacking vegetation, where the composition of the substrate and degree of flooding distinguish classes: Rock Bottom, Unconsolidated Bottom, Reef (sedentary invertebrate colony), Streambed, Rocky Shore, and Unconsolidated Shore. Permanently flooded nonvegetated areas are classified as either Rock Bottom or Unconsolidated Bottom, while exposed areas are typed as Streambed, Rocky Shore, or Unconsolidated Shore. Invertebrate reefs are found in both permanently flooded and exposed areas.

Each class is further divided into *subclasses* to better define the type of substrate in nonvegetated areas (e.g., bedrock, rubble, cobble-gravel, mud, sand, and organic) or the type of dominant vegetation (e.g., persistent or nonpersistent emergents, moss, lichen, or broad-leaved deciduous, needle-leaved deciduous, broad-leaved evergreen, needle-leaved evergreen, and dead woody plants). Below the subclass level, *dominance level* can be applied to specify the predominant plant or animal in the wetland community.

To allow better description of a given wetland or deepwater habitat in regard to hydrologic, chemical, and soil characteristics and to human impacts, the classification system contains four types of specific modifiers: (1) Water Regime, (2) Water Chemistry, (3) Soil, and (4) Special. These modifiers may be applied to class and lower levels of the classification hierarchy.

Water regime modifiers describe flooding or soil saturation conditions and are divided into two main groups: tidal and nontidal. Tidal water regimes are used where water level fluctuations are largely driven by oceanic tides. Tidal regimes can be subdivided into two general categories, one for salt and brackish water tidal areas and another for freshwater tidal areas. This distinction is needed because of the special importance of seasonal river overflow and groundwater inflows in freshwater tidal areas. By contrast, nontidal modifiers define conditions where surface water runoff, ground-water discharge, and/or wind effects (i.e., lake seiches) cause water level changes. Both tidal and nontidal water regime modifiers are presented and briefly defined in Table 2.

Water chemistry modifiers are divided into two categories which describe the water's salinity or hydrogen ion concentration (pH): (1) salinity modifiers and (2) pH modifiers. Like water regimes, salinity modifiers have been further subdivided into two groups: halinity modifiers for tidal areas and salinity modifiers for nontidal areas. Estuarine and marine waters are dominated by sodium chloride, which is gradually diluted by fresh water as it moves upstream in coastal rivers. On the other hand, the salinity of inland waters is dominated by four major cations (i.e., calcium, magnesium, sodium, and potassium) and three major anions (i.e., carbonate, sulfate, and chloride). Interactions between precipitation, surface runoff, groundwater flow, evaporation, and sometimes plant evapotranspiration form inland salts which are most common in arid and semiarid regions of the country. Table 3 shows ranges of halinity and salinity modifiers which are a modification of the Venice System (Remane and Schlieper 1971). The other set of water chemistry modifiers are pH modifiers for identifying acid ($pH<5.5$), circumneutral (5.5-7.4) and alkaline ($pH>7.4$) waters. Some studies have shown a good correlation between plant distribution and pH levels (Sjors 1950; Jeglum

1971). Moreover, pH can be used to distinguish between mineral-rich (e.g., fens) and mineral-poor wetlands (e.g., bogs).

The third group of modifiers - soil modifiers - are presented because the nature of the soil, which exerts strong influences on plant growth and reproduction as well as on the animals living in it. Two soil modifiers are given: (1) mineral and (2) organic. In general, if a soil has 20 percent or more organic matter by weight in the upper 16 inches, it is considered an organic soil, whereas if it has less than this amount, it is a mineral soil. For specific definitions, please refer to Appendix D of the Service's classification system (Cowardin et al. 1979).

The final set of modifiers - special modifiers - were established to describe the activities of people or beavers affecting wetlands and deepwater habitats. These modifiers include: excavated, impounded (i.e., to obstruct outflow of water), diked (i.e., to obstruct inflow of water), partly drained, farmed, and artificial (i.e., materials deposited to create or modify a wetland or deepwater habitat).

Table 1. Classes and subclasses of wetlands and deepwater habitats (Cowardin et al. 1979).

Class	**Brief Description**	**Subclasses**
Rock Bottom	Generally permanently flooded areas with bottom substrates consisting of at least 75% stones and boulders and less than 30% vegetative cover.	Bedrock; Rubble
Unconsolidated Bottom	Generally permanently flooded areas with bottom substrates consisting of at least 25% particles smaller than stones and less than 30% vegetative cover.	Cobble-gravel; Sand; Mud; Organic
Aquatic Bed	Generally permanently flooded areas vegetated by plants growing principally on or below the water surface line.	Algal; Aquatic Moss; Rooted Vascular; Floating Vascular
Reef	Ridge-like or mound-like structures formed by the colonization and growth of sedentary invertebrates.	Coral; Mollusk; Worm
Streambed	Channel whose bottom is completely dewatered at low water periods.	Bedrock; Rubble; Cobble-gravel; Sand; Mud; Organic; Vegetated
Rocky Shore	Wetlands characterized by bedrock, stones or boulders with areal coverage of 75% or more and with less than 30% coverage by vegetation.	Bedrock; Rubble
Unconsolidated Shore	Wetlands having unconsolidated substrates with less than 75% coverage by stone, boulders and bedrock and less than 30% vegetative cover, except by pioneer plants.	Cobble-gravel; Sand; Mud; Organic; Vegetated
Moss-Lichen Wetland	Wetlands dominated by mosses or lichens where other plants have less than 30% coverage.	Moss; Lichen
Emergent Wetland	Wetlands dominated by erect, rooted, herbaceous hydrophytes.	Persistent; Nonpersistent
Scrub-Shrub Wetland	Wetlands dominated by woody vegetation less than 20 feet (6 m) tall.	Broad-leaved Deciduous; Needle-leaved Deciduous; Broad-leaved Evergreen; Needle-leaved Evergreen; Dead
Forested Wetland	Wetlands dominated by woody vegetation 20 feet (6 m) or taller.	Broad-leaved Deciduous; Needle-leaved Deciduous; Broad-leaved Evergreen; Needle-leaved Evergreen; Dead

Table 2. Water regime modifiers, both tidal and nontidal groups (Cowardin et al. 1979).

Group	Type of Water	Water Regime	Definition
Tidal	Saltwater and brackish areas	Subtidal	Permanently flooded tidal waters
		Irregularly exposed	Exposed less often than daily by tides
		Regularly flooded	Daily tidal flooding and exposure to air
		Irregularly flooded	Flooded less often than daily and typically exposed to air
	Freshwater	Permanently flooded-tidal	Permanently flooded by tides and river or exposed irregularly by tides
		Semipermanently flooded-tidal	Flooded for most of the growing season by river overflow but with tidal fluctuation in water levels
		Regularly flooded	Daily tidal flooding and exposure to air
		Seasonally flooded-tidal	Flooded irregularly by tides and seasonally by river overflow
		Temporarily flooded-tidal	Flooded irregularly by tides and for brief periods during growing season by river overflow
Nontidal	Inland freshwater and saline areas	Permanently flooded	Flooded throughout the year in all years
		Intermittently exposed	Flooded year-round except during extreme droughts
		Semipermanently flooded	Flooded throughout the growing season in most years
		Seasonally flooded	Flooded for extended periods in growing season, but surface water is usually absent by end of growing season
		Saturated	Surface water is seldom present, but substrate is saturated to the surface for most of the season
		Temporarily flooded	Flooded for only brief periods during growing season, with water table usually well below the soil surface for most of the season

Intermittently flooded	Substrate is usually exposed and only flooded for variable periods without detectable seasonal periodicity (not always wetland; may be upland in some situations)
Artificially flooded	Duration and amount of flooding is controlled by means of pumps or siphons in combination with dikes or dams

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Table 3. Salinity modifiers for coastal and inland areas (Cowardin et al. 1979).

Coastal Modifiers[2]	**Inland Modifiers**[3]	**Salinity (ι)**	**Approximate Specific Conductance (Mhos at 25^{o} C)**
Hyperhaline	Hypersaline	> 40	> 60,000
Euhaline	Eusaline	30-40	45,000-60,000
Mixohaline (Brackish)	Mixosaline[4]	0.5-30	800-45,000
Polyhaline	Polysaline	18-30	30,000-45,000
Mesohaline	Mesosaline	5-18	8,000-30,000
Oligohaline	Oligosaline	0.5-5	800-8,000
Fresh	Fresh	< 0.5	< 800

[2]Coastal modifiers are employed in the marine and estuarine systems.

[3]Inland modifiers are employed in the riverine, lacustrine and palustrine systems.

[4]The term "brackish" should not be used for inland wetlands or deepwater habitats.

Methods

Updating the National Wetlands Inventory

The Coastal Resources Division of the Georgia Department of Natural Resources, with assistance from a support contractor, Atkins North America, Inc. (formerly PBS&J), updated the NWI for Coastal Georgia with strict adherence to the Wetland Mapping Standard of the Federal Geographic Data Committee (FDGC) Wetland Subcommittee (2009) and following the Data Collection Requirements and Procedures for Mapping Wetland, Deepwater and Related Habitats of the United States (Dahl et al. 2009). Both documents were available in final draft format at the beginning of the project making it possible to apply the new mapping standards to the coastal Georgia NWI updates. The FWS actively participated in the updating process by providing quality control review of the draft wetland delineations to assure that the revised NWI was consistent with the NWI nationally and suitable for inclusion as a part of the wetland data layer of the National Spatial Data Infrastructure.

Photo Interpretation

An on-screen or "heads up" digitization process was employed using ArcMap 9 software for identifying, classifying, and delineating wetlands. Wetlands were interpreted from USGS high resolution (0.5 meter) color orthoimagery taken in 2006. The orthoimagery also served as the base photography for displaying the NWI update. For locations along the southern coast where USGS imagery was unavailable, Florida Bureau of Survey and Mapping LABINS high resolution color infrared imagery taken in 2004 served as the base photography. In locations along the western portion of the study area where neither of these data sets were available , National Agriculture Imagery Program (NAIP) imagery taken in 2007 was utilized as the base photography. Care was taken to place wetland boundaries of well-defined features within 20 feet of the boundary position on the imagery, as practicable, to ensure that National Map Accuracy Standards were met. The imagery was routinely interpreted at a scale of approximately 1:7000, but was viewed at much larger scales as interpretation questions arose. Regular utilization of collateral data was an important part of the wetland identification and classification process. Digital geo-referenced collateral information was layered in the GIS for contemporaneous viewing during the interpretation process. Wetlands were classified in accordance with the Cowardin et al. (1979) to system, subsystem, class, subclass level with water regime and special modifiers. The minimum size wetland regularly mapped and classified was between 0.25 to 0.5 acres.

During the interpretation process, natural resource professionals routinely reviewed collateral digital data sets, as available, including the 2007 NAIP imagery, USGS Orthophoto Quadrangle color-infrared imagery with one-meter resolution (taken in 1999), USGS 1:24,000 topographic quadrangles, the USGS National Hydrography Dataset (NHD) (published in 2009) depicting streams, the NRCS soil survey geographic data (SSURGO), LiDAR elevation data for Glynn County, the previous NWI representing 1983 conditions, and the DNR Wildlife Resources Division National Vegetation Classification System data for Glynn County and portions of other counties.

Ground Truth Acquisition

Field verification or ground truth acquisition is essential to every high quality remotely sensed natural resources inventory. Field verification took place from August 2008 to October 2009. Seventy-six person days were expended visiting 378 sites. Site visits were limited to those areas that were accessible by roads or short excursions on foot. Special care was taken to avoid trespassing on private property. Sites were selected that either (1) would provide information not discernible from aerial photographs in combination with the collateral data, (2) had conflicting information, or (3) were needed to verify the preliminary delineations. Site visits took place on four occasions (August 25-28, 2008, December 7-12, 2008, March 30-April 3, 2009, and October 5-9, 2009) and were led by Atkins, with periodic accompaniment by the DNR, The Nature Conservancy, Mulkey Engineering and Consultants and FWS.

Quality Control of Wetland Delineation and Classification

Wetland interpretations, delineations, and classifications were reviewed at least two times prior to submittal for review by the FWS for evaluation and comment. The initial review was provided by an experienced wetland scientist. Upon completion of the review, the delineations were returned to the original photo interpreter for correction as necessary. Once corrections were made, the work was reviewed again by a wetland scientist other than the initiator of the work. Sites where delineation or classification uncertainty remained were tagged for field review. Additional editorial corrections were made after each field review exercise.

Topological Review

Once project scientists were satisfied that wetland boundaries and classifications were accurately assigned, a topological review was conducted. This review is designed to ensure polygons had no overlap or multipart features. The FWS Wetland Verification Tool was then applied to the data set as a final quality control check for incorrect wetland codes, adjacent wetlands, sliver wetlands, sliver uplands, lake and pond sizes,.

Submittal of Draft NWI Updates to FWS

Draft data files were submitted to the FWS Southeast Regional NWI Coordinator for review and evaluation on a regular basis as sections of the coast were completed. After each review, editorial comments were discussed with the FWS Coordinator to ensure that they were interpreted correctly and to incorporate suggestions for improvement into the ongoing database development. Final editorial changes were then incorporated into the database.

Final Database and Map Products

After the incorporation of all editorial comments and suggestions, work areas were edge-matched, topology was rechecked, and the FWS verification tool was reapplied as a final check. The updated NWI was submitted to CRD as a single, high quality seamless ESRI ArcGIS 9.2 File Geodatabase in

Albers Equal Area Conic, NAD 83, meters projection. The updated NWI for coastal Georgia can be viewed online at the FWS NWI Wetland Mapper Site (http://www.fws.gov/wetlands/Data/Mapper.html). In addition to the geodatabase, nearly 300 interactive 1:12,000 scale orthophoto maps were produced in PDF format. Map layers, which can be turned on or off at the user's discretion, include the updated NWI, the aerial photograph used as the mapping base, the contour lines, USGS hydrographic data, the roads network, and geographic place names. The PDF maps are named in accordance with the USGS orthophoto quarter quadrangle for which they represent (e.g., Hinesville SE).

Enhancing the NWI Data for Functional Assessment

Background

A set of abiotic attributes were developed by FWS to increase the information contained in the NWI database and to create what is known as the NWI+ database. The four groups of attributes describe:

(1) landscape position (relationship of a wetland to a waterbody if present: marine—ocean, estuarine—tidal brackish, lotic—river/stream, lentic—lake/reservoir, and terrene—not significantly affected by such waters, or no waterbody present, or the source of a stream);
(2) landform (physical shape of the wetland—basin, flat, floodplain, fringe, island, and slope);
(3) water flow path (inflow, outflow, throughflow, isolated, bidirectional-nontidal, and bidirectional-tidal); and
(4) waterbody type (different types of estuaries, rivers, lakes, and ponds).

Collectively, the attributes are known as LLWW descriptors, which represent the first letter of each descriptor (landscape position, landform, water flow path, and waterbody type). Dichotomous keys have been developed to interpret these attributes (Tiner 2003b). Other modifiers are also included in these keys to further describe wetland characteristics. LLWW descriptors can be added to the NWI database by interpreting topography from digital raster graphics (DRGs) or digital elevation model data (DEMs), stream courses from the NHD and/or aerial imagery, and waterbody types from aerial imagery. The interpretations can be done by employing some automated GIS routines, coupled with manual review and interpretation by wetland specialists.

The NWI+ database adds value and increases the functionality of the original NWI database. Besides providing more features that can be used to predict wetland functions from the NWI database, NWI+ makes it possible to better characterize the nation's wetlands. For example, all of the palustrine wetlands, which account for 95 percent of the wetlands in the conterminous United States, can now be linked to rivers, streams, lakes, and ponds, where appropriate, so that the acreage of floodplain wetlands, lakeside wetlands, and geographically isolated wetlands can be reported. The Wetlands Subcommittee of the FGDC recognized the value added by the LLWW descriptors and recommended that they be included in wetland mapping to increase the functionality of wetland inventory databases (FGDC Wetlands Subcommittee 2009).

Adding Abiotic Descriptors to the NWI Database

For this project, LLWW descriptors were applied to all wetlands in the NWI digital database in accordance with the definitions and dichotomous keys developed by the FWS (Tiner 2003a). Section 4 of this document provides a set of simplified dichotomous keys for applying these descriptors (see Appendix C for coding scheme). For consistency and accuracy, the LLWW descriptors were added to the NWI database by the wetland scientists who updated the NWI and were familiar with the study area. NWI data were viewed with on-line USGS topographic maps (DRGs) to identify wetlands along streams and general slope characteristics. Aerial imagery was used to determine waterbody types (e.g., ponds). Six wetland landscape positions (including two lotic types) describing the relationship between a wetland and an adjacent waterbody were identified:

(1) marine – on the shores of the open ocean and its embayments,
(2) estuarine – associated with tidal brackish waters (estuaries),
(3) lotic (river or stream; see below)– along freshwater rivers and streams and periodically flooded, at least during high discharge periods (including freshwater tidal reaches of coastal rivers),
(4) lentic – in lakes, reservoirs, and their basins where water levels are significantly affected by the presence of these waterbodies, and
(5) terrene – isolated or headwater wetlands, fragments of former isolated or headwater wetlands that are now connected to downslope wetlands via drainage ditches, and wetlands on broad, flat terrain cut through by streams but where overbank flooding does not occur (e.g., hydrologically decoupled from streams).

Lotic wetlands were further separated by river and stream sections based on watercourse width (i.e., polygon = river; linear = stream at a scale of 1:24,000) and then divided into one of five gradients:

(1) high (e.g., shallow mountain streams on steep slopes – not present in the study area),
(2) middle (e.g., streams with moderate slopes – not present in the study area),
(3) low (e.g., mainstem rivers with considerable floodplain development and slow-moving streams),
(4) intermittent (i.e., periodic flows), and
(5) tidal (i.e., under the influence of tides).

Map G-2 shows the generalized locations of these LLWW wetland types across the landscape. Eight landforms, describing the physical form of a wetland or the predominant land mass upon which it occurs (e.g., floodplain), were identified (Map G-3): basin, flat, floodplain, fringe, island, slope, and interfluves (see Appendix C for definitions).

Additional modifiers were assigned to indicate water flow paths associated with wetlands: bidirectional-tidal, bidirectional-nontidal, throughflow, inflow, outflow, or isolated (Map G-4). Surface water connections were emphasized because they are more readily observable than groundwater linkages. Bidirectional flow paths were assigned to all intertidal wetlands. Throughflow wetlands were identified as having either a watercourse or another type of wetland above and below them. Most lotic wetlands were observed to be throughflow types. Inflow pathways were determined where watercourses could be observed entering the wetland but no surface water outlet could be seen. Outflow wetlands were identified as those appearing to have water leaving them and moving downstream via a watercourse or a slope wetland. Isolated wetlands were observed to be closed ("geographically isolated") depressions or flats where water appeared to come from direct precipitation, localized surface water runoff, and/or groundwater discharge. From the surface water perspective, these wetlands appear to be isolated from other wetlands since they lack an apparent surface water connection; however it should be recognized that they may be hydrologically linked to other wetlands and waterbodies via groundwater, while others may be connected by small streams that were not mapped on the collateral data sources.

Other descriptors applied to mapped wetlands include headwater, drainage-divide, and partly drained. Headwater wetlands appear to be sources of streams or wetlands along first-order (perennial) streams. Wetlands described as drainage-divide wetlands appear to have outflow in two directions to two separate drainage systems. Partly drained wetlands were typically ditched wetlands. For open water habitats, additional descriptors following Tiner (2003a) were applied, including water flow path, and pond, estuary, and lake types.

Since ponds were separated from wetlands for the LLWW classification, wetland acreage totals are different for NWI and LLWW. NWI routinely classifies open water areas 20 acres or smaller as palustrine unconsolidated bottom wetlands. These areas were not reclassified as lacustrine in the NWI database, so deepwater habitat acreage of lacustrine waters and acreage of palustrine unconsolidated bottoms based on NWI will be different than LLWW totals for lakes and ponds. Ponds were separated into three categories: natural, dammed/impounded, and excavated.

Classifications were reviewed for accuracy prior to performing the analysis of wetland functions. Despite this review, it is possible that a few wetlands may have been misclassified due to the complexity and enormity of the dataset that contained over 52,000 polygons.

Preliminary Assessment of Wetland Functions

After creating the NWI+ database (the enhanced NWI database), analyses were performed to produce a preliminary assessment of wetland functions for the study area. Both wetlands and ponds were evaluated for performance of 11 functions:

(1) surface water detention,
(2) coastal storm surge detention,
(3) streamflow maintenance,
(4) nutrient transformation,
(5) carbon sequestration,
(6) retention of sediment and other particulates,
(7) bank and shoreline stabilization,
(8) provision of fish and aquatic invertebrate habitat,
(9) provision of waterfowl and waterbird habitat,
(10) provision of other wildlife habitat,
(11) provision of habitat for unique, uncommon, or highly diverse plant communities.

The preliminary assessment of wetland functions for coastal Georgia was accomplished under the guidance of Ralph Tiner (FWS, Hadley, MA). This study employed a landscape-level functional assessment approach that may be called "Watershed-based Preliminary Assessment of Wetland Functions" (W-PAWF). W-PAWF applies general knowledge about wetlands and their functions to develop a watershed or area-wide overview that highlights possible wetlands of significance in terms of performance of various functions. The rationale for correlating wetland characteristics with wetland functions in the northeastern U.S. is described in Tiner (2003b). The procedure begins with the identification of wetland attributes or characteristics from the suite of characteristics described by the NWI, with the addition of LLWW modifiers which contribute to the performance of each wetland function. Then, using GIS technology, wetlands are selected that exhibit those particular characteristics. The information resulting from the selection process can be portrayed graphically on maps or in tabular form.

In order to develop region-specific information for the six–county study area, the relationships (formerly called correlations) developed for use in the northeastern U.S. were introduced to and reviewed by a group of Georgia scientists from federal, state, and local agencies, non-profit organizations, and academic institutions at an August 31, 2010 workshop on Little St. Simons Island. The peer group provided comments that were used to re-evaluate the relationships and tailor them to coastal Georgia. In cases where there were differences in opinions, the points were considered and decisions were made by consensus between the DNR-CRD, Atkins North America, and Ralph Tiner. A detailed rationale for the selection of Georgia specific characteristics and their relationship to wetland functions is found in Tiner (2011) included in its entirety as Appendix D. Using the sets of characteristics important to each of the 11 functions developed from the workshop, ArcView 10 software was utilized to select wetlands from the NWI+ database which exhibited those characteristics.

Data Analysis and Compilation

GIS was used to analyze the data and produce wetland statistics (acreage summaries) for the overall study area and for each of the six coastal counties. Tables were prepared to summarize the results of the NWI update (i.e., the extent of different wetland types by NWI classification) and to correlate wetland characteristics with wetland functions to identify wetlands of significance for 11 functions. After running the analyses, a series of maps was generated to display the variety of wetland types and to highlight wetlands that may perform various functions at significant levels (see Appendix G). Statistics were mostly generated from Microsoft's Excel program, whereas thematic maps were generated by ArcView software. *<u>Special Note:</u> When summarizing data, percentages given usually refer to percent of wetland acreage, while for convenience, the narrative will refer to them as "percent of wetlands." In reference to ponds, the actual number of ponds mapped is known, so percent of ponds by number and by acreage are reported.*

Limitations of the Inventory and the Assessment

Wetland Inventory and Digital Database

Since the NWI data were derived from 2006 imagery, they do not reflect changes in some wetlands that have occurred in the past six years. These changes may be due to permitted alterations by federal, state, and local governments or to natural processes including erosion, accretion, and sea level rise. Despite this, the 2006 database should reasonably reflect contemporary conditions because wetlands in this area are well regulated.

It is important to recognize the limitations of any wetland mapping effort derived mainly through photointerpretation techniques (see Tiner 1990, 1997, and 1999 for details). NWI data, or any other wetland data derived from these techniques, do not include all wetlands. Some wetlands are simply too small to map given the imagery used, while others avoid detection due to evergreen tree cover, dry surface conditions, or other factors. For this inventory and assessment the minimum size of the wetland targeted mapping unit was one-half acre, but many wetlands (especially ponds) smaller than this were mapped. Wetland units may contain small areas that are different from the mapped type (i.e., inclusions) due to scale and map complexity issues. For example, a 10-acre forested wetland may include small areas of emergent wetlands or small upland islands not discernable from aerial photography due to canopy cover. Drier-end wetlands such as temporarily flooded palustrine wetlands are often difficult to separate from nonwetlands through photointerpretation. Finally, despite our best attempts at quality control, some errors of interpretation and classification are likely to occur due to the sheer number of polygons in the wetland database (over 52,000).

Preliminary Assessment of Wetland Functions[5]

The landscape-level functional assessment employed in this study is preliminary, based on wetland characteristics interpreted through remote sensing and the best professional judgment of wetland specialists. Wetlands believed to be providing high and moderate levels of performance for a particular function were highlighted. The process for the qualitative assignment of ranking as high or moderate is described in detail by Tiner (2011), included in its entirety in Appendix D. In general those wetlands exhibiting the full range of characteristics supporting a particular function were assigned a high ranking while those wetlands exhibiting some, but not all characteristics, were assigned a moderate ranking. As the focus of this report is on wetlands, a functional assessment of deepwater habitats (e.g., lakes, rivers, estuaries, and submerged marine aquatic beds) and linear features such as perennial and intermittent streams was outside of the report's scope. The importance of permanently flooded habitats to fish, for example, should be obvious and the beneficial functions of small streams (even intermittent ones) to water quality and sediment retention should also be recognized (Meyer et al. 2003). No attempt was made to produce a more qualitative ranking for each function or for each wetland based on multiple functions as this would require more input from other sources, well beyond the scope of this study. For a technical review of wetland functions, see Mitch and Gosselink (2008) and for broad overviews see Tiner (2005, in press).

[5] This chapter was derived extensively from Tiner (2011), included as Appendix D.

Functional assessment of wetlands can involve many approaches. Typically such assessments are done in the field on a case-by-case basis by comparing observed features to those required to perform certain functions or by measuring actual performance. The present study is not a substitution for such evaluations, which are the ultimate assessment of individual wetland function. Yet, for a landscape-level analysis, area-wide on-the-ground assessments are not practical, cost-effective or even possible given access considerations. For watershed planning and landscape-level evaluation purposes, a more generalized assessment is optimal for targeting wetlands that may provide certain functions, especially for those functions dependent on landscape position, landform, vegetation life form, and other photointerpretable features. These preliminary results can be field-verified when evaluating particular wetlands for acquisition (e.g., for conservation of biodiversity or for preserving flood storage capacity). More recent aerial photography may also be examined to aid in further evaluations (e.g., condition of wetland/stream buffers or adjacent land use) that can supplement this preliminary assessment.

W-PAWF does not account for a wetland's opportunity to provide a function resulting from a certain land use practice upstream or the presence of certain structures or land uses downstream. For example, two wetlands of equal size and like vegetation may be in the right landscape position to retain sediments. One, however, may be downstream of a land-clearing operation that has generated considerable suspended sediments in the water column, while the other is downstream from an undisturbed forest. The former should be actively performing significant sediment trapping, while the latter is not receiving as much material. Yet if land-clearing takes place upstream of the latter area, the second wetland will likely trap sediments as well as the first wetland. The entire W-PAWF analysis typically tends to ignore opportunity whether the function has been or ever will be fully employed. W-PAWF also does not consider the condition of the adjacent upland (e.g., level of disturbance) or the water quality of the associated waterbody, which may be regarded as important metrics for assessing the health of individual wetlands.

This preliminary assessment does not obviate the need for more detailed assessments of the various functions. It should be viewed as a starting point for more rigorous assessments, as it attempts to highlight wetlands that likely provide significant functions, based on generally accepted principles and the source information used for this analysis. The data may also be useful for town-wide assessments and other geographic area-specific evaluations, yet the wetland classifications (both NWI and LLWW) should be field checked for accuracy as this will influence the functional assessment results. This assessment method could serve as a rapid site-assessment technique to gain a general sense of what functions are likely to be performed by a particular wetland, followed by a more in-depth site evaluation as necessary depending on project objectives. This is particularly true for assessing fish and wildlife habitats and biodiversity. Other sources of data may exist to help refine some of the findings of this report. Additional modeling could be done, for example, to identify habitats of likely significance to individual species of animals (based on their specific life history requirements). Georgia DNR Wildlife Resources Division data could be used to highlight wetlands supporting rare, threatened, and endangered species.

Results

The following text describes the statistical results of the circa 2006 update of the NWI, the application of LLWW types (landscape position, landform, and water flow path) to each NWI wetland polygon, and the landscape-level assessment of wetland functions. Tables summarizing the statistical findings are included.

In addition to summary tables and short narratives, the following fifteen maps showing NWI types, LLWW types and potential wetlands of significance for each of 11 functions were prepared and are available in reproducible PDF format from the Coastal Resources Division of the Georgia Department of Natural Resources. Images of these maps and county specific function maps are included in Appendix G.

Page	**Theme**
G-1	Wetlands by NWI Types
G-2	Wetlands by Landscape Position
G-3	Wetlands by Landform
G-4	Wetlands by Water Flow Path
G-5	Potential Wetlands of Significance for Surface Water Detention
G-6	Potential Wetlands of Significance for Coastal Storm Surge Detention
G-7	Potential Wetlands of Significance for Streamflow Maintenance
G-8	Potential Wetlands of Significance for Nutrient Transformation
G-9	Potential Wetlands of Significance for Carbon Sequestration
G-10	Potential Wetlands of Significance for Retention of Sediment and Other Particulates
G-11	Potential Wetlands of Significance for Bank and Shoreline Stabilization
G-12	Potential Wetlands of Significance for Provision of Fish and Aquatic Invertebrate Habitat
G-13	Potential Wetlands of Significance for Provision of Waterfowl and Waterbird Habitat
G-14	Potential Wetlands of Significance for Provision of Other Wildlife Habitat
G-15	Potential Wetlands of Significance for Unique, Uncommon, or Highly Diverse Plant Communities

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Wetlands of Coastal Georgia

<u>NWI Types</u>

Wetlands of the six-county region total 804,227 acres (Table 4) and cover nearly 40 percent of the study area. Palustrine wetlands (freshwater) are most abundant, occupying 432,419 acres and comprising about 54 percent of the region's wetlands. Nearly 79 percent of palustrine wetlands are forested. Palustrine emergent and scrub-shrub wetlands account for only 12 percent and 7 percent of freshwater wetlands, respectively. Estuarine wetlands are second in abundance, occupying 368,484 acres or about 46 percent of the area's wetlands. Emergent wetlands are the most common estuarine type (95%). Marine wetlands inventoried total 3,084 acres, comprised exclusively of unconsolidated shore (marine beaches and flats). Marine wetlands make up less than one percent of the coastal wetlands total. Only 151 acres of lacustrine and 90 acres of riverine wetlands were inventoried.

<u>LLWW Types</u>

Wetlands in the estuarine landscape position account for less than half of the wetlands (46%) in the region, while wetlands in the marine landscape position represent less than one percent of the total (Table 5). By definition, all estuarine and marine wetlands have bidirectional-tidal water flows. Almost 31 percent of the area's wetlands are in the lotic landscape position (i.e. associated with rivers and streams). Most of the region's lotic wetlands exhibited throughflow water pathways (63% of the lotic acreage) or bidirectional-tidal (freshwater tidal) water pathways. Less than one percent of the wetlands are lentic types (along lakes and deep ponds classified as palustrine unconsolidated bottoms by NWI). The water flow path of 78 percent of the lentic wetlands is classified as isolated, whereas about 22 percent of the lentic wetlands have an obvious stream running from them. Twenty-two percent of wetlands are located in the terrene landscape position, mainly in headwater locations or in isolated depressions. Most (83%) of the region's terrene wetlands are outflow types (typically the source of a stream). The remainder are either wetlands that receive surface or groundwater, which flows through the wetland and into another wetland or stream, or are geographically isolated wetlands (surrounded by upland and lacking a detectable surface water connection to other wetlands or waters).

All marine wetlands and 93 percent of the estuarine wetlands are classified as fringe landform types with open access to bays, sounds or the Atlantic Ocean. Estuarine wetlands classified as basin landforms are usually the result of partial hydrologic blockage by roads or railroad crossings. Most lotic wetlands (88%) are basin types (subject to prolonged seasonal flooding), while nearly all remaining lotic wetlands are classified as flats (subject to short-term flooding). Sixty-one percent of the terrene wetlands are classified as basins (depressions) and 39 percent as flats. Terrene basins are seasonally flooded or wetter while terrene flats are temporarily flooded or seasonally saturated. Lentic wetlands are by definition fringe landforms.

Ponds occupy 9,266 acres or one percent of the region's wetlands. A total of 4,416 ponds were inventoried, with nearly all (95%) identified as excavated (Table 6). The average size of ponds in coastal Georgia is about 2.1 acres. Nearly three quarters (74%) of ponds appear to be hydrologically isolated, while most of the remainder have outflow or throughflow water pathways.

Preliminary Functional Assessment

Sixty percent of the wetlands (including ponds) in coastal Georgia are predicted to perform eight of the eleven functions at high to moderate levels (Table 7). As much as 97 percent of the wetlands is deemed important for nutrient transformation; carbon sequestration; habitat for wildlife other than waterfowl and other waterbirds; and retention of sediment and other particulates. Over three-quarters of the wetlands are predicted to contribute to bank and shoreline stabilization. Over 60 percent of the wetlands are predicted to provide coastal storm surge detention, fish and aquatic invertebrate habitat, and waterfowl and waterbird habitat. Forty-one percent of wetlands provide surface water detention. Relatively few wetlands (23%) are located in landscape positions where they could contribute to maintaining streamflow. Only 4 percent of the wetlands are recognized as uncommon or highly diverse plant communities that contribute significantly to the area's biodiversity. These plant communities included the following types: Palustrine tidal emergent wetlands (regularly flooded, seasonally flooded-tidal, and semipermanently flooded-tidal water regimes), Palustrine tidal scrub-shrub wetlands (regularly flooded, seasonally flooded-tidal, and semipermanently flooded-tidal water regimes), Freshwater vegetated wetlands on barrier islands (semipermanently flooded, semipermanently flooded-tidal, and permanently flooded), Carolina bay wetlands (relatively intact), and Palustrine vegetated wetlands that are permanently flooded. (Note: Since this assessment was based on remotely sensed information and largely on observable life-form differences in plant communities and water regimes, it did not attempt to identify wetlands that do or may support rare or endangered species. Such wetlands would have to be identified through other means – contact Georgia's Natural Heritage Program and others for such data.)

Table 4. Wetlands of Coastal Georgia classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Marine	Unconsolidated Shore	3,084
Total Marine Wetlands		**3,084**
Estuarine	Emergent	304,920
	Emergent/Forested	2
	Emergent/Scrub-Shrub	107
	Emergent/Unconsolidated Shore	46,206
	(Subtotal Emergent)	(351,236)
	Forested, Broad-leaved Deciduous	13
	Forested, Broad-leaved Evergreen	1,832
	Forested, Needle-leaved Evergreen	206
	Forested/Emergent	2
	(Subtotal Forested)	(2,053)
	Scrub-Shrub, Broad-leaved Deciduous	533
	Scrub-Shrub, Broad-leaved Evergreen	3,464
	Scrub-Shrub, Needle-leaved Evergreen	383
	Scrub-Shrub/Emergent	115
	(Subtotal Scrub-Shrub)	(4,495)
	Unconsolidated Shore	10,509
	Unconsolidated Shore/Emergent	190
	(Subtotal Nonvegetated)	(10,700)
Total Estuarine Wetlands		**368,484**
Lacustrine	Aquatic Bed	108
	Emergent	10
	Unconsolidated Shore	32
Total Lacustrine Wetlands		**151**
Palustrine	Aquatic Bed	826
	Aquatic Bed/Unconsolidated Bottom	6
	(Subtotal Aquatic Bed)	(832)
	Emergent	50,147
	Emergent/Aquatic Bed	178
	Emergent/Forested	1,638
	Emergent/Scrub-Shrub	548
	(Subtotal Emergent)	(52,511)
	Forested, Broad-leaved Deciduous	202,949
	Forested, Broad-leaved Evergreen	30,450
	Forested, Needle-leaved Deciduous	83,007
	Forested, Needle-leaved Evergreen	21,739

Table 4 (cont'd)	Forested/Emergent	434
	Forested/Scrub-Shrub	1,075
	(Subtotal Forested)	(339,743)
	Scrub-Shrub, Broad-leaved Deciduous	21,750
	Scrub-Shrub, Broad-leaved Evergreen	5,670
	Scrub-Shrub, Needle-leaved Deciduous	1,113
	Scrub-Shrub, Needle-leaved Evergreen	1,453
	Scrub-Shrub/Emergent	393
	Scrub-Shrub/Forested	520
	(Subtotal Scrub-Shrub)	(30,899)
	Unconsolidated Bottom	8,242
	Unconsolidated Shore	192
	Unconsolidated Shore/Emergent	1
	(Subtotal Nonvegetated)	(8,434)
Total Palustrine Wetlands		**432,419**
Riverine	Unconsolidated Shore	90
Total Riverine Wetlands		**90**
GRAND TOTAL (All Wetlands)		**804,227**

Table 5. Wetlands classified by landscape position, landform, and water flow path for coastal Georgia. Note: Ponds were treated as waterbody type (see Table 6) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Marine	Fringe	Bidirectional-tidal	3,084
Total Marine			**3,084**
Estuarine	Fringe	Bidirectional-tidal	341,187
	Basin	Bidirectional-tidal	27,334
Total Estuarine			**368,521**
Lentic	Fringe	Isolated	355
		Outflow	99
Total Lentic			**454**
Lotic River	Fringe	Bidirectional-tidal	73
	(Subtotal Fringe)		(73)
	Floodplain-basin	Bidirectional-tidal	87,044
		Throughflow	11,940
	(Subtotal Basin)		(98,983)
	Floodplain-flat	Bidirectional-tidal	4,479
		Throughflow	2,598
	(Subtotal Flat)		(7,077)
Total Lotic River			**106,134**
Lotic Stream	Basin	Outflow	57
		Throughflow	109,543
	(Subtotal Basin)		(109,600)
	Flat	Throughflow	29,744
	(Subtotal Flat)		(29,744)
Total Lotic Stream			**139,344**
Terrene	Basin	Isolated	22,975
		Outflow	85,596
	(Subtotal Basin)		(108,571)
	Flat	Isolated	6,550
		Outflow	62,266
		Throughflow	13
	(Subtotal Flat)		(68,828)
	Island	Isolated	26
	(Subtotal Island)		(26)
Total Terrene			**177,425**
GRAND TOTAL			**794,961**

Table 6. Pond acreage for coastal Georgia.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	32	38
	Mesotidal	43	126
	Outflow	44	274
	Throughflow	19	172
Total Natural Ponds		**138**	**610**
Impounded	Isolated	31	107
	Mesotidal	5	15
	Outflow	37	172
	Throughflow	7	49
Total Impounded Ponds		**80**	**343**
Excavated	Isolated	3,191	5,767
	Mesotidal	29	91
	Outflow	702	1,787
	Throughflow	276	667
Total Excavated Ponds		**4,198**	**8,313**
GRAND TOTAL		**4,416**	**9,266**

Table 7. Wetlands of potential significance for various functions for Coastal Georgia. Note: Results include ponds.

Function	Significance	Acreage	% of All Wetlands
Surface Water Detention	High	122,923	15%
	Moderate	206,768	26%
	Total	**329,691**	**41%**
Coastal Storm Surge Detention	High	462,862	58%
	Moderate	20,059	2%
	Total	**482,921**	**60%**
Streamflow Maintenance	High	57,965	7%
	Moderate	126,006	16%
	Total	**183,971**	**23%**
Nutrient Transformation	High	680,893	85%
	Moderate	101,185	13%
	Total	**782,078**	**97%**
Carbon Sequestration	High	679,414	84%
	Moderate	119,280	15%
	Total	**798,694**	**99%**
Retention of Sediments	High	567,281	71%
	Moderate	157,944	20%
	Total	**725,225**	**90%**
Shoreline Stabilization	High	605,410	75%
	Moderate	16,598	2%
	Total	**622,008**	**77%**
Fish and Shellfish Habitat	High	470,370	58%
	Moderate	38,883	5%
	Total	**509,253**	**63%**
Waterfowl and Waterbird Habitat	High	456,882	57%
	Moderate	43,552	5%
	Total	**500,434**	**62%**
Other Wildlife Habitat	High	738,574	92%

Table 7 (cont'd).

	Moderate	42,566	5%
	Total	**781,140**	**97%**
Unique, Diverse Communities	Palustrine Vegetated (H WR)	78	--
	Selected PEM (N,R,T WR)	21,462	3%
	Selected PSS (N,R,T WR)	8,843	1%
	Barrier Island (F,T,H WR)	1,307	--
	Carolina Bays (Relatively Intact)	919	--
	Total	**32,609**	**4%**

Wetlands of Bryan County

NWI Types

Bryan County, located between Chatham and Liberty counties, has 103,703 acres of wetlands covering 36 percent of the land surface. Palustrine wetlands are most abundant, occupying 82,865 acres and comprising about 80 percent of the county's wetlands (Table 8). Palustrine forested wetlands are the most common, representing nearly 88 percent of palustrine wetlands. The remaining palustrine vegetated wetlands include emergent (almost 7%) and scrub-shrub (4%) types. Estuarine wetlands are second in abundance, occupying 20,830 acres or about 20 percent of the county's wetlands. Emergent wetlands were the most common estuarine type, comprising 96 percent of estuarine wetlands.

LLWW Types

Wetlands in the estuarine landscape position account for about a fifth the county's wetlands (Table 9). By definition, all estuarine wetlands have bidirectional-tidal water flow paths. Forty-nine percent of the county's wetlands are lotic in landscape position (i.e. associated with rivers and streams). Lotic wetlands in Bryan County are typically throughflow types (89%), while most of the rest are bidirectional-tidal (freshwater tidal). Thirty percent of wetlands are located in the terrene landscape position, mainly in headwater positions or in isolated depressions. About 86 percent of terrene wetlands in the county are outflow types (typically the source of a stream).

Ninety-two percent of the estuarine wetlands are identified as fringe landform types with open access to bays, sounds or the Atlantic Ocean. Most of the remaining estuarine wetlands are partially blocked by roads or railroad crossings and therefore classified as basins. Most lotic wetlands (71%) were basin landform types, with most of the remainder being flats. Fifty-six percent of the terrene wetlands are classified as flats and 44 percent as basins (depressions).

Ponds account for only 1 percent of the freshwater wetlands (Table 10). A total of 505 ponds were inventoried in Bryan County with an average size of 2.1 acres. Nearly all appear to be excavated.

Preliminary Functional Assessment

Over half of the wetlands in Bryan County (including ponds) are predicted to perform six of the eleven functions at high to moderate levels (Table 11). Almost all wetlands (99%) of the county were deemed important for nutrient transformation, carbon sequestration, and as habitat for wildlife other than waterfowl and waterbirds. About 80 percent of the county's wetlands are predicted to be important for retention of sediment and other particulates. Over 70 percent appear important for bank and shoreline stabilization and water retention. Less than half of the wetlands (46%) seem to be important for streamflow maintenance. Between 30 and 39 percent of Bryan County wetlands are predicted to be important for coastal storm surge detention, habitat for fish and aquatic invertebrates, and habitat for waterfowl and waterbirds.

Table 8. Wetlands of Bryan County classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Estuarine	Emergent	19,125
	Emergent/Unconsolidated Shore	914
	(Subtotal Emergent)	(20,039)
	Forested, Broad-leaved Evergreen	201
	Scrub-Shrub, Broad-leaved Deciduous	27
	Scrub-Shrub, Broad-leaved Evergreen	79
	(Subtotal Scrub-Shrub)	(307)
	Unconsolidated Shore	484
Total Estuarine Wetlands		**20,830**
Palustrine	Aquatic Bed	175
	Emergent	5,367
	Emergent/Forested	98
	Emergent/Scrub-Shrub	153
	(Subtotal Emergent)	(5,618)
	Forested, Broad-leaved Deciduous	39,254
	Forested, Broad-leaved Evergreen	14,307
	Forested, Dead	15
	Forested, Needle-leaved Deciduous	12,440
	Forested, Needle-leaved Evergreen	6,616
	Forested/Emergent	25
	Forested/Scrub-Shrub	169
	(Subtotal Forested)	(72,826)
	Scrub-Shrub, Broad-leaved Deciduous	1,663
	Scrub-Shrub, Broad-leaved Evergreen	1,352
	Scrub-Shrub, Needle-leaved Deciduous	96
	Scrub-Shrub, Needle-leaved Evergreen	77
	Scrub-Shrub/Emergent	170
	Scrub-Shrub/Forested	18
	(Subtotal Scrub-Shrub)	(3,376)
	Unconsolidated Bottom	835
	Unconsolidated Shore	35
	(Subtotal Nonvegetated)	(870)
Total Palustrine Wetlands		**82,865**
Riverine	Unconsolidated Shore	8
Total Unconsolidated Shore		**8**
GRAND TOTAL (All Wetlands)		**103,703**

Table 9. Wetlands classified by landscape position, landform, and water flow path for Bryan County. Note: Ponds were treated as waterbody type (see Table 10) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Estuarine	Fringe	Bidirectional-tidal	19,132
	Basin	Bidirectional-tidal	1,698
Total Estuarine			**20,830**
Lotic River	Fringe	Bidirectional-tidal	5
	(Subtotal Fringe)		(5)
	Floodplain-basin	Bidirectional-tidal	5,412
		Throughflow	6,810
	(Subtotal Basin)		(12,223)
	Floodplain-flat	Bidirectional-tidal	135
		Throughflow	1,513
	(Subtotal Flat)		(1,649)
Total Lotic River			**13,877**
Lotic Stream	Basin	Outflow	57
		Throughflow	24,334
	(Subtotal Basin)		(24,391)
	Flat	Throughflow	13,011
	(Subtotal Flat)		(13,011)
Total Lotic Stream			**37,402**
Terrene	Basin	Isolated	2,824
		Outflow	10,667
	(Subtotal Basin)		(13,491)
	Flat	Isolated	1,338
		Outflow	15,706
	(Subtotal Flat)		(17,045)
	Island	Isolated	12
	(Subtotal Island)		(12)
Total Terrene			**30,548**
GRAND TOTAL			**102,658**

Table 10. Pond acreage for Bryan County.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	1	11
	Throughflow	2	138
Total Natural Ponds		**3**	**148**
Impounded	Isolated	4	5
	Outflow	7	30
	Throughflow	5	37
Total Impounded Ponds		**16**	**72**
Excavated	Isolated	343	585
	Mesotidal	1	17
	Outflow	81	137
	Throughflow	61	86
Total Excavated Ponds		**486**	**825**
GRAND TOTAL		**505**	**1,045**

Table 11. Wetlands of potential significance for various functions for Bryan County. Note: Results include ponds.

Function	**Significance**	**Acreage**	**% of All Wetlands**
Surface Water Detention	High	31,515	30%
	Moderate	45,018	43%
	Total	**76,533**	**74%**
Coastal Storm Surge Detention	High	26,372	25%
	Moderate	4,474	4%
	Total	**30,846**	**30%**
Streamflow Maintenance	High	18,278	18%
	Moderate	29,453	28%
	Total	**47,731**	**46%**
Nutrient Transformation	High	70,801	68%
	Moderate	31,541	30%
	Total	**102,342**	**99%**
Carbon Sequestration	High	70,801	68%
	Moderate	32,828	32%
	Total	**103,629**	**100%**
Retention of Sediments	High	56,991	55%
	Moderate	26,684	26%
	Total	**83,675**	**81%**
Shoreline Stabilization	High	71,649	69%
	Moderate	569	1%
	Total	**72,218**	**70%**
Fish and Shellfish Habitat	High	33,917	33%
	Moderate	6,946	7%
	Total	**40,863**	**39%**
Waterfowl and Waterbird Habitat	High	28,796	28%
	Moderate	4,921	5%
	Total	**33,717**	**33%**

Table 11 (cont'd).

Other Wildlife Habitat	High	96,276	93%
	Moderate	5,891	6%
	Total	**102,167**	**99%**
Unique, Diverse Communities	Selected PEM (N,R,T WR)	332	--
	Selected PSS (N,R,T WR)	3	--
	Total	**335**	**--**

Wetlands of Camden County

NWI Types

Wetlands of Camden County, located at the Florida border and the largest of the coastal counties, total 171,783 acres (Table 12) and cover nearly 39 percent of the county land area. Camden County has more wetland area than any other coastal county. Palustrine wetlands are most abundant, occupying 95,603 acres and comprising about 55 percent of the county's wetlands. Forested wetlands are most common, representing nearly 78 percent of palustrine wetlands. Palustrine emergent and scrub-shrub wetlands each account for 10 percent of freshwater wetlands . Estuarine wetlands make up 75,176 acres or about 44 percent of the county's wetlands. Emergent wetlands are the most common estuarine type (96%).

LLWW Types

Wetlands in the estuarine landscape position account for 44 percent of Camden County wetlands (Table 13). By definition, all estuarine wetlands have bidirectional-tidal water flow. Over 25 percent of the area's wetlands are lotic. Fifty-nine percent of lotic wetlands in Camden County exhibit bidirectional-tidal water flow path and 41 percent throughflow water pathways. Twenty-nine percent of wetlands are located in the terrene landscape position, mainly in headwater positions or in isolated depressions. Importantly, 88 percent of these terrene wetlands are outflow water flow path types (typically the source of a stream).

All marine wetlands and 91 percent of estuarine wetlands in Camden County are identified as fringe landscape types, having open access to a bay, sound or the Atlantic Ocean. Most of the county's remaining estuarine wetlands are partially blocked hydrologically by roads or railroad crossings and are classified as basins. Most lotic wetlands (88%) are basin types. Fifty-nine percent of the terrene wetlands are classified as basins (depressions) and 41 percent as flats.

Ponds account for about 2 percent of the freshwater wetlands. A total of 863 ponds were inventoried in Camden County, 93 percent are identified as excavated (Table 14). The average size of ponds in Camden County is nearly 2.1 acres.

Preliminary Functional Assessment

Over 60 percent of the wetlands in Camden County (including ponds) are predicted to perform 8 of 11 functions at high to moderate levels (Table 15). More than 97 percent of the wetlands are deemed important for nutrient transformation, carbon sequestration, and for providing wildlife habitat for wildlife other than waterfowl. Eighty-seven percent of Camden County's wetlands are predicted to retain sediment and other particulates. Seventy-one percent of wetlands in the county appear to provide bank and shoreline stabilization. Almost two-thirds (63%) of the wetlands are predicted to provide coastal storm surge protection and support fish and aquatic invertebrates. Over half (57%) likely provide waterfowl and waterbird habitat. Forty percent of wetlands appear to provide for surface water detention. Relatively few wetlands (19%) are located in landscape positions where they can contribute to maintaining streamflow. Only 5 percent of the wetlands are recognized as uncommon types and significant for contributing to the county's biodiversity.

Table 12. Wetlands of Camden County classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Estuarine	Emergent	64,348
	Emergent/Forested	1
	Emergent/Scrub-Shrub	21
	Emergent/Unconsolidated Shore	7,636
	(Subtotal Emergent)	(72,006)
	Forested, Broad-leaved Deciduous	2
	Forested, Broad-leaved Evergreen	108
	Forested, Needle-leaved Evergreen	79
	(Subtotal Forested)	(189)
	Scrub-Shrub, Broad-leaved Deciduous	2
	Scrub-Shrub, Broad-leaved Evergreen	682
	Scrub-Shrub, Needle-leaved Evergreen	296
	Scrub-Shrub/Emergent	55
	(Subtotal Scrub-Shrub)	(1,035)
	Unconsolidated Shore	1,921
	Unconsolidated Shore/Emergent	25
	(Subtotal Nonvegetated)	(1,946)
Total Estuarine Wetlands		**75,176**
Lacustrine	Emergent	10
Total Lacustrine Wetlands		**10**
Marine	Unconsolidated Shore	994
Total Marine Wetlands		**994**
Palustrine	Aquatic Bed	187
	Emergent	9,281
	Emergent/Forested	159
	Emergent/Scrub-Shrub	87
	(Subtotal Emergent)	(9,528)
	Forested, Broad-leaved Deciduous	51,322
	Forested, Broad-leaved Evergreen	7,636
	Forested, Dead	39
	Forested, Needle-leaved Deciduous	10,388
	Forested, Needle-leaved Evergreen	5,468
	Forested/Emergent	43
	Forested/Scrub-Shrub	27
	(Subtotal Forested)	(74,923)
	Scrub-Shrub, Broad-leaved Deciduous	5,816
	Scrub-Shrub, Broad-leaved Evergreen	2,387
	Scrub-Shrub, Needle-leaved Deciduous	280

Table 12 (cont'd).

	Scrub-Shrub, Needle-leaved Evergreen	804
	Scrub-Shrub/Emergent	39
	Scrub-Shrub/Forested	25
	(Subtotal Scrub-Shrub)	(9,351)
	Unconsolidated Bottom	1,589
	Unconsolidated Shore	24
	Unconsolidated Shore/Emergent	1
	(Subtotal Nonvegetated)	(1,614)
Total Palustrine Wetlands		**95,603**
GRAND TOTAL (All Wetlands)		**171,783**

Table 13. Wetlands classified by landscape position, landform, and water flow path for Camden County. Note: Ponds were treated as waterbody type (see Table 14) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Marine	Fringe	Bidirectional-tidal	994
Total Marine			**994**
Estuarine	Fringe	Bidirectional-tidal	68,551
	Basin	Bidirectional-tidal	6,625
Total Estuarine			**75,176**
Lentic	Fringe	Outflow	10
Total Lentic			**10**
Lotic River	Floodplain-basin	Bidirectional-tidal	23,815
		Throughflow	1,953
	(Subtotal Basin)		(25,768)
	Floodplain-flat	Bidirectional-tidal	1,675
		Throughflow	446
	(Subtotal Flat)		(2,121)
Total Lotic River			**27,889**
Lotic Stream	Basin	Throughflow	12,410
	Flat	Throughflow	3,072
Total Lotic Stream			**15,482**
Terrene	Basin	Isolated	4,520
		Outflow	25,366
	(Subtotal Basin)		(29,886)
	Flat	Isolated	1,331
		Outflow	19,208
	(Subtotal Flat)		(20,538)
	Island	Isolated	6
	(Subtotal Island)		(6)
Total Terrene			**50,431**
GRAND TOTAL			**169,982**

Table 14. Pond acreage for Camden County.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	9	10
	Mesotidal	10	28
	Outflow	26	112
	Throughflow	4	19
Total Natural Ponds		**49**	**170**
Impounded	Isolated	2	1
	Mesotidal	1	8
	Outflow	9	43
Total Impounded Ponds		**12**	**52**
Excavated	Isolated	571	1,047
	Mesotidal	15	25
	Outflow	199	456
	Throughflow	17	52
Total Excavated Ponds		**802**	**1,579**
GRAND TOTAL		**863**	**1,801**

Table 15. Wetlands of potential significance for various functions for Camden County. Note: Results include ponds.

Function	Significance	Acreage	% of All Wetlands
Surface Water Detention	High	14,422	8%
	Moderate	53,968	31%
	Total	**68,390**	**40%**
Coastal Storm Surge Detention	High	101,505	59%
	Moderate	5,935	3%
	Total	**107,440**	**63%**
Streamflow Maintenance	High	12,989	8%
	Moderate	19,268	11%
	Total	**32,257**	**19%**
Nutrient Transformation	High	145,050	84%
	Moderate	22,205	13%
	Total	**167,255**	**97%**
Carbon Sequestration	High	144,954	84%
	Moderate	25,604	15%
	Total	**170,558**	**99%**
Retention of Sediments	High	111,657	65%
	Moderate	37,308	22%
	Total	**148,965**	**87%**
Shoreline Stabilization	High	116,721	68%
	Moderate	4,891	3%
	Total	**121,612**	**71%**
Fish and Shellfish Habitat	High	93,650	55%
	Moderate	14,570	8%
	Total	**108,220**	**63%**
Waterfowl and Waterbird Habitat	High	90,437	53%
	Moderate	7,014	4%
	Total	**97,451**	**57%**

Table 15 (cont'd).

Other Wildlife Habitat	High	155,862	91%
	Moderate	11,205	7%
	Total	**167,067**	**97%**
Unique, Diverse Communities	Barrier Island (F,T,H WR)	303	--
	Selected PEM (N,R,T WR)	3,849	2%
	Selected PSS (N,R,T WR)	4,274	2%
	Total	**8,426**	**5%**

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Wetlands of Chatham County

NWI Types

Wetlands of Chatham County, located along the northern coast below the South Carolina border, total 135,374 acres (Table 16) and cover 37 percent of the county land area. Estuarine wetlands are the most abundant, occupying 88,567 acres or about 65 percent of the county's wetlands. Emergent wetlands are the most common estuarine type (95%). Palustrine wetlands are also abundant, occupying 46,310 acres and comprising about 34 percent of the county's wetlands. Forested wetlands are the most common palustrine type, representing 65 percent of palustrine wetlands. Palustrine emergent and scrub-shrub wetlands account for 19 percent and 11 percent of freshwater vegetated wetlands, respectively. The remaining 6 percent of freshwater wetlands are nonvegetated.

LLWW Types

Wetlands in the estuarine landscape position account for 65 percent of Chatham County wetlands (Table 17). By definition, all estuarine and marine wetlands have bidirectional-tidal water flow. Approximately 21 percent of the area's wetlands are associated with rivers and streams; classified as lotic in landscape position. Over half (52%) of lotic wetlands in Chatham County have bidirectional-tidal water flow and 48 percent have throughflow water. Twelve percent of wetalnds are located in the terrene landscape position, mainly in headwater positions or in isolated depressions. Importantly, 78 percent of these terrene wetlands exhibit outflow (typically the source of a stream).

All marine wetlands and 97 percent of the estuarine wetlands are identified as fringe landform types with open access to bays, sounds or the Atlantic Ocean. The rest of county's estuarine wetlands have partial hydrologic blockage and are classified as basin types. Most of Chatham County's lotic wetlands (80%) are the basin landform type, with the remaining being the flats type. Fifty-two percent of the terrene wetlands are identified as basins (depressions) and 48 percent as flats. Over 78 percent of the terrene wetlands have water outflow and may be viewed as headwater wetlands.

Ponds account for about six percent of the county's freshwater wetlands. A total of 1,199 ponds were inventoried in Chatham County, of which 98 percent appear to be excavated (Table 18). The average size of ponds for Chatham County is 2.3 acres.

Preliminary Functional Assessment

Over three-quarters of the wetlands in Chatham County (including ponds) are predicted to perform 8 of the 11 functions at high to moderate levels (Table 19). At least 94 percent of the wetlands are deemed important for nutrient transformation, carbon sequestration, retention of sediment and other particulates, and for providing wildlife habitat for wildlife other than waterfowl. Eighty-seven percent of Chatham County's wetlands appear to be important for bank and shoreline stabilization. At least three-quarters of the wetlands in the county are predicted to provide coastal storm surge protection (77%), support fish and aquatic invertebrates (75%), and provide waterfowl and waterbird habitat (76%). Twenty-two percent of wetlands are predicted to provide surface water detention. Relatively few wetlands (8%) were located in landscape positions where they could contribute to maintaining streamflow. Only 4 percent of the wetlands are recognized as uncommon types and significant for contributing to the county's biodiversity.

Table 16. Wetlands of Chatham County classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Estuarine	Emergent	72,588
	Emergent/Forested	1
	Emergent/Scrub-Shrub	26
	Emergent/Unconsolidated Shore	11,670
	(Subtotal Emergent)	(84,287)
	Forested, Broad-leaved Deciduous	12
	Forested, Broad-leaved Evergreen	856
	Forested, Needle-leaved Evergreen	55
	Forested/Emergent	2
	(Subtotal Forested)	(924)
	Scrub-Shrub, Broad-leaved Deciduous	425
	Scrub-Shrub, Broad-leaved Evergreen	605
	Scrub-Shrub, Needle-leaved Evergreen	73
	Scrub-Shrub/Emergent	45
	(Subtotal Scrub-Shrub)	(1,148)
	Unconsolidated Shore	2,180
	Unconsolidated Shore/Emergent	28
	(Subtotal Nonvegetated)	(2,208)
Total Estuarine Wetlands		**88,567**
Lacustrine	Aquatic Bed	41
Total Lacustrine Wetlands		**41**
Marine	Unconsolidated Shore	453
Total Marine Wetlands		**453**
Palustrine	Aquatic Bed	179
	Aquatic Bed/Unconsolidated Bottom	6
	(Subtotal Aquatic Bed)	(185)
	Emergent	8,246
	Emergent/Aquatic Bed	77
	Emergent/Forested	116
	Emergent/Scrub-Shrub	170
	(Subtotal Emergent)	(8,608)
	Forested, Broad-leaved Deciduous	24,398
	Forested, Broad-leaved Evergreen	453
	Forested, Dead	12
	Forested, Needle-leaved Deciduous	3,412
	Forested, Needle-leaved Evergreen	1,179
	Forested/Emergent	35

Table 16 (cont'd).

	Forested/Scrub-Shrub	508
	(Subtotal Forested)	(29,997)
	Scrub-Shrub, Broad-leaved Deciduous	4,157
	Scrub-Shrub, Broad-leaved Evergreen	154
	Scrub-Shrub, Needle-leaved Evergreen	364
	Scrub-Shrub/Emergent	67
	Scrub-Shrub/Forested	223
	(Subtotal Scrub-Shrub)	(4,964)
	Unconsolidated Bottom	2,550
	Unconsolidated Shore	7
	(Subtotal Nonvegetated)	(2,557)
Total Palustrine Wetlands		**46,310**
Riverine	Unconsolidated Shore	3
Total Riverine Wetlands		**3**
GRAND TOTAL (All Wetlands)		**135,374**

Table 17. Wetlands classified by landscape position, landform, and water flow path for Chatham County. Note: Ponds were treated as waterbody type (see Table 18) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Marine	Fringe	Bidirectional-tidal	453
Total Marine			**453**
Estuarine	Fringe	Bidirectional-tidal	85,836
	Basin	Bidirectional-tidal	2,731
Total Estuarine			**88,567**
Lentic	Fringe	Outflow	41
Total Lentic			**41**
Lotic River	Fringe	Bidirectional-tidal	4
	(Subtotal Fringe)		(4)
	Floodplain-basin	Bidirectional-tidal	13,804
		Throughflow	380
	(Subtotal Basin)		(14,184)
	Floodplain-flat	Bidirectional-tidal	615
		Throughflow	166
	(Subtotal Flat)		(781)
Total Lotic River			**14,970**
Lotic Stream	Basin	Throughflow	8,202
	Flat	Throughflow	4,740
Total Lotic Stream			**12,941**
Terrene	Basin	Isolated	2,097
		Outflow	5,979
	(Subtotal Basin)		(8,076)
	Flat	Isolated	1,294
		Outflow	6,290
	(Subtotal Flat)		(7,584)
Total Terrene			**15,660**
GRAND TOTAL			**132,632**

Table 18. Pond acreage for Chatham County.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	9	7
	Mesotidal	3	12
	Outflow	4	22
	Throughflow	4	3
Total Natural Ponds		**20**	**44**
Impounded	Isolated	3	9
	Outflow	4	14
Total Impounded Ponds		**7**	**23**
Excavated	Isolated	925	1,873
	Mesotidal	4	31
	Outflow	133	432
	Throughflow	110	339
Total Excavated Ponds		**1,172**	**2,674**
GRAND TOTAL		**1,199**	**2,742**

Table 19. Wetlands of potential significance for various functions for Chatham County. Note: Results include ponds.

Function	Significance	Acreage	% of All Wetlands
Surface Water Detention	High	9,079	7%
	Moderate	20,544	15%
	Total	**29,623**	**22%**
Coastal Storm Surge Detention	High	103,401	76%
	Moderate	1,446	1%
	Total	**104,847**	**77%**
Streamflow Maintenance	High	2,777	2%
	Moderate	7,470	6%
	Total	**10,247**	**8%**
Nutrient Transformation	High	117,184	87%
	Moderate	12,997	10%
	Total	**130,181**	**96%**
Carbon Sequestration	High	116,005	86%
	Moderate	17,304	13%
	Total	**133,309**	**98%**
Retention of Sediments	High	108,937	80%
	Moderate	18,719	14%
	Total	**127,656**	**94%**
Shoreline Stabilization	High	115,002	85%
	Moderate	2,250	2%
	Total	**117,252**	**87%**
Fish and Shellfish Habitat	High	98,106	72%
	Moderate	3,079	2%
	Total	**101,185**	**75%**
Waterfowl and Waterbird Habitat	High	99,036	73%
	Moderate	3,714	3%
	Total	**102,750**	**76%**
Other Wildlife Habitat	High	123,872	92%

Table 19 (cont'd).

	Moderate	6,086	4%
	Total	**129,958**	**96%**
Unique, Diverse Communities	Barrier Island (F,T,H WR)	163	--
	Selected PEM (N,R,T WR)	5,714	3%
	Palustrine Vegetated (H WR)	42	--
	Selected PSS (N,R,T WR)	1,514	1%
	Total	**7,433**	**4%**

Wetlands of Glynn County

NWI Types

Wetlands of Glynn County, located between McIntosh and Camden counties, comprise 125,328 acres (Table 20) and cover 42 percent of the county land area. Estuarine wetlands are the most abundant, occupying 71,484 acres or about 57 percent of the county's wetlands. Emergent wetlands are the most common estuarine type (92%). Palustrine wetlands are also abundant, occupying 52,905 acres and comprising about 42 percent of the county's wetlands. Palustrine forested wetlands are most common, representing 70 percent of palustrine wetlands. Palustrine emergent and scrub-shrub wetlands account for 17 percent and 11 percent of freshwater wetlands and scrub-shrub wetlands, respectively.

LLWW Types

Wetlands in the estuarine landscape position make up 57 percent of Glynn County wetlands (Table 21). By definition, all estuarine and marine wetlands have bidirectional-tidal water flow. Approximately 24 percent of the county's wetlands are lotic. Over half (51%) of lotic wetlands in Glynn County have bidirectional-tidal flows and 48 percent have throughflow water pathways. Seventeen percent of wetlands are located in the terrene landscape position, mainly in headwater positions or in isolated depressions. Eighty-four percent of terrene wetlands exhibit outflow and are typically the source of a stream.

All marine wetlands and 83 percent of the estuarine wetlands are identified as fringe types with open access to bays, sounds or the Atlantic Ocean. Many of the remaining estuarine wetlands were located behind roads or railroad crossings which partially block hydrologic access and are therefore classified as basin landform types. Most lotic wetlands (94%) in Glynn County are basin types. Sixty-one percent of the terrene wetlands are basins (depressions) and 39 percent are flats.

Ponds account for about 3 percent of the county's freshwater wetlands. A total of 858 ponds were inventoried in Glynn County and 97 percent appear to have been excavated (Table 22). The average size of ponds in Glynn County is 1.9 acres.

Preliminary Functional Assessment

Over 70 percent of the wetlands in Glynn County (including ponds) are predicted to perform 8 of 11 functions at high to moderate levels (Table 23). More than 93 percent of the wetlands are deemed important for nutrient transformation, carbon sequestration, retention of sediment and other particulates, and for providing wildlife habitat for wildlife other than waterfowl. Eighty-three percent of Glynn County's wetlands appear to be important for bank and shoreline stabilization. Over three-quarters (77%) of the wetlands in the county are likely to support fish and aquatic invertebrates, and provide waterfowl and waterbird habitat. Seventy-one percent appear to provide coastal storm surge protection. Twenty-nine percent of the wetlands potentially provide surface water detention. Relatively few wetlands (17%) are located in landscape positions where they can contribute to maintaining streamflow. Seven percent of the wetlands are recognized as uncommon types and significant for contributing to the county's biodiversity.

Table 20. Wetlands of Glynn County classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Estuarine	Emergent	63,339
	Emergent/Scrub-Shrub	17
	Emergent/Unconsolidated Shore	3,004
	(Subtotal Emergent)	(66,360)
	Forested, Broad-leaved Evergreen	103
	Forested, Needle-leaved Evergreen	72
	(Subtotal Forested)	(175)
	Scrub-Shrub, Broad-leaved Deciduous	43
	Scrub-Shrub, Broad-leaved Evergreen	514
	Scrub-Shrub, Needle-leaved Evergreen	14
	Scrub-Shrub/Emergent	3
	(Subtotal Scrub-Shrub)	(574)
	Unconsolidated Shore	4,248
	Unconsolidated Shore/Emergent	128
	(Subtotal Nonvegetated)	(4,376)
Total Estuarine Wetlands		**71,484**
Lacustrine	Unconsolidated Shore	32
Total Lacustrine Wetlands		**32**
Marine	Unconsolidated Shore	906
Total Marine Wetlands		**906**
Palustrine	Aquatic Bed	97
	Emergent	8,869
	Emergent/Aquatic Bed	7
	Emergent/Forested	31
	Emergent/Scrub-Shrub	6
	(Subtotal Emergent)	(8,912)
	Forested, Broad-leaved Deciduous	19,023
	Forested, Broad-leaved Evergreen	1,326
	Forested, Needle-leaved Deciduous	14,328
	Forested, Needle-leaved Evergreen	1,867
	Forested/Emergent	4
	Forested/Scrub-Shrub	256
	(Subtotal Forested)	(36,803)
	Scrub-Shrub, Broad-leaved Deciduous	4,608
	Scrub-Shrub, Broad-leaved Evergreen	492
	Scrub-Shrub, Needle-leaved Deciduous	235
	Scrub-Shrub, Needle-leaved Evergreen	174

Table 20 (cont'd).

	Scrub-Shrub/Emergent	21
	Scrub-Shrub/Forested	61
	(Subtotal Scrub-Shrub)	(5,592)
	Unconsolidated Bottom	1,462
	Unconsolidated Shore	39
	(Subtotal Nonvegetated)	(1,501)
Total Palustrine Wetlands		**52,905**
GRAND TOTAL (All Wetlands)		**125,328**

Table 21. Wetlands classified by landscape position, landform, and water flow path for Glynn County. Note: Ponds were treated as waterbody type (see Table 22) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Marine	Fringe	Bidirectional-tidal	906
Total Marine			**906**
Estuarine	Fringe	Bidirectional-tidal	59,087
	Basin	Bidirectional-tidal	12,398
Total Estuarine			**71,484**
Lentic	Fringe	Isolated	32
Total Lentic			**32**
Lotic River	Floodplain-basin	Bidirectional-tidal	14,947
	Floodplain-flat	Bidirectional-tidal	492
Total Lotic River			**15,439**
Lotic Stream	Basin	Throughflow	13,175
	Flat	Throughflow	1,199
Total Lotic Stream			**14,374**
Terrene	Basin	Isolated	2,605
		Outflow	10,602
	(Subtotal Basin)		(13,206)
	Flat	Isolated	804
		Outflow	7,466
		Throughflow	13
	(Subtotal Flat)		(8,282)
	Island	Isolated	6
	(Subtotal Island)		(6)
Total Terrene			**21,494**
GRAND TOTAL			**123,729**

Table 22. Pond acreage for Glynn County.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	6	4
	Mesotidal	4	10
	Outflow	4	39
Total Natural Ponds		**14**	**53**
Impounded	Isolated	6	22
	Mesotidal	4	7
Total Impounded Ponds		**10**	**29**
Excavated	Isolated	653	1,068
	Mesotidal	9	18
	Outflow	157	414
	Throughflow	15	18
Total Excavated Ponds		**834**	**1,517**
GRAND TOTAL		**858**	**1,598**

Table 23. Wetlands of potential significance for various functions for Glynn County. Note: Results include ponds.

Function	Significance	Acreage	% of All Wetlands
Surface Water Detention	High	13,232	11%
	Moderate	22,662	18%
	Total	**35,894**	**29%**
Coastal Storm Surge Detention	High	87,804	70%
	Moderate	1,211	1%
	Total	**89,015**	**71%**
Streamflow Maintenance	High	4,940	4%
	Moderate	16,252	13%
	Total	**21,192**	**17%**
Nutrient Transformation	High	108,931	87%
	Moderate	9,710	8%
	Total	**118,641**	**95%**
Carbon Sequestration	High	108,780	87%
	Moderate	15,448	12%
	Total	**124,228**	**99%**
Retention of Sediments	High	95,356	76%
	Moderate	20,667	16%
	Total	**116,023**	**93%**
Shoreline Stabilization	High	97,381	78%
	Moderate	6,492	5%
	Total	**103,873**	**83%**
Fish and Shellfish Habitat	High	93,537	75%
	Moderate	3,173	3%
	Total	**96,710**	**77%**
Waterfowl and Waterbird Habitat	High	91,686	73%
	Moderate	4,298	3%
	Total	**95,984**	**77%**
Other Wildlife Habitat	High	112,600	90%

Table 23 (cont'd).

	Moderate	5,944	5%
	Total	**118,544**	**95%**
Unique, Diverse Communities	Barrier Island (F,T,H WR)	18	--
	Selected PEM (N,R,T WR)	5,897	5%
	Palustrine Vegetated (H WR)	7	--
	Selected PSS (N,R,T WR)	2,212	2%
	Total	**8,134**	**7%**

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Wetlands of Liberty County

NWI Types

Wetlands of Liberty County, located along the north central coast, comprise 126,560 acres (Table 24) and cover 36 percent of the county land area. Palustrine wetlands are the most abundant, occupying 83,716 acres or about 66 percent of the county's wetlands. Palustrine forested wetlands (70,621 acres) are the most common palustrine type, representing 84 percent of palustrine wetlands. Palustrine emergent wetlands account for 9 percent of freshwater wetlands and scrub-shrub wetlands account for 5 percent. Estuarine wetlands (42,548 acres) make up 34 percent of the county's wetlands. Emergent wetlands are the most common estuarine type (96%).

LLWW Types

Wetlands in the estuarine landscape position account for 34 percent of Liberty County wetlands (Table 25). By definition, all estuarine and marine wetlands have bidirectional-tidal water flow. Approximately 38 percent of the county's wetlands are classified as lotic. Nearly all (96%) lotic wetlands in Liberty County have throughflow water pathways. Less than 4 percent have bidirectional-tidal water flow. Twenty-seven percent of the wetlands are located in the terrene landscape position, mainly in headwater positions or in isolated depressions. Importantly, 80 percent of these terrene wetlands are outflow types that are typically the source of a stream.

All marine wetlands and 91 percent of the estuarine wetlands are identified as fringe landform types with open access to bays, sounds or the Atlantic Ocean. About 9 percent of Liberty County's estuarine wetlands are classified as basin types. The basin classification usually results from partial hydrologic blockage by roads or railroad crossings. Most lotic wetlands (85%) in the county are basin landform types. Seventy-five percent of the terrene wetlands are described as basins (depressions) and 25 percent as flats.

Ponds account for only about 2 percent of the county's freshwater wetlands. A total of 649 ponds were inventoried in Liberty County, 94 percent of which were identified as excavated (Table 26). The average size of ponds in Liberty County is 2.2 acres.

Preliminary Functional Assessment

Over 50 percent of the wetlands in Liberty County (including ponds) were predicted to perform seven of the eleven functions at high to moderate levels (Table 27). More than 92 percent of the wetlands are deemed important for nutrient transformation, carbon sequestration, retention of sediment and other particulates, and for providing habitat for wildlife other than waterfowl and other water birds. Seventy-two percent of Liberty County's wetlands are seen as important for shoreline stabilization. Sixty-four percent appear important for surface water detention. Over half (54%) of the wetlands in the county are anticipated to provide waterfowl and waterbird habitat and 43 percent are likely to support fish and aquatic invertebrates. Forty-one percent of wetlands are located in landscape positions where they could contribute to maintaining streamflow. Thirty-eight percent are predicted to provide coastal storm surge protection. Only 2 percent of the wetlands are recognized as uncommon types and significant for contributing to the county's biodiversity.

Table 24. Wetlands of Liberty County classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Estuarine	Emergent	29,299
	Emergent/Scrub-Shrub	4
	Emergent/Unconsolidated Shore	11,653
	(Subtotal Emergent)	(40,956)
	Forested, Broad-leaved Evergreen	315
	Scrub-Shrub, Broad-leaved Deciduous	35
	Scrub-Shrub, Broad-leaved Evergreen	828
	Scrub-Shrub/Emergent	12
	(Subtotal Scrub-Shrub)	(875)
	Unconsolidated Shore	403
Total Estuarine Wetlands		**42,548**
Lacustrine	Aquatic Bed	66
Total Lacustrine Wetlands		**66**
Marine	Unconsolidated Shore	229
Total Marine Wetlands		**229**
Palustrine	Aquatic Bed	119
	Emergent	6,243
	Emergent/Aquatic Bed	78
	Emergent/Forested	1,228
	Emergent/Scrub-Shrub	73
	(Subtotal Emergent)	(7,622)
	Forested, Broad-leaved Deciduous	40,769
	Forested, Broad-leaved Evergreen	5,025
	Forested, Dead	24
	Forested, Needle-leaved Deciduous	20,346
	Forested, Needle-leaved Evergreen	4,304
	Forested/Emergent	70
	Forested/Scrub-Shrub	83
	(Subtotal Forested)	(70,621)
	Scrub-Shrub, Broad-leaved Deciduous	2,918
	Scrub-Shrub, Broad-leaved Evergreen	540
	Scrub-Shrub, Needle-leaved Deciduous	320
	Scrub-Shrub, Needle-leaved Evergreen	22
	Scrub-Shrub/Emergent	70
	Scrub-Shrub/Forested	189
	(Subtotal Scrub-Shrub)	(4,059)
	Unconsolidated Bottom	1,215

Table 24 (cont'd).

	Unconsolidated Shore	80
	(Subtotal Nonvegetated)	(1,295)
Total Palustrine Wetlands		**83,716**
Riverine	Unconsolidated Shore	2
Total Riverine Wetlands		**2**
GRAND TOTAL (All Wetlands)		**126,560**

Table 25. Wetlands classified by landscape position, landform, and water flow path for Liberty County. Note: Ponds were treated as waterbody type (see Table 26) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Marine	Fringe	Bidirectional-tidal	229
Total Marine			**229**
Estuarine	Fringe	Bidirectional-tidal	38,796
	Basin	Bidirectional-tidal	3,752
Total Estuarine			**42,548**
Lentic	Fringe	Isolated	324
		Outflow	45
Total Lentic			**369**
Lotic River	Floodplain-basin	Bidirectional-tidal	1,616
		Throughflow	2,535
	(Subtotal Basin)		(4,152)
	Floodplain-flat	Bidirectional-tidal	169
		Throughflow	470
	(Subtotal Flat)		(638)
Total Lotic River			**4,790**
Lotic Stream	Basin	Throughflow	36,411
	Flat	Throughflow	6,368
Total Lotic Stream			**42,779**
Terrene	Basin	Isolated	5,626
		Outflow	20,106
	(Subtotal Basin)		(25,732)
	Flat	Isolated	1,111
		Outflow	7,587
	(Subtotal Flat)		(8,698)
	Island	Isolated	1
	(Subtotal Island)		(1)
Total Terrene			**34,431**
GRAND TOTAL			**125,146**

Table 26. Pond acreage for Liberty County.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	5	6
	Outflow	5	54
	Throughflow	8	11
Total Natural Ponds		**18**	**71**
Impounded	Isolated	10	40
	Outflow	10	65
	Throughflow	2	12
Total Impounded Ponds		**22**	**117**
Excavated	Isolated	451	823
	Outflow	89	233
	Throughflow	69	170
Total Excavated Ponds		**609**	**1,226**
GRAND TOTAL		**649**	**1,414**

Table 27. Wetlands of potential significance for various functions for Liberty County. Note: Results include ponds.

Function	Significance	Acreage	% of All Wetlands
Surface Water Detention	High	39,391	31%
	Moderate	41,253	33%
	Total	**80,644**	**64%**
Coastal Storm Surge Detention	High	44,562	35%
	Moderate	3,413	3%
	Total	**47,975**	**38%**
Streamflow Maintenance	High	13,503	11%
	Moderate	37,881	30%
	Total	**51,384**	**41%**
Nutrient Transformation	High	109,273	86%
	Moderate	15,358	12%
	Total	**124,631**	**98%**
Carbon Sequestration	High	109,269	86%
	Moderate	16,882	13%
	Total	**126,151**	**100%**
Retention of Sediments	High	83,024	66%
	Moderate	33,584	27%
	Total	**116,608**	**92%**
Shoreline Stabilization	High	90,202	71%
	Moderate	692	1%
	Total	**90,894**	**72%**
Fish and Shellfish Habitat	High	51,765	41%
	Moderate	2,639	2%
	Total	**54,404**	**43%**
Waterfowl and Waterbird Habitat	High	49,767	39%
	Moderate	18,146	14%
	Total	**67,913**	**54%**
Other Wildlife Habitat	High	115,960	92%

Table 27 (cont'd).

	Moderate	8,487	7%
	Total	**124,447**	**98%**
Unique, Diverse Communities	Barrier Island (F,T,H WR)	39	--
	Selected PEM (N,R,T WR)	844	1%
	Palustrine Vegetated (H WR)	30	--
	Selected PSS (N,R,T WR)	419	--
	Carolina Bays (Relatively Intact)	919	1%
	Total	**2,251**	**2%**

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Wetlands of McIntosh County

NWI Types

Wetlands of McIntosh County, located midway along the coast, comprise 141,479 acres (Table 28) and cover 45 percent of the county's land area. McIntosh County has the greatest density of wetlands of the coastal counties. There are slightly more palustrine wetlands than estuarine wetlands in the county. Palustrine wetlands occupy 71,020 acres and estuarine wetlands total 69,878 acres. Forested wetlands (54,573 acres) were the most common palustrine type, representing 77 percent of palustrine wetlands. Palustrine emergent wetlands account for 17 percent of freshwater wetlands and scrub-shrub wetlands account for 5 percent. Estuarine emergent wetlands are the most common estuarine type (97%).

LLWW Types

Wetlands in the estuarine landscape position make up nearly 50 percent of McIntosh County wetlands (Table 29). By definition, all estuarine and marine wetlands have bidirectional-tidal water flow. Almost one-third (32%) of the county's wetlands are lotic. Most (63%) of the lotic wetlands in McIntosh County have bidirectional- tidal water flow, with the remainder having throughflow. Eighteen percent of wetlands are located in the terrene landscape position, mainly in headwater positions or in isolated depressions. Importantly, 76 percent of terrene wetlands are outflow types (typically the source of a stream).

All marine wetlands and over 99 percent of the estuarine wetlands in McIntosh County are identified as fringe landform types having open access to bays, sounds or the Atlantic Ocean. Most lotic wetlands (94%) are basin types. Seventy-three percent of the terrene wetlands are basins (depressions) and 27 percent are flats.

Ponds account for nearly 1 percent of the county's freshwater wetlands. A total of 342 ponds were inventoried in McIntosh County, 86 percent of which were identified as excavated (Table 30). The average size of ponds in McIntosh County is 1.9 acres.

Preliminary Functional Assessment

Nearly three-quarters (72%) of the wetlands in McIntosh County (including ponds) are predicted to perform eight of the eleven functions at high to moderate levels (Table 31). At least 94 percent of the wetlands were deemed important for nutrient transformation, carbon sequestration, retention of sediment and other particulates, and for providing wildlife habitat for wildlife other than waterfowl and other waterbirds. Eight-two percent are likely to provide bank and shoreline stabilization. At least 72 percent of McIntosh County's wetlands are likely to be important for waterfowl and other water bird habitat, fish and aquatic invertebrate habitat and coastal storm surge detention. Twenty-seven percent are predicted to contribute to surface water detention and fifteen percent of wetlands were located in landscape positions where they could contribute to maintaining streamflow. Four percent of the wetlands are recognized as uncommon types and significant for contributing to the county's biodiversity.

Table 28. Wetlands of McIntosh County classified by NWI types (Cowardin et al. 1979).

System	Class	Acreage
Estuarine	Emergent	56,220
	Emergent/Scrub-Shrub	39
	Emergent/Unconsolidated Shore	11,329
	(Subtotal Emergent)	(67,588)
	Forested, Broad-leaved Evergreen	250
	Scrub-Shrub, Broad-leaved Deciduous	1
	Scrub-Shrub, Broad-leaved Evergreen	756
	(Subtotal Scrub-Shrub)	(757)
	Unconsolidated Shore	1,273
	Unconsolidated Shore/Emergent	10
	(Subtotal Nonvegetated)	(1,283)
Total Estuarine Wetlands		**69,878**
Lacustrine	Aquatic Bed	2
Total Lacustrine Wetlands		**2**
Marine	Unconsolidated Shore	502
Total Marine Wetlands		**502**
Palustrine	Aquatic Bed	68
	Emergent	12,141
	Emergent/Aquatic Bed	16
	Emergent/Forested	6
	Emergent/Scrub-Shrub	60
	(Subtotal Emergent)	(12,223)
	Forested, Broad-leaved Deciduous	28,182
	Forested, Broad-leaved Evergreen	1,703
	Forested, Needle-leaved Deciduous	22,093
	Forested, Needle-leaved Evergreen	2,306
	Forested/Emergent	257
	Forested/Scrub-Shrub	32
	(Subtotal Forested)	(54,573)
	Scrub-Shrub, Broad-leaved Deciduous	2,588
	Scrub-Shrub, Broad-leaved Evergreen	745
	Scrub-Shrub, Needle-leaved Deciduous	183
	Scrub-Shrub, Needle-leaved Evergreen	13
	Scrub-Shrub/Emergent	26
	Scrub-Shrub/Forested	4
	(Subtotal Scrub-Shrub)	(3,558)
	Unconsolidated Bottom	591

Table 28 (cont'd).

	Unconsolidated Shore	7
	(Subtotal Nonvegetated)	(598)
Total Palustrine Wetlands		**71,020**
Riverine	Unconsolidated Shore	78
Total Riverine Wetlands		**78**
GRAND TOTAL (All Wetlands)		**141,479**

Table 29. Wetlands classified by landscape position, landform, and water flow path for McIntosh County. Note: Ponds were treated as waterbody type (see Table 30) for summary.

Landscape Position	Landform	Water Flow Path	Acreage
Marine	Fringe	Bidirectional-tidal	502
Total Marine			**502**
Estuarine	Fringe	Bidirectional-tidal	69,786
	Basin	Bidirectional-tidal	129
Total Estuarine			**69,915**
Lentic	Fringe	Outflow	2
Total Lentic			**2**
Lotic River	Fringe	Bidirectional-tidal	64
	(Subtotal Fringe)		(64)
	Floodplain-basin	Bidirectional-tidal	27,449
		Throughflow	261
	(Subtotal Basin)		(27,710)
	Floodplain-flat	Bidirectional-tidal	1,392
		Throughflow	3
	(Subtotal Flat)		(1,395)
Total Lotic River			**29,169**
Lotic Stream	Basin	Throughflow	15,013
	Flat	Throughflow	1,354
Total Lotic Stream			**16,366**
Terrene	Basin	Isolated	5,304
		Outflow	12,874
	(Subtotal Basin)		(18,179)
	Flat	Isolated	672
		Outflow	6,008
	(Subtotal Flat)		(6,680)
Total Terrene			**24,859**
GRAND TOTAL			**140,813**

Table 30. Pond acreage for McIntosh County.

Type of Pond	Water Flow Path	Number of Ponds	Acreage
Natural	Isolated	2	1
	Mesotidal	26	76
	Outflow	5	48
	Throughflow	1	<1
Total Natural Ponds		**34**	**125**
Impounded	Isolated	6	29
	Outflow	7	21
Total Impounded Ponds		**13**	**50**
Excavated	Isolated	248	372
	Outflow	43	116
	Throughflow	4	4
Total Excavated Ponds		**295**	**492**
GRAND TOTAL		**342**	**666**

Table 31. Wetlands of potential significance for various functions for McIntosh County. Note: Results include ponds.

Function	Significance	Acreage	% of All Wetlands
Surface Water Detention	High	15,284	11%
	Moderate	23,323	16%
	Total	**38,607**	**27%**
Coastal Storm Surge Detention	High	99,218	70%
	Moderate	3,580	3%
	Total	**102,798**	**73%**
Streamflow Maintenance	High	5,478	4%
	Moderate	15,682	11%
	Total	**21,160**	**15%**
Nutrient Transformation	High	129,654	92%
	Moderate	9,374	7%
	Total	**139,028**	**98%**
Carbon Sequestration	High	129,606	92%
	Moderate	11,218	8%
	Total	**140,824**	**100%**
Retention of Sediments	High	111,317	79%
	Moderate	20,981	15%
	Total	**132,298**	**94%**
Shoreline Stabilization	High	114,455	81%
	Moderate	1,704	1%
	Total	**116,159**	**82%**
Fish and Shellfish Habitat	High	99,396	70%
	Moderate	8,476	6%
	Total	**107,872**	**76%**
Waterfowl and Waterbird Habitat	High	96,502	68%
	Moderate	5,458	4%
	Total	**101,960**	**72%**

Table 31 (cont'd).

Other Wildlife Habitat	High	134,004	95%
	Moderate	4,954	4%
	Total	**138,958**	**98%**
Unique, Diverse Communities	Barrier Island (F,T,H WR)	784	--
	Selected PEM (N,R,T WR)	4,826	3%
	Selected PSS (N,R,T WR)	421	--
	Total	**6,031**	**4%**

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Discussion

The wetland functional assessment presented here is preliminary, based on relationships between wetland characteristics in the enhanced NWI database (NWI+) and eleven wetland functions. The assessment focused on wetlands (including ponds) and not on other aquatic habitats (deepwater habitats). Although field work played an important role in developing the NWI+ for coastal Georgia, the information reported in this study is primarily from remotely sensed data sources (i.e. from the interpretation of aerial photography), and should be utilized as a starting point when making wetland management or land use decisions. Site specific evaluations are prudent where important environmental decisions are concerned. *Users of the NWI+ data are reminded that the wetlands delineated by the updated NWI are defined in accordance with the Cowardin et al. (1979) classification and are not intended to represent jurisdictional wetlands as defined by state, local, or federal agencies.*

The functional assessment and the NWI+ database from which it was derived should always be considered in the context of the timeframe it represents. The NWI+ database, developed from aerial photographs taken in 2006, represents conditions as they existed at that time. It should be anticipated that alterations to the landscape have occurred since that time, resulting from both natural and anthropogenic causes. Similarly, the state of our understanding of how wetlands work and the values they provide is evolving. As we learn more about wetland functions and values and their relationship to their hydrogeomorphic and biological characteristics, the relationships used for this assessment can be adjusted and the NWI+ data can be reevaluated.

The precision of the NWI+ data for coastal Georgia has not been rigorously tested in a statistical fashion. To do so would be especially costly and time consuming, in part because of the vast amount of private land in the study area to which access (for field verification) is largely denied, as well as the various levels of classification detail included in the database that would need to be evaluated. Confidence in the data and an understanding of its limitations will be determined as the NWI+ and functional assessment are used, especially as they are applied and evaluated on-the-ground in practical situations.

The NWI+ data layer developed for this project can be used to answer numerous wetland planning questions and in various land use planning contexts. A GIS user guide to the NWI+ data layer is included as Appendix E. Inquiries regarding where wetlands are located, what types they are, and which ones are potentially important are virtually limitless depending only on the creativity of the GIS operator. The utility of the data layer increases as it is combined with other GIS data layers. For example, comparing the 1980s version NWI to the updated wetland inventory could provide an understanding of where and what kinds of wetlands have been lost or degraded and how the loss has affected wetland functions and values important to the residents of coastal Georgia. With this information in hand it may be possible to develop a plan to mitigate for the functional loss or to develop a plan to protect those functions from further loss or degradation.

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Recommendations

(1) Expand the NWI+ mapping and functional assessment to the next tier of counties westward in order to develop the capability to manage and evaluate wetland resources on a watershed basis. Wetlands and other water-dependent natural resources are most effectively managed on watershed basis. Until complete watersheds have been inventoried the capacity to manage wetland resources in a holistic fashion will be somewhat compromised.

(2) Encourage and contribute to the acquisition of high-resolution digital color infrared aerial photography. High quality aerial photography is an invaluable resource for a variety of land use planning applications. Color infrared aerial photography taken during leaf-off period in the late spring is especially useful for detailed delineation and classification of wetlands. For best results, imagery should be acquired during periods of normal rainfall and not during drought.

(3) Evaluate the accuracy of the wetland classifications and predicted wetland functions by conducting field investigations. Record the specific locations where discrepancies between on-the-ground observations and the NWI+ and Landscape-level Wetland Functional Assessment databases are observed. Keeping and evaluating these records would provide an index of the quality of the databases in lieu of a statistical evaluation of precision, as well as inform improvement of future updates to the databases.

(4) Conduct a wetland trend analysis to determine which types of wetlands have been lost or altered and relate this information to functions that have also been lost or impaired. Having the trend information could assist community leaders in protecting wetlands that have been vulnerable yet provide functions that local citizens wish to preserve. In addition, understanding trend analyses could assist resource managers in mitigating the losses of identified wetland functions. At a minimum, such studies should be conducted in high-growth areas and surrounding locales.

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Summary

The NWI update documented over 804,200 acres of wetlands in the six-county study area. Wetlands comprised about 40 percent of the area. Palustrine wetlands (freshwater) represented more than half (54%) of the wetlands. Palustrine forested wetland was the most common freshwater wetland type. Most (57%) palustrine forested wetlands were associated with rivers or streams (lotic). Estuarine intertidal emergent was the most prevalent saltwater type, encompassing 351,236 acres. Of the coastal counties, McIntosh County had the highest wetland density with wetlands covering 45 percent of the land surface.

From a functional standpoint, nearly all of the wetlands were predicted as having high to moderate significance for nutrient transformation, carbon sequestration, retention of sediment and other particulates and as wildlife habitat. Over three-quarters of the wetlands were predicted to be important for shoreline stabilization. More than half of the wetland acreage was recognized as important for coastal storm surge detention, fish and shellfish habitat and waterfowl and waterbird habitat.

Less wetland acreage was designated as significant for streamflow maintenance because fewer wetlands were in headwater locations than along rivers and streams or coastal waters. Wetlands identified as unique or diverse plant communities are by definition rare in the region. Only 4 percent of the area's wetlands were so designated, yet they contribute disproportionately to maintaining the area's biodiversity.

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Appendix A. NWI Classification Coding.

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WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System: M - Marine

Subsystem: 1 - Subtidal

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RF – Reef
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud	1 Algal 3 Rooted Vascular	1 Coral 3 Worm

Subsystem: 2 - Intertidal

Class	AB – Aquatic Bed	RF – Reef	RS – Rocky Shore	US – Unconsolidated Shore
Subclass	1 Algal 3 Rooted Vascular	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic

System: E - Estuarine

Subsystem: 1 - Subtidal

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RF – Reef
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 4 Floating Vascular	2 Mollusk 3 Worm

Subsystem: 2 - Intertidal

Class	AB – Aquatic Bed	RF – Reef	SB – Streambed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Algal 3 Rooted Vascular 4 Floating Vascular	2 Mollusk 3 Worm	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Persistent 2 Non-persistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

System: R - Riverine

Subsystem: 1 - Tidal; 2 – Lower Perennial; 3 – Upper Perennial; 4* - Intermittent; 5* – Unknown Perennial

Class	RB** – Rock Bottom	UB – Unconsolidated Bottom	SB** – Streambed	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent

* **Intermittent** is limited to the **Streambed** Class;
Unknown Perennial is limited to **Unconsolidated Bottom** Class code **R5UB** only

** **Rock Bottom** is not permitted for the **Lower Perennial** Subsystem;
Streambed is limited to **Tidal** and **Intermittent** Subsystems

Classification of Wetlands and Deepwater Habitats of the United States, Cowardin *et al*. 1979

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System: L - Lacustrine

Subsystem: 1 - Limnetic

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular

Subsystem: 2 - Littoral

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent

System: P - Palustrine

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	US – Unconsolidated Shore	ML – Moss-Lichen	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inland Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	i Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							

Appendix B. Wetland Community Descriptions.

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WETLAND COMMUNITY DESCRIPTIONS

The following descriptions are intended to provide general information on the variety, distribution, composition, and conservation status of wetland biotic communities in coastal Georgia along with the most commonly used classification codes employed by the National Wetlands Inventory to identify them. The community descriptions were compiled by the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Wildlife and Natural Heritage Program, with funding provided, in part, by a grant from the U.S. Environmental Protection Agency, CD 994507-94-0, "A Guide to Georgia Wetlands".

All photos are courtesy of Georgia Department of Natural Resources.

Information on community composition, distribution, soils, etc. was derived from a variety of sources, including field notes, published and unpublished reports, and personal communications. The wetland community types presented here are both generalized and idealized. In some cases a given wetland community type represents several subtypes that could easily be considered distinctive biotic communities. In all cases, an attempt has been made to describe the "ideal" wetland community in that only native species have been listed as community components.

Although these idealized communities cannot be directly identified from the NWI database, it should be possible to pinpoint their most likely locations and acreages using GIS technology that employs the following data layers: NWIPlus (NWI and LLWW), soils as identified in the description, and ecoregional subdivisional information.

The following are the primary sources of published information on the community types described in this section.

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COMMUNITY TYPE: Barrier Island Pond

NWI CLASSIFICATION CODE(S): PABF, PABH, PUSF, PUBH, PEM1F

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Usually found in broad flats or in elliptical to linear interdune depressions on Georgia's coastal barrier islands.

SOILS: Usually mapped only as open water areas within soils such as Rutlege fine sand, Mandarin fine sand, Johnston Loam, and Leon fine sand.

HYDROLOGY: Palustrine, seasonally to permanently flooded. Water levels often fluctuate widely. Some ponds are connected to the local groundwater system, while others may be more or less isolated by a layer of organic material. Many barrier island ponds are periodically inundated by spring or storm tides, and thus have fluctuating salinity.

GENERAL DESCRIPTION: Variable in physiognomy and species composition; deeper, more permanently flooded ponds often have a large extent of open water; shallower ponds are usually dominated by a combination of submergent, emergent and/or floating macrophytes. Trees and shrubs are present mainly along the edges of the ponds.

DOMINANT/INDICATOR PLANTS:

Trees: *Salix caroliniana, Diospyros virginiana, Sabal palmetto, Acer rubrum, Nyssa biflora, Persea palustris*

Shrubs: *Cephalanthus occidentalis*, *Decodon verticillatus*, *Ilex cassine*

Emergents: *Sagittaria graminea, Sagittaria latifolia, Cladium jamaicense, Pontederia cordata, Typha latifolia, Typha angustifolia*

Submergents: *Myriophyllum* spp., *Ceratophyllum echinatum, Utricularia* spp., *Potamogeton* spp.

Floating macrophytes: *Azolla caroliniana, Nuphar luteum, Nelumbo lutea, Nymphoides aquatica, Brasenia schreberi*, *Nymphaea odorata*, *Limnobium spongia*

SYNONYMY: Palustrine Aquatic Bed, Semipermanently or Permanently Flooded; Palustrine Unconsolidated Shore/Bottom, Semipermanently or Permanently Flooded and Palustrine Emergent, Semipermanently Flooded (Cowardin et al.); Pond (COE); Interdune Pond (NCHP)

RARE SPECIES: *Lucania goodei*, *Mycteria americana*. The bluefin killifish (*Lucania goodei*) is found in manmade freshwater ponds on Sapelo and Blackbeard Islands.

COMMENTS: Succession in barrier island ponds typically involves a shift in dominance from floating macrophytes to deep-water emergents (duck weed and pickerelweed), and finally to shallow-water emergents (saw-grass, sand cordgrass, water willow), shrubs (marsh mallow, dahoon) and trees (red maple, black willow, swamp blackgum). This eutrophication process may be accelerated by deposition of sand from shifting dunes, and by the addition of nutrients from bird guano and other organic materials. Pumping of water from the underlying aquifer has impacted many freshwater ponds that have a direct connection to the groundwater or that formerly received water from artesian flows. Occasional fires during periods of drought oxidize organic materials in the pond bottom, reduce the abundance of woody species, and generally create conditions more typical of earlier successional stages. Barrier island ponds are very important foraging areas for wading birds such as herons, egrets, ibis, and wood storks.

Barrier Island Pond, Cumberland Island National Seashore

COMMUNITY TYPE: Bay Swamp

NWI CLASSIFICATION CODE(S): PFO3B, PFO3C

GEOGRAPHIC RANGE: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Found in domed peatlands, broad interstream flats, Carolina bay depressions, and shallow drainageways.

SOILS: Nearly level to slighty sloping shallow histosols or oligotrophic mineral soils with shallow to deep organic (peaty) surface layers. Examples include Rutlege and Bayboro soils

HYDROLOGY: Palustrine, saturated or seasonally flooded.

GENERAL DESCRIPTION: Forested wetland dominated by three species of broad-leaved evergreen trees known colloquially as “bays”: *Magnolia virginiana, Gordonia lasianthus, and Persea palustris. Other trees found in the canopy include Acer rubrum, Nyssa biflora, Pinus taeda, Pinus serotina, Quercus laurifolia, and Quercus nigra*. The vine/shrub layer is often dense and fairly diverse. The herbaceous groundlayer vegetation may be sparse, consisting mainly of ferns and sphagnum moss.

DOMINANT/INDICATOR PLANTS:

Trees: *Magnolia virginiana, Gordonia lasianthus, Persea palustris*

Shrubs/woody vines: *Cyrilla racemiflora, Leucothoe racemosa, Lyonia lucida, Lyonia ligustrina, Viburnum nudum, Viburnum cassinoides, Ilex coriacea, Ilex cassine, Smilax laurifolia*.

Herbs: *Woodwardia virginica, Sphagnum* spp.

SYNONYMY: Palustrine Forested, Broad-leaved Evergreen, Saturated or Seasonally Flooded (Cowardin et al.); Bay Swamp (COE); Bay Forest (NCHP)

RARE SPECIES: *Ambystoma cingulatum, Clemmys guttata, Amphiuma pholeter*

COMMENTS: This forested wetland is considered a late successional community in a variety of hydrogeomorphic settings in the Coastal Plain. During periods of prolonged drought, these usually-wet habitats may burn. Fire is an important factor in the dynamics of bay swamps; it is thought that a fire return interval of 35 to 45 years may contribute to the persistence of this type. More frequent fires may cause a shift toward shrub swamp or pond pine-dominated forest. This wetland type has been impacted significantly by ditching and conversion to agricultural or silvicultural uses.

COMMUNITY TYPE: Blackwater Creek Swamp

NWI CLASSIFICATION CODE(S): PFO1/3A, PFO1/3C

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Found along the stream channels and narrow lower floodplains of small to medium-sized nonalluvial (blackwater) streams, where the drainage is too steep for the development of peat-filled bays and bayheads, but not steep enough so that floods carry away accumulated humus and litter.

SOILS: A wide variety of poorly drained moist organic or alluvial soils.

HYDROLOGY: Palustrine, intermittently to seasonally flooded. Blackwater streams tend to have highly variable flows (both within and between years). Floods are often of short duration, and flows in the summer months may be very low. These streams carry water that is highly acidic, high in dissoved organic materials, and low in suspended materials and nutrients. Many of these streams have significant input from springs located near their headwaters.

GENERAL DESCRIPTION: Forested wetland dominated by broadleaved deciduous and broadleaved evergreen trees and shrubs, occupying the relatively narrow floodplains of small nonalluvial streams. The canopy and understory tree vegetation is dense and species-rich; the shrub/woody vine layer is similarly diverse, but the herbaceous groundlayer vegetation is relatively sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Nyssa biflora, Magnolia virginiana, Liriodendron tulipifera, Quercus laurifolia, Acer rubrum, Persea palustris, Pinus taeda, Pinus elliottii, Gordonia lasianthus, Nyssa ogeeghe, Taxodium ascendens*

Shrubs/Woody Vines: *Viburnum rufidulum, Viburnum cassinoides, Cyrilla racemiflora, Itea virginica, Pinckneya pubens, Vaccinium elliottii, Cliftonia monophylla, Rhododendron nudiflorum, Berchemia scandens, Smilax walteri, Smilax laurifolia, Decumaria barbarea, Vitis rotundifolia*

Herbs: *Osmunda cinnamomea, Onoclea sensibilis, Saururus cernuus*

SYNONYMY: Palustrine, Forested, Broad-leaved Deciduous and Broad-leaved Evergreen, Temporarily to Seasonally Flooded (Cowardin et al.); Coastal Plain Small Stream Swamp, Blackwater Subtype (NCHP); Blackwater Branch or Creek Swamps (Wharton);

RARE SPECIES: Dryopteris *celsa, Litsea aestivalis, Lindera subcoriacea, Cacalia diversifolia, Ilicium floridanum, Lythrum curtissii, Myriophyllum laxum, Pinguicula primuliflora, Clemmys guttata, Amphiuma pholeter*

COMMENTS: This community type usually transitions upstream into shrub swamp, and downstream into blackwater river swamp. Near the heads of many blackwater streams there is significant input from springs; these creeks often have little dissolved organic material and are known by some as “clearwater streams”. In areas with relatively steep terrain (e.g., the fall-line sandhills) very moist slope environments called "steepheads" can be found at the heads of these ravines. These steepheads can be considered transitional between wetland and mesic upland habitats. Blackwater creek swamps are ubiquitous in the Coastal Plain of Georgia, and exhibit variability in both physiognomy and species composition. This variability probably reflects differences in past land use, the relative contribution of runoff vs. groundwater discharge, and fire frequency, among other factors. This wetland community has been negatively impacted by channelization, impoundment, fertilizer runoff from adjacent fields, and encroachment by silviculture.

Bay Swamp, Fort Stewart along Canoochee River

COMMUNITY TYPE: Blackwater River Swamp

NWI CLASSIFICATION CODE(S): PFO1/2C, PFO2/1F

GEOGRAPHIC RANGE: Lower Coastal Plain

TOPOGRAPHIC SETTING: Backswamps, secondary channels, sloughs, and lower floodplains of larger non-alluvial (blackwater) streams.

SOILS: A variety of poorly-drained mineral and organic soils (e.g., Lumbee and Rains)

HYDROLOGY: Palustrine, seasonally to semipermanently flooded. Flows are highly variable throughout the year. Waters of blackwater streams are typically low in suspended minerals, highly acidic, low in nutrients, and high in dissolved organic materials.

GENERAL DESCRIPTION: A forested wetland usually dominated by swamp blackgum (occasionally tupelo gum) and baldcypress, sometimes with pondcypress (especially in sloughs). The understory tree and shrub vegetation layers are often patchy or sparse, depending on substrate, topography, and disturbance; typical dominants include red maple, ogeechee lime, lyonia, buttonbush, myrtle-leaved holly, and sebastian bush. A variety of floating and emergent aquatic plants can be found within the main channels and sloughs.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium distichum, Nyssa biflora, Acer rubrum, Persea palustris, Taxodium ascendens, Fraxinus caroliniana, Planera aquatica, Nyssa ogeche, Quercus laurifolia, Quercus nigra*.

Shrubs: *Cyrilla racemiflora, Clethra alnifolia, Lyonia lucida, Ilex myrtifolia, Crataegus marshallii, Sambucus canadensis, Sebastiana fruticosa, Cephalanthus occidentalis*.

Herbs: *Hydrocotyle* spp., *Myriophyllum* spp., *Nuphar luteum, Saururus cernuus, Lemna* spp., *Juncus repens, Juncus validus, Tillandsia usneoides, Polypodium polypodioides*.

SYNONYMY: Palustrine forested, Broad-leaved Deciduous-Needle-leaved Deciduous, Semipermanently Flooded (Cowardin et al.); Cypress-Gum Swamp, Blackwater Subtype (NCHP).

RARE SPECIES: *Corynorhinus rafinesquii, Epidendrum conopseum, Elanoides forficatus, Farancia erytrogramma, Amphiuma pholeter, Haliaeetus leucocephalus, Mycteria americana*

COMMENTS: Floodplains of blackwater rivers are typically narrower than those of alluvial (brownwater) rivers. Flooding causes little overbank deposition of sediment, but often results in accumulations of fine silt on sand bars. Blackwater river swamps may have significant deposits of organic muck in deep pools and sloughs. The low nutrient levels of these swamps, combined with the physiological stress caused by flood/drought cycles, may be responsible for extremely slow growth rates of cypress and swamp blackgum trees. A dwarf cypress swamp on the Alapaha River in Irwin County contains pondcypress trees approximately 800 years old. Ebenezer Creek, a blackwater tributary of the Savannah River, has an unusual "backwater swamp" hydrology caused by an extremely low elevational gradient near the mouth of the creek. High water levels in the Savannah River produce a "water dam" effect, often resulting in a reverse flow of water from the river into the creek. The lower portion of this backwater swamp contains an old-growth baldcypress-tupelo gum community. Some of the baldcypress trees in this swamp are over 1,000 years old.

Blackwater River Swamp, Townsend, GA

COMMUNITY TYPE: Bottomland Hardwood Forest (Coastal Plain)

NWI CLASSIFICATION CODE(S): PFO1A, PFO1B, PFO1C

GEOGRAPHIC RANGE: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Relict natural levees, terraces, point bar ridges, and other relatively high parts of floodplains along blackwater and brownwater streams in the Coastal Plain

SOILS: A wide variety of silty or sandy alluvial soils (e.g., Lumbee, Muckalee)

HYDROLOGY: Palustrine, seasonally to intermittently flooded. The water table may remain close to the soil surface for much of the year, or may change dramatically during the growing season.

GENERAL DESCRIPTION: A forested wetland with a relatively diverse canopy of deciduous hardwood species, including water oak, willow oak, laurel oak, red maple, sweetgum, green ash, overcup oak, and water hickory. Understory tree/shrub vegetation is similarly diverse; typical species include ironwood, common pawpaw, American holly, swamp redbay, sweetbay, black titi, cyrilla, possumhaw, sweet pepperbush. The herbaceous groundlayer vegetation is relatively sparse.

DOMINANT/INDICATOR SPECIES:

Trees: *Quercus nigra, Quercus phellos, Quercus laurifolia, Quercus lyrata, Fraxinus pennsylvanica, Acer rubrum, Liquidambar styraciflua, Carya aquatica, Carya cordiformis, Pinus taeda, Magnolia virginiana, Carpinus caroliniana, Asimina triloba*

Shrubs/Woody Vines: *Cyrilla racemiflora, Cliftonia monophylla, Vaccinium elliottii, Ilex opaca, Ilex decidua, Itea virginica, Rhapidophyllum hystrix, Sabal minor, Sebastiana fruticosa, Smilax rotundifolia, Smilax laurifolia, Toxicodendron radicans, Vitis rotundifolia, Berchemia scandens*

Herbs: *Chasmanthium latifolium, Polygonum virginicum, Justicia ovata, Boehmeria cylindrica, Diodia virginica, Arundinaria gigantea*

SYNONYMY: Palustrine, Forested, Broad-leaved Deciduous, Seasonally Flooded and Saturated or Temporarily Flooded (Cowardin et al.); Coastal Plain Bottomland Hardwoods, Blackwater and Brownwater Subtypes (NCHP); Bottomland Forests (COE); Blackwater River and Swamp, and Alluvial River Swamp, Coastal Plain (Wharton)

RARE SPECIES: *Rhapidophyllum hystrix, Arnogossum diversifolia, Sideroxylon thornei, Lindera melissifolia, Lythrum curtissii, Salix floridana, Thalictrum debile, Campephilus principalis, Corynorhinus rafinesquii, Elanoides forficatus, Vermivora bachmanii*

COMMENTS: Bottomland hardwood forests of the Coastal Plain represent an important wetland type in Georgia, in terms of overall species diversity and areal extent. Distinctions in the species composition of blackwater and brownwater river floodplain forests are not well understood, but field studies indicate that alluvial systems often support more diverse bottomland hardwood forests. This may be due in part to the greater amount of overbank deposition of nutrient-rich sediments and the lower acidity of the flood waters. Two birds thought to be near extinction, Bachman's warbler and the ivory-billed woodpecker, were inhabitants of mature bottomland hardwood forests of the Southeast. Many other vertebrate species, such as wood ducks and Rafinesque's big-eared bat, depend on tree cavities found in mature swamp systems for roosting habitat. Construction of reservoirs on Georgia's major alluvial rivers has greatly modified the hydrology of coastal plain bottomland hardwood forests. Today, overbank flooding events are less frequent and less extensive, resulting in decreased nutrient input to the floodplain from alluvial sediments. Silvicultural activities such as high-grading, ditching, and conversion to pine plantation have also taken a significant toll on this wetland community type. Forest fragmentation resulting from extensive timber cutting and road construction has created avenues for invasion by exotic species such as Chinese privet, Nepal grass, and Japanese honeysuckle.

Bottomland Hardwood Forest, McIntosh County

COMMUNITY TYPE: Brackish Marsh

NWI CLASSIFICATION CODE(S): E2EM1P, E2EM1N

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Lower portions of tidal river floodplains, sounds, open estuarine areas, and margins of tidal creeks, where salinity is diluted by freshwater flows. Also found in irregularly-flooded transition areas between salt marsh and salt shrub zone, where precipitation dilutes soil salinity.

SOILS: Very poorly drained organic or loamy soils, underlain by sandy to clayey sediments; these soils often have a high sulfur content.

HYDROLOGY: Estuarine, tidal, irregularly to regularly flooded, mixohaline (0.5 to 30 parts per thousand). Brackish marsh areas usually are inundated by tidal waters less frequently than so-called "low salt marsh" dominated by smooth cordgrass.

GENERAL DESCRIPTION: A coastal marsh community dominated by a small group of emergent herbs, including black needlerush, giant cordgrass, and three-square bullrush. Other species characteristic of this environment include salt marsh bulrush, softstem bulrush, marsh cordgrass, tropical cattail, narrow-leaved cattail, and pickerel weed. Shrubs are very sparse, and trees are absent.

DOMINANT/INDICATOR PLANTS:

Herbs: *Juncus roemerianus, Spartina cynosuroides, Scirpus americanus, Spartina bakeri, Pontederia cordata, Cladium jamaicense*

Shrubs: *Borrichia frutescens, Baccharis halimifolia, Iva frutescens, Myrica cerifera*

SYNONYMY: Estuarine, Intertidal, Emergent, Persistent, Regularly or Irregularly Flooded, Mixohaline (Cowardin et al.); Brackish Marsh (NCHP); High Salt Marshes (COE); Needlerush Marsh, Edge Zone Marsh, and Brackish Marsh (Wharton)

RARE SPECIES: *Physostegia leptophylla, Eleocharis albida, Eleocharis fallax, Scirpus cylindricus, Thalia dealbata*

COMMENTS: As described here, this wetland type includes plant communities of several different topographic settings in relatively close proximity; the common environmental denominator is a brackish or mixohaline environment. These brackish marsh habitats share a similarly high level of primary productivity, but differ somewhat in the amount of daily inundation and the amount of nutrient exchange with adjacent areas. It is sometimes difficult to map a clear and simple boundary between salt marsh and brackish marsh because of the spatially complex interaction of various factors (e.g., topography, tides, and freshwater flows) within the coastal zone. For example, black needlerush marsh exists as a zonal community type along tidal creeks that flow through salt marshes as well as circular or irregularly-shaped patches on slight rises or mounds in the salt marsh intertidal zone. The boundary between black needlerush- and smooth cordgrass-dominated patches is almost always visually distinct, however. A 1990 landcover mapping project utilizing satellite imagery produced an estimate of 91,950 acres of brackish marsh in Georgia. The ecology of brackish intertidal marshes has not been researched as thoroughly as that of adjacent salt marsh habitats.

Brackish Marsh, Blackbeard Island NWR

COMMUNITY TYPE: Brownwater River Swamp (Coastal Plain)

NWI CLASSIFICATION CODE(S): PFO1/2C, PFO2/1F

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Backswamps, sloughs, and other semipermanently flooded areas within the floodplains of alluvial rivers.

SOILS: Poorly drained mucky, silty, or sandy alluvial soils (e.g., Bibb, Bladen, Rains, Wehadkee)

HYDROLOGY: Palustrine, seasonally to semipermanently flooded. Water table is usually high throughout the year. In general, this habitat is inundated by water six months or more each year.

GENERAL DESCRIPTION: A forested wetland dominated by baldcypress and tupelo gum, sometimes with other canopy species such as overcup oak and swamp blackgum. The understory tree/shrub vegetation may be patchy, often consisting of species such as swamp privet, water elm, swamp dogwood, red maple and Carolina ash. The groundlayer herbaceous vegetation is usually sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium distichum, Nyssa aquatica, Nyssa biflora, Quercus lyrata, Fraxinus caroliniana*

Shrubs: *Forestiera acuminata, Cornus stricta, Clethra alnifolia, Cephalanthus occidentalis*

Herbs: *Saururus cernuus, Boehmeria cylindrica, Onoclea sensibilis, Osmunda regalis, Woodwardia areolata, Hydrocotle* spp.

SYNONYMY: Cypress-gum Swamp, Brownwater Subtype (NCHP); Palustrine, Forested, Needle-leaved Deciduous-Broad-leaved Deciduous, Seasonally to Semipermanently Flooded (Cowardin et al.); Cypress Swamps (COE); Alluvial River Swamp, Coastal Plain (Wharton)

RARE SPECIES: *Epidendrum conopseum, Tillandsia recurvata, Acantharchus pomotis, Amphiuma pholeter, Corynorhinus rafinesquii, Elanoides forficatus, Enneacanthus chaetodon, Fundulus cinculatus, Necturus alabamensis*

COMMENTS: These wetland communities occur in low-lying parts of the floodplains of alluvial rivers. Substrates of sloughs and backwater areas provide nutrient-rich habitats for benthic organisms. Cypress-gum swamps and similar habitats on the floodplains are considerably higher in productivity of insects, annelids, and crustaceans than the main river channel. These invertebrates produced on the floodplain support fish and other vertebrate consumers in the river system. Sloughs and other semipermanently flooded environments on the floodplain also support a diverse assemblage of aquatic amphibians, including water dogs, sirens, and amphiumas. Seldom-seen snakes include the rainbow, mud, black swamp, and striped swamp. More common are cottonmouths and canebrake (timber) rattlesnakes. Alluvial river swamps are important habitats for a variety of perching and wading birds. Removal of cypress by logging has shifted the dominance of some former cypress-dominated swamps to water tupelo stands.

Brownwater River Swamp, Wanye County along Altamaha River

COMMUNITY TYPE: Carolina Bay Pond

NWI CLASSIFICATION CODE(S): PEM1B, PEM1C, PSS3B, PFO1/3B, PFO3/4B

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain, primarily in the Vidalia Upland and Tifton Upland districts.

TOPOGRAPHIC SETTING: Elliptical or oval depressions in sandy upland areas.

SOILS: Mineral or organic soils; Carolina bays usually have well-drained sandy soils near their outer rim, grading into sandy loams and sandy clay loams near the center of the pond. Many Carolina bays are underlain by an impermeable clay lens. Peat deposits may be thick, or poorly developed.

HYDROLOGY: Intermittently to semipermanently flooded; may be primarily ombrotrophic (receiving all water directly from precipitation) or fed by springs. Carolina bays usually have surface water outflow, and may have a continuous or intermittent connection to groundwater.

GENERAL DESCRIPTION: An elongate depression pond dominated by shrubs and emergent, submergent, and floating aquatic macrophytes, with scattered patches of trees. Physiognomy and species composition are highly variable, due to topography, fire frequency, hydrology, and past land use practices.

DOMINANT/INDICATOR PLANTS:

Trees: *Nyssa biflora, Taxodium ascendens, Diospyros virginiana, Pinus serotina, Acer rubrum, Persea borbonia*

Shrubs: *Cephalanthus occidentalis, Cyrilla racemiflora, Ilex myrtifolia, Leucothoe lucida, Lyonia lucida, Stillingia aquatica*

Herbs: *Panicum hemitomum, Polygonum hirsutum., Pontederia cordata, Juncus canadensis, Rhyncospora tracyi, Eleocharis robbinsii, Leersia hexandra, Decodon verticillatus, Nymphaea odorata, Nymphoides aquaticum, Brasenia schreberi*

SYNONYMY: Palustrine, Emergent, Persistent, Saturated to Semipermanently Flooded (Cowardin et al.); Carolina Bays (Wharton); Upland Depression Pond (NCHP)

RARE SPECIES: *Myriophyllum laxum, Ptilimnium nodosum, Sarracenia minor, Notophthalmus perstriatus, Neofiber alleni, Mycteria americana*

COMMENTS: Fire frequency is an important factor in determining the species composition of Carolina bay ponds. In the absence of fire, peat deposits accumulate, the depth of the water decreases, and ecological succession proceeds through a shrub-dominated stage (shrub bog or pocosin) to a tree-dominated community (bay swamp). Frequent fire reduces peat levels and may return the bay to a shrub- or herb-dominated community. Plant species diversity often increases following intense fires. Under natural conditions, the periodic reduction of peat layers from fires results in cyclical successional patterns. Animals characteristic of Carolina bays are typically semi-aquatic. Carolina bay ponds serve as important sites for amphibian reproduction and larval development. They also provide foraging habitat for a wide variety of waterfowl. These habitats can be considered hydric "islands" within the sandy coastal plain landscape. Carolina bay ponds represent the only major lentic (non-flowing) aquatic system in the central and eastern Coastal Plain of Georgia. These communities have been affected significantly by construction of ditches and clearing of natural vegetation. Many Carolina bays have been converted to agricultural or silvicultural uses.

COMMUNITY TYPE: Coastal Plain Herb Bog/Seep

NWI CLASSIFICATION CODE(S): PEM1B

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain, especially in the Tifton Upland District

TOPOGRAPHIC SETTING: Low swales and depressions, lower slopes, and poorly drained flats in regions of sandy soils.

SOILS: A variety of wet, acidic, sandy soils, usually with a surface layer of peat, and often underlain by a clay hardpan. Examples include Plummer, Rains, Pelham, Bladen, and Rutlege soils.

HYDROLOGY: Palustrine, seasonally to semipermanently saturated. These communities receive water directly from precipitation as well as by lateral seepage from adjacent areas. The water table is at or near the surface of the soil for much of the year. These habitats are rarely flooded.

GENERAL DESCRIPTION: A wetland community dominated by a wide variety of grasses and forbs, with very sparse occurrence of shrubs and trees. The herbaceous groundlayer vegetation typically contains a very diverse mix of grasses, sedges, composites, orchids, lilies, sundews, and pitcherplants.

DOMINANT/INDICATOR PLANTS:

Trees: *Pinus palustris, Pinus elliottii, Nyssa biflora, Acer rubrum*

Shrubs: *Ilex glabra, Myrica cerifera, Stillingia aquatica, Gaylussacia frondosa*

Herbs: *Sarracenia flava, Sarracenia minor, Sarracenia psittacina, Rhexia mariana, Drosera capillaris, Platanthera blephariglottis, Platanthera cristata, Cleistes divaricata, Calapogon tuberosus, Bigelowia nudata, Ctenium aromaticum, Dichromena colorata, Aristida beyrichiana, Xyris* sp., *Eriocaulon decangulare, Helianthus angustifolius, Pteridium aquilinum, Oxypolis filiformis, Polygala lutea, Pinguicula caerulea*

SYNONYMY: Pine Savannah, and Sandhill Seep (NCHP); Herb Bog (Wharton); Palustrine, Emergent, Persistent, Saturated (Cowardin et al.); Savannahs (COE); Pine Savannah, "Open Savannah" subtype (SCHP)

RARE SPECIES: *Balduina atropurpurea, Calapogon multiflorus, Rhynchospora torreyana, Hartwrightia floridana, Sarracenia flava, Sarracenia rubra, Sarracenia minor, Sarracenia psittacina, Sarracenia leucophylla, Sarracenia purpurea, Stokesia laevis, Drosera filiformis, Schwalbea americana, Clemmys guttata*

COMMENTS: Coastal plain herb bogs and seeps occupy sites ranging from the sides of sandy rolling hills to broad interstream flats. These two environments differ slightly in terms of hydrology, the former (bog) receiving most of its water from precipitation, the latter (seep) receiving much of its water from lateral seepage from adjacent areas. However, they have many ecological and floristic similarities, so they are treated as one wetland type in this discussion. Coastal Plain Herb Bogs/Seeps are treated as subtypes of Pine Savanna by some authors; they are separated here based on their lower density of trees and shrubs, their higher diversity of herbaceous species, and their wetter substrate. Herb bogs/seeps can thus be thought of as occurring as especially diverse "gaps" within a matrix of pine savanna. Frequent fire is necessary for the maintenance of these wetland communities; in the absence of fire, shrubs and trees shade out the sun-loving herbaceous plants, and species diversity declines dramatically. Seasonality of fires is also an important factor in determining species dominance in coastal plain herb bogs and seeps. Fires occurring in the spring and summer tend to favor growth and reproduction of grasses, while winter burns may cause an increase in woody shrubs such as gallberry. Herb bogs have been impacted by fire suppression, ditching, grazing, and conversion to pine plantation.

Coastal Plain Herb Bog/Seep, Bellville, GA

COMMUNITY TYPE: Coastal Plain Shrub Bog/Seep

NWI CLASSIFICATION CODE(S): PSS3B, PSS3C

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain; most common in the Tifton Upland District.

TOPOGRAPHIC SETTING: Low swales and depressions, lower slopes, and poorly drained flats in regions of sandy soils. Often associated with Carolina bays, sandhills, and the heads of blackwater creeks.

SOILS: A variety of wet, acidic, peaty or sandy soils, often underlain by a clay hardpan. Examples include Plummer, Rains, Pelham, Osier, Bibb, and Rutlege soils.

HYDROLOGY: Palustrine, seasonally to semipermanently saturated. These communities receive water directly from precipitation, as well as by lateral seepage from adjacent areas. The water table is at or near the surface of the soil for much of the year. These habitats are infrequently flooded.

GENERAL DESCRIPTION: A wetland community with a dense and relatively diverse layer of shrubs, woody vines, and small or dwarfed trees. The herbaceous groundlayer vegetation is sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Pinus serotina, Magnolia virginiana, Acer rubrum, Persea borbonia; Gordonia lasianthus*

Shrubs: *Cliftonia monophylla, Cyrilla racemiflora, Zenobia pulverulenta, Lyonia lucida, Lyonia ligustrina, Lyonia ferruginea, Viburnum nudum, Clethra alnifolia, Ilex glabra, Ilex americana, Leucothoe racemosa, Leucothoe axillaris, Kalmia hirsuta, Gaylussacia frondosa, Vaccinium* sp. *(amoenum, corymbosum, attrococcum, stamineum), Rhododendron viscosum, Itea virginica, Sorbus arbutifolia, Alnus serrulata*

Woody vines: *Smilax laurifolia, Smilax walteri*

Herbs: *Osmunda cinnamomea, Osmunda regalis, Woodwardia virginica, Sphagnum* sp.

SYNONYMY: Palustrine, Scrub/Shrub, Broad-leaved Evergreen, Seasonally Flooded or Saturated (Cowardin et al.); Low Pocosin, High Pocosin, Small Depression Pocosin, and Streamhead Pocosin (NCHP); Shrub Swamp (COE); Shrub Bog (Wharton)

RARE SPECIES: *Sarracenia rubra, Myrica inodora, Zenobia pulverulenta, Fothergilla gardenii*

COMMENTS: As described here, this wetland type includes several similar shrub-dominated communities in a variety of topographic settings and hydrologic conditions. The relative contributions of direct precipitation and lateral seepage vary from site to site; floristic distinctions caused by these topographic and hydrologic variations are not well understood. Another complicating factor is the effect of fire return interval on physiognomy and species composition of these communities. Frequently-burned sites tend to have a dense layer of low-growing shrubs, while infrequently-burned sites have a greater abundance of deciduous hardwood trees such as red maple, sweetbay, and swamp blackgum. Species diversity in these wetland habitats is highest shortly after occurrence of fire and declines gradually thereafter. In general, the height of the vegetation increases with decreasing thickness of peat deposits. Depressions with deep peat accumulations and little hydrologic input other than precipitation tend to support dense shrub bogs less than 1.5 meters tall ("low pocosin"). Shrub-dominated bogs and seeps typically occur in areas with lower incidence of fire than herb-dominated bogs/seeps (i.e., downslope or in soils that are saturated or flooded for longer periods of time). Shrub-dominated communities may be found around the perimeter of Carolina bay ponds, along shallow drains below herb bogs, at the upper ends of many small nonalluvial streams, along the lower slopes of sandhills, and in depression ponds within pine-dominated flatwoods. While few rare species are known from these habitats, they are important as representative community types of the Coastal Plain. These habitats are being lost due to fire suppression, ditching, and conversion to other uses.

COMMUNITY TYPE: Cypress/gum pond

NWI CLASSIFICATION CODE(S): PFO2/1F, PFO1/2C

GEOGRAPHIC RANGE: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Circular to elongate depressions throughout the Coastal Plain. These may include Carolina bays, limesink depressions, and "Grady ponds".

SOILS: A wide variety of sandy acidic soils, often with an impervious clay layer. (e.g., Rains, Grady)

HYDROLOGY: Palustrine, seasonally to semipermanently flooded. Cypress/gum ponds remain flooded for longer periods than cypress savannas. In some cases they may hold water year-round. Many cypress/gum ponds have outflow to other ponds or to streams during wet periods; some ponds are spring-fed.

GENERAL DESCRIPTION: A forested wetland of ponded depressions, dominated by pondcypress and/or swamp blackgum. The shrub layer is usually relatively sparse, consisting of species adapted to high or widely-fluctuating water levels (e.g., myrtle-leaved holly, lyonia, buttonbush, titi). The herbaceous vegetation is similarly sparse, including emergent and floating macrophytes as well as species rooted on stumps and floating logs.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium ascendens, Nyssa biflora, Acer rubrum, Pinus elliottii*

Shrubs/woody vines: *Lyonia lucida, Ilex myrtifolia, Litsea aestivalis, Cepalanthus occidentalis, Myrica cerifera, Cyrilla racemiflora, Smilax laurifolia, Toxicodendron radicans, Pieris phyllyreifolia*

Herbs: *Nuphar luteum, Nymphaea odorata, Brasenia schreberi, Utricularia* sp., *Saururus cernuus, Boehmeria cylindrica*

SYNONYMY: Pondcypress Pond (SCHP); Palustrine, Forested, Needle-leaved Deciduous, Seasonally to semipermanently flooded (Cowardin et al.); Cypress Swamps (COE); Cypress Pond, Gum Pond (Wharton)

RARE SPECIES: *Litsea aestivalis, Lindera melissifolia, Lobelia boykinii, Myriophylllum laxum, Panicum hirstii, Ptilimnium nodosum, Rhynchospora harperi, Zenobia pulverulenta, Acantharchus pomotis, Ambystoma cingulatum, Amphiuma pholeter, Clemmys guttata, Mycteria americana, Notophthalmus perstriatus*

COMMENTS: These habitats are relatively common in the Dougherty Plain, Tifton Upland, and the Atlantic Coastal Plain Flatwoods regions. Species composition and physiognomy of these wetlands are influenced strongly by water depth, peat depth, and fire return interval. Cypress/gum ponds are generally quite nutrient poor and acidic. In the absence of fire, these communities may eventually succeed to hydric hammocks. Ponds dominated by swamp blackgum (Nyssa biflora) are less common than those with both pondcypress and swamp blackgum in the canopy. Gum ponds are thought to be underlain by thick clay layers, and may experience higher water levels, less fluctuation in water levels, and lower frequency of fires than cypress-dominated ponds. Cypress/gum ponds are important foraging and roosting habitats for wading birds such as egrets, herons, and wood storks. Those that lack predaceous fish are important breeding habitats for salamanders, including the State-protected flatwoods salamander. A wide variety of tree frogs, toads, snakes, and turtles also makes use of these habitats.

Cypress/Gum Pond, Camden County

COMMUNITY TYPE: Cypress Savanna

NWI CLASSIFICATION CODE(S): PEM1C, PEM1A

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Circular to elongate shallow depressions, and nonalluvial flats. These may include Carolina bays and limesink depressions, as well as depressions and flats in Pleistocene sediments.

SOILS: Sandy soils with a clay hardpan base (e.g., Rains)

HYDROLOGY: Palustrine, temporarily to seasonally flooded; these sites flood less often than cypress/gum ponds, and more often than pond pine woodland.

GENERAL DESCRIPTION: A wetland community with widely-spaced pondcypress trees and a dense herbaceous groundlayer dominated by grasses and sedges. The shrub layer is usually very sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium ascendens; may also include Nyssa biflora, Acer rubrum, Diospyros virginiana*

Shrubs: *Ilex myrtifolia, Cyrilla racemiflora, Lyonia lucida, Hypericum* sp., *Decodon verticillatus, Cephalanthus occidentalis*

Herbs: *Panicum hemitomum, Panicum verrucosum, Dicanthelium* spp., *Erianthus alopecuroides, Rhyncospora* spp., *Andropogon virginicus, Pluchea rosea, Lachnanthes caroliniana, Rhexia* spp., *Ludwigia* spp., *Cladium jamaicense, Boltonia caroliniana, Eleocharis* spp.

SYNONYMY: Palustrine, Emergent, Persistent, Temporarily/Seasonally Flooded (Cowardin et al.); Savannahs (COE); Cypress Savanna (NCHP); Pond Cypress Savannah (SCHP); Cypress Savannah (Wharton)

RARE SPECIES: *Oxypolis canbyi, Ptilimnium nodosum, Sarracenia minor, Lobelia boykinii, Panicum hirstii, Rhexia aristosa, Clemmys guttata, Ambystoma cingulatum*

COMMENTS: Cypress savannas are found in a variety of topographic settings, from shallow clay-based Carolina bay depressions to seasonally-flooded limesink depressions, to flats and depressions in deposits associated with Pleistocene coastal terraces. These habitats are often flooded in the early spring, but dry out during the summer months. They are generally drier than cypress/gum ponds, and wetter than pine savannas. Cypress savannas burn frequently enough to limit growth of trees and shrubs and stimulate the growth of grasses and sedges. Like cypress/gum ponds, they provide important breeding or foraging habitats for a wide variety of amphibians, reptiles, birds, and mammals. This habitat is being lost through drainage and conversion to silvicultural or agricultural uses.

COMMUNITY TYPE: Estuarine Mud Bar/Flat

NWI CLASSIFICATION CODE(S): E2USN, E2USM

GEOGRAPHIC SETTING: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Tidal creeks, rivers, sounds, and open estuaries, where water is brackish or mesohaline (5 to 20 ppt), and where muddy sediments are regularly or irregularly exposed at low tide.

SOILS: Unconsolidated muds and silts, generally not mapped

HYDROLOGY: Estuarine, intermittently exposed, unconsolidated bottom

GENERAL DESCRIPTION: Regularly or irregularly exposed muddy or silty estuarine areas; generally unvegetated except for ephemeral adventives. The configuration and microtopography of mud bars and flats change constantly in response to water currents. Bars are intertidal areas configured as low islands, while flats are more gently sloping and continuous with permanently exposed (terrestrial) habitats.

DOMINANT/INDICATOR PLANTS:

Herbs: Mostly species of marine/estuarine algae

SYNONYMY: Intertidal Mud/Sand Flat (SCHP); Oligohaline Creek, Tidal Creek and River, Estuaries and Sounds (Wharton, in part), Estuarine, Intertidal, Unconsolidated Shore, Regularly Flooded to Irregularly Exposed (Cowardin et al,)

RARE SPECIES*: Charadrius melodus, Charadrius wilsonia*

COMMENTS: Unvegetated soft bottom areas represent the most extensive submerged habitat in estuarine areas of the Southeast. Sediment type varies with force of the water in the system. Silts and clays are most common in environments with relatively low energy, while sands are deposited by water bodies with higher turbulence and velocity. The type of sediment in turn determines the composition and diversity of the benthic invertebrate communities that characterize these habitats. For example, silts and clays support populations of bacteria as much as two orders of magnitude higher than sand, perhaps because the former substrate types provide much greater surface area. Meiofauna such as burrowing nematodes are also much more abundant in fine sediments than in sand. On the other hand, the greater compaction of fine sediments may limit the vertical distribution of benthic organisms. The typical mixture of clays, silts, fine sands, and organic matter that cover the bottom of most estuaries of the Southeast supports animal communities dominated by polychaete worms and bivalves, such as Rangia cuneata and Polymesoda caroliniana. Salinity also controls the distribution of organisms within these environments. In general, brackish or oligohaline areas support high densities of relatively few species, while areas of higher and lower salinity support a greater diversity of benthic organisms. Above-ground animals found in this habitat include fiddler crabs, floating and diving waterfowl, wading birds, and shorebirds. Shorebirds such as plovers, sandpipers, and dowitchers, feed primarily on small invertebrates and are dependent on intertidal bars and flats for food. Skates, rays, and other demersal fishes may feed over mud flats during high tides. In shell rake areas or sites with woody debris, oysters may colonize and form reefs. These intertidal hard-bottom habitats are structurally and biologically more diverse than the relatively amorphous mud flats and bars.

COMMUNITY TYPE: Forested Canebrake (Coastal Plain)

NWI CLASSIFICATION CODE(S): PFO1A, PFO1C

GEOGRAPHIC RANGE: Coastal Plain

TOPOGRAPHIC SETTING: Floodplain ridges and relict (inactive) levees along blackwater and brownwater streams, and transition zones between floodplains and adjacent upland areas; also found on some broad interstream flats.

SOILS: A wide variety of sandy alluvial soils.

HYDROLOGY: Palustrine, Intermittently to seasonally flooded

GENERAL DESCRIPTION: A forested wetland dominated by various broadleaved deciduous trees, with a dense, almost impenetrable understory of *Arundinaria gigantea*, river cane. The groundlayer herbaceous layer is usually very sparse.

DOMINANT/INDICATOR SPECIES:

Trees: *Quercus nigra, Quercus phellos, Quercus michauxii, Quercus laurifolia, Fraxinus pennsylvanica, Carya cordiformis, Carpinus caroliniana, Liquidambar styraciflua, Celtis laevigata, Ulmus americana, Pinus taeda, Ilex opaca*

Shrubs/Woody Vines: *Arundinaria gigantea, Toxicodendron radicans, Vitis rotundifolia, Rubus* spp.,

Herbs: *Chasmanthium latifolium, Chasmanthium laxum, Viola* spp.

SYNONYMY: Palustrine, Forested, Broad-leaved Deciduous, Temporarily to Seasonally Flooded (Cowardin et al.); Coastal Plain Bottomland Hardwood Forest, Blackwater and Brownwater Subtypes, and Nonriverine Wet Hardwood Forest (NCHP, in part); Coastal Plain Alluvial River and Swamp-Coastal Plain, and Blackwater River and Swamp (Wharton, in part); Bottomland Hardwoods (SCHP)

RARE SPECIES: *Vermivora bachmanii, Limnothlypis swainsonii*

COMMENTS: This wetland community type, mentioned by some authors as a variant of the "typical" bottomland hardwood forest of the Coastal Plain, is specifically mentioned here because of its distinctive physiognomy and its conservation status. Canebrakes are generally found in high areas of the floodplain, and along the upland/wetland interface (Zone V). The canopy dominants are variable, but include many of the typical broadleaved deciduous species of bottomland hardwood forests. River cane is a species adapted to drier portions of the floodplain, and can form dense thickets following natural disturbances such as fire, treefalls, and severe floods. Once established, it can persist for long periods in closed-canopy floodplain forests, but without periodic fire it will gradually decrease in abundance. Canebrakes are more common and more extensive along alluvial rivers than nonalluvial streams. This wetland community type has apparently declined significantly since pre-Columbian times. Early travelers in the Southeast made note of the extensive canebrakes present along the floodplains of rivers. These communities were probably maintained by a combination of lightning-caused fires and fires set by American Indians; the relatively frequent low-intensity fires spread from upland areas into the higher parts of the floodplain, reducing the density of woody shrubs and trees. Occasional severe floods and blowdowns also probably helped to maintain canebrakes by opening up small to medium-sized gaps in the canopy.

Some researchers feel that extensive unforested canebrakes were remnants of abandoned agricultural fields. However, river cane is a dominant understory component of many bottomland hardwood forests, and it is not difficult to imagine natural conditions in which these communities were maintained. Over the past several decades fire suppression and flood control have reduced the extent of forested canebrakes in Georgia and elsewhere. Several researchers have theorized that forested canebrakes were the requisite habitat of Bachman's warbler, now thought to be close to extinction. Based upon what is known of this warbler's nesting and foraging requirements, it is thought to have been largely restricted to canebrake habitats, requiring vast expanses of this community type for maintenance of population viability. Swainson's warbler, an uncommon bird of the Southeast, also makes use of forested canebrakes, but apparently is not as narrowly adapted to this declining habitat.

Forested Canebrake, McIntosh County

COMMUNITY TYPE: Hydric Hammock

NWI CLASSIFICATION CODE(S): PFO1A, PFO1B

GEOGRAPHIC LOCATION: Coastal Plain

TOPOGRAPHIC SETTING: Low ridges, knolls, and relict (not active) levees of river floodplains; slight rises or mounds in wet nonalluvial flats or karst depressions

SOILS: A variety of sandy or loamy soils, often with impervious clay or marl layers (e.g., Meggett)

HYDROLOGY: Palustrine, seasonally flooded to saturated. These habitats rarely receive alluvium, but flooding occurs seasonally to occasionally, and the water table is usually close to the soil surface. A clay or marl layer in the soil may provide a perched water table.

GENERAL DESCRIPTION: A forested wetland of low hills or ridges in wet terrain. The canopy is dominated by deciduous and evergreen hardwood trees such as sweetbay, southern magnolia, American beech, swamp chestnut oak, American holly, sweetgum, red maple, laurel oak, willow oak, water oak, and cabbage palm. The understory may include red buckeye, swamp palmetto, American hophornbeam, common pawpaw, needlepalm, and flowering dogwood. The herbaceous groundlayer vegetation is usually relatively sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Magnolia virginiana, Magnolia grandiflora, Quercus michauxii, Quercus laurifolia, Quercus nigra, Quercus phellos, Liquidambar styraciflua, Acer floridanum, Acer rubrum, Sabal palmetto, Cornus florida, Carpinus caroliniana*

Shrubs/woody vines: *Sabal minor*, *Aesculus pavia*, *Rhapidophyllum hystrix*, *Berchemia scandens, Toxicodendron radicans, Vitis* spp.

Herbs: *Polystichum acrostichoides, Sanicula* sp., *Boehmeria cylindrica*

SYNONYMY: Palustrine, Forested, Broad-leaved Deciduous, Seasonally Flooded/Saturated (Cowardin et al.); Nonriverine Wet Hardwood Forest and Wet Marl Forest (NCHP); Beech-Magnolia Hammock (SCHP, in part)

RARE SPECIES: *Epidendrum conopseum, Tillandsia recurvata*

COMMENTS: Hydric hammocks represent islands of fire-intolerant mesic and hydric species on infrequently flooded or saturated substrates. Species diversity and composition in this community type are influenced by soil chemistry and moisture regime. Hydric hammocks on soils with marl near the surface have higher pH, and this is reflected in greater plant diversity, especially in the herbaceous groundlayer vegetation. Similarly, those sites with impervious clay or marl layers near the soil surface have a greater abundance of species adapted to saturated soils (e.g., swamp palmetto, baldcypress, and red maple). Higher or better-drained hammocks may include species such as American beech, spruce pine, and southern magnolia. Dudley's Hammock in Lanier County is an example of hydric hammock. Many small examples of hydric hammock have been documented from Chatham County near Savannah. This wetland type has been adversely impacted by residential and industrial development along the coast of Georgia.

Hydric Hammock, Mays Bluff, GA

COMMUNITY TYPE: Intertidal Beach/Sand Bar

NWI CLASSIFICATION CODE(S): M2USN, M2USM, M2USP

GEOGRAPHIC LOCATION: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Gently-sloping sandy shoreline facing the open ocean and exposed to direct wave action, or sand bars and flats near mouths of tidal rivers.

SOILS: Unconsolidated sands, usually mapped as "Beach Association"

HYDROLOGY: Marine, tidally influenced, regularly flooded to intermittently exposed.

GENERAL DESCRIPTION: An essentially unvegetated intertidal marine habitat, characterized by high wave energy, constantly-shifting substrate, and euhaline conditions.

DOMINANT/INDICATOR PLANTS: Usually none within the intertidal zone. Along the upper edge of the spring high tide line there may be a few beach-adapted herbs, such as *Paspalum vaginatum, Cakile harperi, Croton punctatus, Sporobolus virginicus, Hydrocotyle bonariensis, Ipomoea pes-caprae, Ipomoea stolonifera, Spartina patens, Sesuvium portulacastrum,* and/or *Sesuvium maritimum*.

SYNONOMY: Marine, Intertidal, Unconsolidated Shore, Regularly Flooded to Irregularly Exposed (Cowardin et al.); Intertidal Beach (SCHP); Beach (Wharton)

RARE SPECIES: *Caretta caretta, Charadrius melodus, Charadrius wilsonia, Chelonia mydas, Dermochelys coriacea, Sterna antillarum, Sterna nilotica, Haematopus palliatus, Polygonum glaucum, Vigna luteola*

COMMENTS: Intertidal sand beaches are high-energy, harsh environments. The substrate is constantly shifting, and moving sands produce a scouring action on any stationary object. These conditions, together with high (euhaline) salinities result in an intertidal habitat with few or no vascular plants, except for relict marsh areas in overwash zones. Georgia's intertidal beaches are typically wide and gently sloping. Because of the configuration of the coastline and the width of the continental shelf, wave energies along the Georgia coast are relatively low, with wave heights averaging 2 to 4 feet. A wide variety of invertebrates can be found in this zone, most of them burrowing in the sand or moving up and down the beach with the rising and falling tides. Dead plant material (primarily marsh grasses) deposited on the beach by tides is known as "beach wrack". This material serves as a source of food and cover for various beach inhabitants. Common invertebrates seen on the beach include sand fiddler crabs, which feed primarily on diatoms and other plant materials in the substrate, and ghost crabs, which are carnivorous. Intertidal beaches and sand bars provide foraging habitat for a great number of shorebirds, including sandpipers, plovers, sanderlings, turnstones, terns, and dowitchers. Mammals making use of beach areas include mice, raccoons, voles, and white-tailed deer. Sea turtles traverse intertidal beaches on their way to and from nesting areas located just above the high tide line.

Intertidal Beach/Sand Bar

COMMUNITY TYPE: Limesink Pond

NWI CLASSIFICATION CODE(S): PABC, PABF, PUBH, PUSC, PUSF

GEOGRAPHIC LOCATION: Coastal Plain (primarily in the Dougherty Plain and Tifton Upland districts)

TOPOGRAPHIC SETTING: Circular, elongate, or irregularly-shaped depressions in regions underlain by limestone or dolomite.

SOILS: A variety of mineral soils with dolomitic clay layers

HYDROLOGY: Palustrine, seasonally to permanently flooded

GENERAL DESCRIPTION: A depression pond with gently to steeply sloping sides. Limesink ponds often have a shrub-dominated shallow water zone, "islands" of stunted trees, and deeper areas dominated by floating macrophytes.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium ascendens, Acer rubrum, Nyssa biflora*

Shrubs: *Cephalanthus occidentalis, Crataegus aestivalis, Hypericum* spp., *Ilex myrtifolia, Lyonia lucida*

Herbs: *Panicum hemitomum, Nymphaea odorata, Nymphoides aquatica, Proserpinaca pectinata, Nuphar luteum, Utricularia* spp., *Brasenia schreberia, Sagittaria* spp.

SYNONYMY: Palustrine, Aquatic Bed/Unconsolidated Bottom, Seasonally to Permanently Flooded (Cowardin et al.); Small Depression Pond (NCHP); Ponds (COE); Limesinks (Wharton); Limestone Sink (SCHP)

RARE SPECIES: *Lindera melissifolia, Litsea aestivalis, Myriophyllum laxum, Sarracenia minor, Sarracenia flava, Ambystoma cingulatum, Enneacanthus chaetodon, Notophthalmus perstriatus*

COMMENTS: Limesink depressions are formed in karst regions when limestone bedrock is dissolved by the groundwater and slumping of the overlying soil occurs. Some limesink depressions receive most of their water directly from precipitation, and may drain quickly and directly into the groundwater; others are more or less connected to surface drainages and may represent disappearing streams. Still others have a layer of soil that precludes rapid drainage into the groundwater, resulting in ponding of water for long periods during the growing season. These limesink ponds are important habitats for a wide variety of aquatic, semi-aquatic, and terrestrial species, including several rare species (see above). Limesink ponds in southwestern Georgia have been impacted significantly by groundwater withdrawal. Pumping of groundwater for agricultural irrigation and other uses has effectively de-watered many limesink ponds. Other limesink ponds have been adversely affected by ditching, sedimentation, and excess nutrient input.

COMMUNITY TYPE: Natural Impoundment Pond (Coastal Plain)

NWI CLASSIFICATION CODE(S): PUSFh, PUBGh, PABFh, PABHh

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain (all districts)

TOPOGRAPHIC SETTING: Small to medium-sized blackwater and brownwater streams in sandy terrain.

SOILS: A variety of mineral and organic soils associated with floodplains.

HYDROLOGY: Palustrine, semipermanently to permanently flooded

GENERAL DESCRIPTION: A pond or stream impoundment caused by the dam-building action of beavers, or other force of nature (e.g., massive debris dams following catastrophic floods, or blockage at the mouths of tributary streams caused by overbank deposition from larger rivers.). This wetland represents a small to medium-sized reservoir, with water slowly flowing through or over the dam. The vegetation is variable in physiognomy and species composition, but usually includes a peripheral zone of trees and shrubs, areas of open water, and expanses of emergent, submergent, and floating macrophytes. These ponds may have extensive areas of drowned trees.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium ascendens, Nyssa biflora, Nyssa aquatica, Acer rubrum, Liriodendron tulipifera*

Shrubs: *Cephalanthus occidentalis, Rosa palustris, Decodon verticillatus, Cyrilla racemiflora*

Herbs: *Juncus effusus, Polygonum* spp., *Peltandra virginica, Nymphaea odorata, Nymphoides aquatica, Pontedaria cordata, Sagittaria* spp., *Nuphar luteum, Ceratophyllum* spp., *Myriophyllum* spp., *Lemna* spp.

SYNONYMY: Palustrine, Unconslidated Shore/Unconsolidated Bottom/Aquatic Bed, Semipermanently to Permanently Flooded (Cowardin et al.); Coastal Plain Semipermanent Impoundment (NCHP); Natural Levee Type, Beaver Dam Type (Wharton)

RARE SPECIES: *Acantharchus pomotis, Clemmys guttata, Pseudemys nelsoni*

COMMENTS: Like man-made impoundments, these systems share some characteristics of both lotic (flowing water) and lentic (ponded water) aquatic habitats. Like streams, they receive and pass on sediments and nutrients. However, they provide habitat for many species adapted to still waters (such as floating aquatic macrophytes). Beaver-impounded streams may progress through several successional stages following the die-off of trees in the center of the pond, including a grass-sedge-forb marsh, a scrub-shrub wetland, and an open water-floating macrophyte pond. These habitats are subject to rapid changes due to abandonment of dams by beavers or destruction of the dam by floodwaters. Beaver ponds provide important foraging habitat for wading birds, ducks, aquatic snakes, turtles, tree frogs, muskrats, swamp rabbits, and raccoons.

COMMUNITY TYPE: Okefenokee Bog-Swamp Complex

NWI CLASSIFICATION CODE(S): Numerous classification codes covering a large variety of wetland classes, subclasses

GEOGRAPHIC LOCATION: Lower Coastal Plain (Okefenokee Basin)

TOPOGRAPHIC SETTING: A vast depressional area or basin bordered on the east by a relict barrier formation (Trail Rdge), and on the west, south, and north by higher-elevation Pliocene deposits.

SOILS: A variety of mineral soils with significant peat deposits

HYDROLOGY: Palustrine, permanently flooded. This extensive wetland complex has been described as an immense sphagnum bog with continuous surface water flow. The Okefenokee Swamp drains to the Atlantic Ocean via the St. Marys River, and to the Gulf of Mexico via the Suwannee River. Average water depth is 2 feet, and average depth to sand bottom in the basin is approximately 10 feet. Surface flow patterns within the heart of the Okefenokee Basin are complex. A man-made sill (low dam) at the southwestern corner of the basin was constructed to stabilize water levels in the swamp.

GENERAL DESCRIPTION: The predominant wetland vegetation types represented within the Okefenokee basin are cypress swamp, sphagnum mat, bay swamp, freshwater marsh, and open water-floating macrophyte. These habitats are similar in many respects to wetlands with similar dominants outside of the Okefenokee Basin, but are distinctive with regard to the presence of deep, extensive peat deposits, the continuous sheet flow of water, and the interspersion and juxtaposition of various plant communities. For the sake of convenience, these are treated here as a wetland complex or mosaic within the Okefenokee Swamp.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium ascendens, Nyssa biflora, Acer rubrum, Persea borbonia, Persea palustris, Pinus elliottii, Gordonia lasianthus, Magnolia virginiana, Ilex cassine*

Shrubs: *Lyonia nitida, Pieris phillyreifolia, Clethra alnifolia, Itea virginica, Cyrilla racemiflora, Ilex cassine, Leucothoe racemosa*

Herbs: *Panicum hemitomum, Eriophorum virginicum, Carex glaucesens, Dulichium arundinaceum, Sphagnum* spp., *Orontium aquaticum, Woodwardia virginica, Osmunda regalis, Sarracenia* spp., *Peltandra virginica, Xyris* spp., *Calopogon* spp., *Habenaria* spp., *Drosera longifolia, Brasenia schreberi, Nuphar luteum, Nymphaea odorata, Sagittaria* spp., *Nymphoides aquatica, Utricularia* spp.

SYNONYMY: Palustrine, Unconsolidated Bottom/Aquatic bed, Permanently Flooded; Palustrine, Emergent, Permanently Flooded; and Palustrine, Forested, Permanently Flooded (Cowardin et al.); Bog Swamp (Wharton)

RARE SPECIES: *Epidendrum conopseum, Sarracenia flava, Sarracenia minor, Sarracenia psittacina, Acantharcus pomotis, Neofiber alleni, Grus canadensis tabida, Grus canadensis pratensis, Corynorhinus rafinesquii, Enneacanthus chaetodon, Fundulus auroguttatus, Clemmys guttata, Macroclemys temminckii*

COMMENTS: The Okefenokee Swamp is a wetland mosaic of national and international significance. This vast bog-swamp ecosystem covers approximately 440,000 acres, making it one of the largest freshwater wetland systems in the United States. The Okefenokee Swamp serves as the headwaters of both the Suwannee and St. Marys rivers, and is contiguous with the Pinhook Swamp of northern Florida. Approximately 20 percent of the Okefenokee Swamp is freshwater marsh or open water/aquatic bed vegetation. This vast wetland complex is located on a large terrace that may represent an ancient marine lagoon. As sea levels dropped, this terrace became isolated from marine environments by the large sand ridge to the east (Trail Ridge); rainwater filling the Okefenokee Basin resulted in the formation of this freshwater swamp-bog system approximately 7,000 years ago. In the 1890's canals were dug in an attempt to drain the swamp for logging and development. Attempts to drain the wetland proved futile, but eventually about 90 percent of the marketable cypress was removed from the swamp. Today most of the Okefenokee Swamp is protected as a National Wildlife Refuge and Wilderness Area.

Under natural conditions, large portions of the Okefenokee Swamp burn every 25 to 30 years, resulting in a temporary reduction in peat layers and woody plant dominance. After a series of severe fires in the 1950's an earthen sill was constructed near the headwaters of the Suwannee River on the southwestern edge of the swamp. Fire suppression and the maintenance of higher than normal water levels have resulted in a gradual increase in peat layers and woody vegetation in the swamp. Plans are now underway to breach the earthen sill and restore more natural hydrologic conditions in the Okefenokee Swamp.

Okefenokee Bog-Swamp Complex, Kings Bay, Brantley County

COMMUNITY TYPE: Oxbow Lake (Coastal Plain)

NWI CLASSIFICATION CODE(S): PUBH, R2UBH, R1UBV

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Floodplains of large brownwater and blackwater rivers.

SOILS: Silty or mucky alluvial soils, generally not mapped in soil surveys

HYDROLOGY: Palustrine or lacustrine, permanently flooded; these ponds or small lakes are formed in cutoff stream meanders, relict scour holes, and old sloughs within the floodplain. They have standing water for all of the growing season, except in extremely dry years. These habitats receive water from directly from precipitation as well as from the river during flood events.

GENERAL DESCRIPTION: Circular or elongate depressions on the active floodplains of large brownwater and blackwater streams. These ponds or small lakes are often vegetated with trees, shrubs, and emergent plants along their edges, with floating aquatic herbs in the center of the ponded area.

DOMINANT/INDICATOR PLANTS:

Trees: *Nyssa biflora, Nyssa aquatica, Nyssa ogeche, Fraxinus caroliniana, Taxodium ascendens, Taxodium distichum, Acer rubrum, Planera aquatica*

Shrubs: *Cephalanthus occidentalis, Forestiera acuminata, Cornus* sp.

Herbs: *Orontium aquaticum, Crinum americanum, Proserpinaca palustris, Osmunda regalis, Ceratophyllum* spp., *Myriophyllum* spp., *Azolla caroliniana*, *Lemna* spp., *Limnobium spongia*

SYNONYMY: Palustrine, Uncolidated Bottom, Permanently Flooded (Cowardin et al.); Oxbow lake (NCHP); Alluvial River and Swamp System, and Blackwater River and Swamp System (Wharton, in part)

RARE SPECIES: *Mycteria americana, Macroclemys temminckii, Elanoides forficatus*

COMMENTS: Oxbow lakes are distinctive lentic habitats in the Coastal Plain. These wetlands are periodically flushed during floods, and may receive substantial inputs of alluvium during these events. Floods can also cause substantial changes in the invertebrate and vertebrate fauna of these ponds. Oxbow lakes and sloughs may represent important sources of phytoplankton and zooplankton to rivers, since they have lower turbidity, more stable substrate, and relatively static water levels. These wetland communities are also important habitats for a wide variety of aquatic amphibians, wading birds, snakes, turtles, and mammals.

COMMUNITY TYPE: Pine Savanna

NWI CLASSIFICATION CODE(S): PFO4A, PFO4B, PEM1A, PEM1B

GEOGRAPHIC RANGE: Coastal Plain (primarily Tifton Upland)

TOPOGRAPHIC SETTING: Nearly level to gently sloping nonalluvial wet sites

SOILS: A variety of wet, highly acidic mineral soils, sometimes underlain by an impervious layer (e.g., Plummer, Pelham, Rains, Rutlege)

HYDROLOGY: Palustrine, seasonally to semipermanently saturated by a high or perched water table.

GENERAL DESCRIPTION: A wetland with an open to sparse canopy dominated by longleaf pine, often with pond pine and slash pine. The shrub layer is sparse, with gallberry, wax myrtle, and blueberries. The herbaceous layer is very diverse and dense, dominated by grasses, sedges, composites, orchids, and lilies.

DOMINANT/INDICATOR PLANTS:

Trees: *Pinus palustris, Pinus serotina, Pinus elliottii*

Shrubs: *Ilex glabra, Myrica cerifera, Vaccinium myrsinites, Gaylussacia frondosa, Gaylussacia dumosa, Kalmia hirsuta*

Herbs: *Aristida beyrichiana, Muhlenbergia expansa, Andropogon scoparium, Ctenium aromaticum, Calopogon* spp., *Rhyncospora* spp., *Helianthus angustifolius, Carphephorus tomentosus, Pteridium aquilinum, Polygala lutea*.

SYNONYMY: Palustrine, Emergent, Persistent, Saturated (Cowardin et al.); Savannahs (COE); Pine Savanna (NCHP); Herb Bogs (Wharton, in part); Pine Savannah, "Closed Savannah" subtype (SCHP)

RARE SPECIES: *Balduina atropurpurea, Fimbristylis perpusilla, Hartwrightia floridana, Sarracenia flava, Sarracenia rubra, Sarracenia minor, Sarracenia psittacina, Sarracenia leucophylla, Sarracenia purpurea, Drosera filiformis, Schwalbea americana, Ambystoma cingulatum, Aimophila aestivalis*

COMMENTS: Pine savannas and coastal plain herb bogs/seeps are similar in species composition, differing mainly in terms of soil moisture, tree and shrub abundance, and diversity of the herbaceous vegetation. In general, pine savannas occur as extensive, relatively uniform wetland communities in broad flats and gently sloping terrain, while herb bogs/seeps may be found as small, patchy openings at the lower ends of slopes, in narrow flats, and on hillside depressions. Frequent fire is necessary for the maintenance of pine savannas; in the absence of fire, this community type succeeds to a closed-canopy pine forest with a dense shrub layer and less diverse herbaceous layer. The seasonality of fires is also an important factor in determining species dominance in pine savannas. Fires occurring in the spring and summer tend to favor grasses, while late fall and winter burns may cause an increase in shrubs such as gallberry. Pine savannas have been impacted significantly by fire suppression, ditching, conversion to pine plantations, and grazing.

Pine Savanna, Colerain, GA

COMMUNITY TYPE: Pond Pine Woodland

NWI CLASSIFICATION CODE(S): PFO4B

GEOGRAPHIC LOCATION: Primarily Lower Coastal Plain

TOPOGRAPHIC SETTING: Poorly drained interstream flats, peaty depression areas, and shallow swales.

SOILS: Acidic, nutrient-poor mineral soils with surface layers of peat; shallow organic deposits.

HYDROLOGY: Palustrine, temporarily flooded or saturated. The water table fluctuates more widely than in cypress savannas, often dropping below the surface organic layers to mineral soil during the summer.

GENERAL DESCRIPTION: A forested wetland with a relatively open canopy dominated by pond pine, with loblolly bay, sweetbay, red maple, swamp redbay, slash pine, and loblolly pine. The shrub layer is tall and dense, with a number of species characteristic of shrub bogs or pocosins. The herbaceous groundlayer vegetation is sparse to nearly absent.

DOMINANT/INDICATOR PLANTS:

Trees: *Pinus serotina, Pinus taeda, Pinus elliottii, Gordonia lasianthus, Persea palustris, Acer rubrum, Magnolia virginiana*

Shrubs/Woody Vines: *Lyonia lucida, Lyonia ligustrina, Cyrilla racemiflora, Clethra alnifolia, Arundinaria gigantea, Ilex coriacea, Ilex glabra, Gaylussacia frondosa, Smilax laurifolia*

Herbs: *Woodwardia virginica, Woodwardia areolata, Sphagnum* spp.

SYNONYMY: Palustrine, Forested, Needleleaved Evergreen, Temporarily Flooded or Saturated (Cowardin et al.); Pond Pine Woodland (NCHP); Low Pine Flatwoods and Needle-leaved Evergreen Swamps (COE, in part); Pond Pine Woodland (SCHP)

RARE SPECIES: *Myrica inodora, Sarracenia rubra*

COMMENTS: Pond pine woodland is a wetland type that appears to vary significantly, both spatially and through time. This community type is susceptible to intense fire, due to the fact that the organic peat deposits dry out during the summer months. Pond pine is adapted to intense fires, having serotinous cones that open following exposure to fire. This tree is also unusual among pines for its ability to reproduce vegetatively from basal and epicormic sprouts. The shrub layer of this wetland type is similarly adapted to frequent fires, recovering quickly by root sprouting. In the absence of fire this community may succeed to a hardwood-dominated wetland type. Where frequent fires have occurred over a long period of time, the understory may be dominated by river cane. This type of canebrake vegetation may have been more common in peaty areas of the lower Coastal Plain in the past. Where fires are less frequent, the understory is usually dominated by a diverse layer of evergreen shrubs.

Pond Pine Woodland

COMMUNITY TYPE: River Shoal/Bar (Coastal Plain)

NWI CLASSIFICATION CODE(S): R2US2C, R1US2N, R1UST

GEOGRAPHIC LOCATION: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Regularly or seasonally flooded rocky or sandy/silty areas within the active channels of brownwater and blackwater rivers

SOILS: Unconsolidated sands and silts; exposed rock or cobble (rarely).

HYDROLOGY: Palustrine, seasonally to frequently flooded

GENERAL DESCRIPTION: Sand bars and shoal areas of major blackwater and brownwater streams. This wetland community type is dominated by emergent or rooted aquatic herbs, with sparse coverage of shrubs and trees.

DOMINANT/INDICATOR PLANTS:

Trees: *Salix nigra, Platanus occidentalis, Taxodium distichum, Betula nigra, Planera aquatica, Carpinus caroliniana*

Shrubs: *Sambucus canadensis, Alnus serrulata, Cornus amomum*

Herbs: *Potamogeton* spp., *Justicia ovata*

SYNONYMY: Riverine, Unconsolidated Shore; Palustrine Emergent, or Scrub-Shrub (Cowardin et al.); Shoal and Stream Bar (SCHP); Sand and Mud Bar (NCHP);

RARE SPECIES: *Elliptio spinosa, Elliptio arctata, Elliptio shepardiana, Elliptio dariensis, Elliptio downiei, Ellliptio hopetonensis, Elliptoideus sloatianus, Fusconaia masoni, Lampsilis subangulata, Lampsilis dolabraeformis, Medionidus penicillatus*

COMMENTS: This wetland type is quite variable with respect to characteristic species, and unstable over time. Sand and silt bars are frequently reshaped and moved by the river, resulting in a paucity of woody shrubs and trees. These habitats have not been well-studied; there are likely differences in the flora and fauna of blackwater and brownwater sand bars. Limestone shoals are uncommon in the Coastal Plain of Georgia, but are known from a few streams such as the Alapaha River, Suwannee River, and Ichawaynochaway Creek. Several rare mussels are known from sandy or gravelly substrates in Coastal Plain streams (see above). While these are generally described and classified as aquatic habitats, these sandy substrates may be exposed for long periods of time during the summer months (especially during drought years), and thus may be thought of as wetland environments.

River Shoal/Bar

COMMUNITY TYPE: Riverbank/levee forest (Coastal Plain)

NWI CLASSIFICATION CODE(S): PFO1A

GEOGRAPHIC RANGE: Upper and lower Coastal Plain

TOPOGRAPHIC SETTING: Active levees and banks of medium to large blackwater and brownwater streams.

SOILS: A variety of relatively well-drained alluvial soils, ranging from sandy to silty.

HYDROLOGY: Palustrine, intermittently flooded.

GENERAL DESCRIPTION: A hardwood-dominated forest occupying the higher portions of riverbanks and active levees lying parallel to major stream channels. Dominant species may include river birch, sweetgum, sycamore, red maple, American elm, water oak, sugarberry, green ash, and water hickory. Typical understory and shrub species include water elm, ironwood, American holly, American hophornbeam, deciduous holly, sweet pepperbush, titi, and highbush and Elliott's blueberry.

DOMINANT/INDICATOR PLANTS:

Trees: *Betula nigra, Liquidambar styraciflua, Platanus occidentalis, Acer rubrum, Planera aquatica, Ulmus americana, Pinus taeda, Quercus nigra, Celtis laevigata, Fraxinus pennsylvanica, Carya aquatica, Carpinus caroliniana, Ostrya virginiana, Nyssa ogeche, Ilex opaca*

Shrubs/woody vines: *Clethra alnifolia, Ilex decidua, Cyrilla racemiflora, Cliftonia monophylla, Rhododendron canescens, Vaccinium corymbosum, Aesculus pavia, Sebastiana fruticosa, Vaccinium elliottii, Campsis radicans, Vitis rotundifolia, Parthenocissus quinquefolius, Toxicodendron radicans*

Herbs: *Chasmanthium latifolium, Boehmeria cylindrica, Elymus hystrix, Viola* spp.

SYNONYMY: Palustrine, Forested, Broad-Leaved Deciduous, Temporarily Flooded (Cowardin et al.); Coastal Plain Levee Forest, Blackwater and Brownwater Subtypes (NCHP); Blackwater River and Swamp System, and Alluvial River and Swamp System, Coastal Plain (in part; Wharton)

RARE SPECIES: *Amorpha georgiana* var. *georgiana*, *Amorpha herbacea* var. *floridana*

COMMENTS: Riverbank/levee forests are found in areas which are frequently disturbed by shifting alluvium and the force of floodwaters. For this reason, species tolerant of physical disturbance (e.g., sweetgum, sycamore, river birch, water elm) are prevalent in this community. As levees become relictual or inactive due to changes in stream flows, riverbank/levee forests may succeed to more typical bottomland hardwood forest. Differences between the riverbank forests of blackwater and brownwater streams have not been studied extensively, but some researchers believe that forests along brownwater streams are characterized by higher diversity of plants.

Riverbank/Levee Forest

COMMUNITY TYPE: Salt Flat

NWI CLASSIFICATION CODE(S): E2US/EM1P

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Interdune flats and swales, and very shallow depressions at or above the upper limit of the intertidal zone; found adjacent to salt marsh, brackish marsh, sand bars/flats, or terrestrial dune communities, on barrier islands and the outer coastal fringe of the mainland.

SOILS: Sandy or loamy soils, very poorly drained, with high salt and sulfur content

HYDROLOGY: Estuarine, intertidal, irregularly flooded, hyperhaline.

GENERAL DESCRIPTION: A sparsely-vegetated wetland of upper intertidal or supratidal flats and shallow depressions, where periodic inundation by seawater and subsequent evaporation result in hyperhaline conditions. This wetland is characterized by a prevalence of succulent halophytic forbs such as saltwort, glasswort, and sea blite. Associated graminoids include salt grass, saltmarsh fimbristylis, and saltmarsh cordgrass. Shrubs are sparse, and trees are absent.

DOMINANT/INDICATOR PLANTS:

Shrubs: *Borrichia frutescens, Limonium carolinianum* (margins)

Herbs: *Batis maritima, Salicornia virginica, Salicornia europaea, Salicornia bigelowii, Distichlis spicata, Spartina bakeri, Sporobolus virginicus*

SYNONYMY: Estuarine, Intertidal, Unconsolidated Shore/Emergent, Irregularly Flooded (Cowardin et. al); Salt Marsh Grass (in part; Wharton); Salt Flat (NCHP); Salt Flats (COE);

RARE SPECIES: *Polygonum glaucum, Charadrius melodus, Charadrius wilsonia*

COMMENTS: Salt flats are harsh environments, with widely-fluctuating salinity and temperatures. They occupy relatively small, discrete areas within a larger matrix of coastal wetland and terrestrial communities. The extreme physical conditions associated with this community result in a very narrow, visually distinct ecotone. Often the center of small depressional salt flats are essentially unvegetated. These habitats are generally well-protected in Georgia, since they occur in areas that are unsuitable for construction or other uses.

COMMUNITY TYPE: Salt Marsh

NWI CLASSIFICATION CODE(S): E2EM1N

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Intertidal areas along the edges of tidal rivers, estuaries, and sounds, and on the mainland-facing sides of barrier islands.

SOILS: Poorly drained silty or sandy clay loams underlain by loamy sand, or organic soils underlain by clay or sand. Salt marsh soils usually have a high sulfur content. Soil salinity may range from hyperhaline to brackish, but is usually in the euhaline range in regularly inundated areas.

HYDROLOGY: Estuarine, intertidal, emergent, persistent, regularly flooded

GENERAL DESCRIPTION: A wetland community dominated by emergent grasses, sedges, and rushes that are inundated regularly by brackish to euhaline tidal waters. By far the most prevalent vascular plant in Georgia salt marshes is Spartina alterniflora, or smooth cordgrass. Other characteristic plants include black needlerush, sea lavender, sea oxeye daisy, salt grass, knotgrass, and saltmarsh aster. The substrate is typically loose, unconsolidated muck.

DOMINANT/INDICATOR PLANTS:

Herbs: *Spartina alterniflora*

SYNONYMY: Estuarine, Intertidal, Emergent, Persistent, Regularly Flooded (Cowardin); Low Salt Marshes (COE); Salt Marsh (NCHP); Smooth Cordgrass Marsh (Wharton);

RARE SPECIES: *Malaclemys terrapin, Ammodramus maritimus, Haematopus palliatus, Laterallus jamaicensis*

COMMENTS: Salt marshes are highly productive wetland ecosystems fed by rivers with inputs of nutrient-laden silt, organic materials, and organisms. The surface layer of the salt marsh soil has sufficient oxygen to allow aerobic respiration, but below the upper few centimeters aerobic conditions prevail. Minerals such as phosphorus and zinc are exchanged between the surface and subsurface sediments, and between the salt marsh and adjacent aquatic systems. Georgia's coastal areas contain approximately 241,000 acres of salt marsh. This floristically simple but productive system serves an important role as a nursery ground for fish, crustaceans, insects, and shellfish, and an important feeding ground for wading birds, shorebirds, raccoons,   Its distribution controlled by salinity, tidal influence, and elevation, the coastal salt marsh zone migrates according to changes in sea levels and sedimentation patterns along the coast.

Salt Marsh, McIntosh County along Sapelo River

COMMUNITY TYPE: Salt Shrub Thicket

NWI CLASSIFICATION CODE(S): E2SS1P, E2SS3/1P, E2SS3/4P

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Found immediately upslope of salt marsh or brackish marsh communities in coastal areas.

SOILS: Poorly drained silty or sandy loam underlain by loamy sand, organic soils underlain by clay or sand, or calcareous shell mounds covered by a thin layer of sand or muck.

HYDROLOGY: Estuarine, intertidal, irregularly flooded

GENERAL DESCRIPTION: A shrub-dominated estuarine community found along the upper border of salt marsh or brackish marsh. This wetland type is infrequently flooded by tidal action, and forms a broad ecotone between wetland and terrestrial environments. Typical shrubs include groundsel tree, marsh elder, yaupon holly, wax myrtle, Florida privet, and false willow. Herbs and trees are relatively sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Juniperus silicicola*

Shrubs: *Baccharis halimifolia, Iva frutescens, Ilex vomitoria, Baccharis angustifolia, Forestiera porulosa, Myrica cerifera*

Herbs: *Cynanchum palustre, Spartina bakeri, Scirpus americanus*

SYNONYMY: Estuarine, Intertidal, Scrub-shrub, Irregularly Flooded (Cowardin et al.); Salt Shrubs (COE); Edge Zone Marsh (Wharton); Salt Shrub (NCHP)

RARE SPECIES: *Malaclemys terrapin, Ammodramus maritimus, Laterallus jamaicensis*

COMMENTS: This wetland community is periodically flooded with brackish or euhaline waters, and may experience salt spray. Other forms of stress come from shifting substrate, and occasional fires spreading from upslope terrestrial habitats. These environmental factors apparently limit the growth of trees, resulting in a community dominated by halophytic shrubs. This community type is usually small in size, occupying a linear transition zone between more extensive wetland and upland communities. It is generally well-protected due to its location adjacent to salt marsh, but some salt shrub communities have been negatively impacted by residential and commercial development along the Georgia coast.

COMMUNITY TYPE: Sandhill Pond

NWI CLASSIFICATION CODE(S): Concentric zonation (outer area to central area) of PFO1/SS1C, PSS1/EM1F, PABH or PUBH

GEOGRAPHIC RANGE: Upper and Lower Coastal Plain

TOPOGRAPHIC SETTING: Depressional areas on top of sandhills

SOILS: Sandy soils with underlying hardpan or clay layer; generally not mapped on soil surveys

HYDROLOGY: Palustrine, seasonally to permanently flooded

GENERAL DESCRIPTION: A small, round to oblong upland depression pond on sandhills. Sandhill ponds typically have an outer zone of trees and shrubs; interior to this is a zone of emergent herbs and scattered shrubs. The center of some sandhill ponds is essentially open water, with floating macrophytes and sparse trees or shrubs. In other ponds, there is no obvious concentric zonation of vegetation. Sandhill ponds may have standing water (at least in the central zone) throughout the year, or may go dry during the summer.

DOMINANT/INDICATOR PLANTS:

Trees: *Nyssa biflora, Acer rubrum, Taxodium ascendens*

Shrubs: *Cephalanthus occidentalis, Cyrilla racemiflora, Lyonia lucida, Ilex myrtifolia*

Herbs: *Panicum hemitomum, Eleocharis equisetoides, Woodwardia virginica, Nuphar luteum, Nymphoides aquatica, Utricularia* spp.

SYNONYMY: Palustrine, Emergent/Scrub-Shrub/Aquatic Bed/Unconsolidated Shore/Unconsolidated Bottom, Seasonally to Permanently Flooded (Cowardin); Small Depression Pond (in part; NCHP); Vernal Pool (in part; NCHP)

RARE SPECIES: *Lindera melissaefolia, Litsea aestivalis, Myriophyllum laxum, Notophthalmus perstriatus, Rana capito*

COMMENTS: Sandhill ponds are physiognomically complex and seasonally variable. Water levels in these small ponds fluctuate widely throughout the year, and from one year to the next. Their topographic position and their small size contribute to this variability. Most of the water input to sandhill ponds comes directly from precipitation; relatively little comes from runoff or seepage from adjacent areas or from groundwater discharge. For this reason, these wetlands are generally nutrient-poor and low in organic materials. During the dry season fires may spread into these ponds from adjacent terrestrial sandhill communities. The combination of periodic fires and fluctuating water levels helps maintain the early successional aspect of these wetlands. In the absence of fire these wetland communities eventually develop significant organic layers and may become dominated by trees and shrubs. Sandhill ponds are often important breeding sites for amphibians, since they rarely contain predatory fish populations.

COMMUNITY TYPE: Tidal Freshwater Marsh

NWI CLASSIFICATION CODE(S): PEM1R, PEM1T

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Edges of tidally influenced rivers, upstream of the saltwater-freshwater mixing zone.

SOILS: Nearly level, poorly drained or very poorly drained organic or mineral soils underlain by sand or clay.

HYDROLOGY: Palustrine, tidal, regularly or irregularly flooded

GENERAL DESCRIPTION: A tidally influenced freshwater wetland dominated by emergent graminoids and forbs. Dominants may vary widely from site to site, but may include giant cutgrass, sawgrass, wild rice, pickerelweed, cattail, and arrow-arum. Many other persistent and nonpersistent herbs may be associated with this wetland type, in lower levels of abundance. Trees and shrubs are generally sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium distichum*

Shrubs: *Myrica cerifera, Hypericum* sp., *Baccharis halimifolia*

Herbs: *Zizaniopsis miliacea, Cladium jamaicense, Zizania aquatica, Pontedaria cordata, Typha domingensis, Typha latifolia, Peltandra virginica, Scirpus validus, Scirpus americanus, Eleocharis* spp., *Erianthus giganteus*

SYNONYMY: Palustrine, Emergent, Eersistent, Seasonally and Semipermanently Flooded Tidal (Cowardin et al.); Deep Marshes (in part; COE); River Marsh and Fresh Water Marsh (in part; Wharton); Tidal Freshwater Marsh (NCHP);

RARE SPECIES: *Physostegia leptophylla, Hibiscus grandiflorus, Ptlimnium macrospermum*

COMMENTS: This wetland type is naturally restricted to the margins of tidal rivers and large creeks above the brackish water zone. As such, its distribution over time depends on patterns of tidal stream flows, sea levels, and alluvial deposition patterns. Extensive areas of freshwater marsh can be found in old rice fields in the tidewater region, but these are anthopogenic (man-made) communities established over former tidal cypress-gum swamp. Many of these former rice fields are managed with dikes and water control structures to provide habitat for waterfowl. Under natural conditions, tidal freshwater swamps are enriched by nutrients from riverine alluvium, and from nutrients derived from seawater. Regularly flooded marshes are thought to be more productive than irregularly flooded marshes, due to higher rates of mineral sedimentation. In pre-settlement times, lightning-caused fires may have played a role in influencing the species composition of tidal freshwater marsh. The frequency of naturally occurring fires in this community type probably varied greatly from site to site, and was influenced by the type and extent of adjacent terrestrial communities.

COMMUNITY TYPE: Tidal River Swamp

NWI CLASSIFICATION CODE(S): PFO1/2T

GEOGRAPHIC RANGE: Lower Coastal Plain (Barrier Island Sequence)

TOPOGRAPHIC SETTING: Margins of lower reaches of tidal rivers and creeks along the Atlantic Coast

SOILS: Very poorly drained organic soils, or mineral soils underlain by sand or clay

HYDROLOGY: Palustrine, regularly to irregularly flooded by tidal action. Little or no salinity (usually < 0.5 ppt).

GENERAL DESCRIPTION: A forested wetland found along the lowermost reaches of tidal streams. The canopy is usually dominated by baldcypress and tupelo gum, but may also contain sweetgum, swamp blackgum, red maple, and loblolly pine. Understory trees and shrubs may include red maple, Carolina ash, swamp redbay, water elm, sweetbay, swamp palmetto, and swamp privet. The herb layer is relatively sparse.

DOMINANT/INDICATOR PLANTS:

Trees: *Taxodium distichum, Nyssa aquatica, Nyssa biflora, Liquidambar styraciflua, Acer rubrum, Pinus taeda, Fraxinus caroliniana, Persea palustris, Nyssa ogeche*

Shrubs/vines: *Forestiera acuminata, Alnus serrulata, Sabal minor, Planera aquatica, Cyrilla racemiflora, Decumaria barbara, Rosa palustris*

Herbs: *Onoclea sensibilis, Justicia ovata, Osmunda regalis, Osmunda cinnamomea, Woodwardia areolata, Arisaema draconitum, Peltandra virginica*

SYNONYMY: Palustrine, Forested, Broad-leaved Deciduous/Needle-leaved Deciduous, Tidally Flooded (Cowardin); Deep Marshes (in part; COE); Tidewater River and Swamp System (Wharton); Tidal Cypress-gum Swamp (NCHP)

COMMENTS: Tidal river swamps are strongly influenced by nutrient and organic material inputs from upstream areas, and by seawater-derived nutrients and sediments. These swamps are reportedly more productive than non-tidal river swamps. Most of Georgia's tidal river swamps were cut over in the early 1900's, and many of these stands have been cut again in the last several decades. The lower Altamaha, Ogeechee, Savannah, and Satilla rivers still contain extensive stands of tidal river swamp. Lewis Island, a tidally influenced area on the lower Altamaha River, contains a small stand of virgin baldcypress-tupelo gum swamp. These trees were not harvested during the early phase of timber cutting because of their inaccessibility. Today Lewis Island is protected as part of the State-owned Altamaha Wildlife Management Area.

Tidal River Swamp, Sapelo Island

COMMUNITY TYPE: Wet Pine Flatwoods

NWI CLASSIFICATION CODE(S): PFO4A, PFO4B

GEOGRAPHIC RANGE: Lower Coastal Plain (primarily Barrier Island Sequence, but also found in portions of Tifton Upland, Vidalia Upland, Bacon Terraces, and Okefenokee Basin districts)

TOPOGRAPHIC SETTING: Flats and very gently sloping terraces on Pleistocene sediments of the lower Coastal Plain, or broad flats near streams elsewhere.

SOILS: Nearly level, poorly drained to very poorly drained sandy soils, sometimes with thin organic layers. Examples include Pelham, Rains, and Leon soils.

HYDROLOGY: Palustrine, saturated to temporarily flooded.

GENERAL DESCRIPTION: A forested wetland dominated by slash pine and/or longleaf pine, with pond pine and loblolly pine much less prevalent. Understory trees are sparse in mature stands. The shrub layer is dense, with gallberry, saw palmetto, blueberries, huckleberries, and various scrub oaks. The herb layer may be sparse or patchy.

DOMINANT/INDICATOR PLANTS:

Trees: *Pinus palustris*, *Pinus elliottii*

Shrubs/vines: *Ilex glabra, Serenoa repens, Vaccinium corymbosum, Vaccinium myrsinites, Gaylussachia frondosa, Gaylussachia dumosa, Kalmia hirsuta*

Herbs: *Pteridium aquilinum, Aristida* spp.*, Panicum virgatum*

SYNONYMY: Palustrine, Forested, Needle-leaved Evergreen, Saturated or Temporarily Flooded (Cowardin); Low Pine Flatwoods (COE); Mesic Pine Flatwoods (Wharton); Wet Pine Flatwoods (NCHP)

RARE SPECIES: *Rhadinea flavilata*, *Heterodon simus, Asimina pygmaea, Asimina reticulata, Galactia floridana, Rhexia nuttallii, Rhynchospora culixa, Zephyrantes simpsonii*

COMMENTS: This community was formerly abundant throughout the lower Atlantic Coastal Plain. The presettlement forest of the Atlantic flatwoods region may have been dominated by longleaf pine. Generations of logging, farming, grazing, fire suppression and turpentining caused a decline of the slower-growing longleaf pines and favored slash pine. In the past several decades, thousands of acres of natural wet pine flatwoods have been logged over and converted to slash pine stands. While not as biologically diverse as pine savannas, wet pine flatwoods support a great variety of plants and animals. Fire is an essential element in maintaining this biological diversity. The dense shrub layer in this community supports fires of high intensity but recovers quickly from these fires. In the absence of fire this community type eventually succeeds to hardwood-dominated Forest.

Wet Pinewood Flatwoods

Appendix C. Coding System for LLWW Descriptors.

(Section 4 From "Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors" pp. 27-36; Tiner 2003a).

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Section 4. Coding System for LLWW Descriptors

The following is the coding scheme for expanding classification of wetlands and waterbodies beyond typical NWI classifications. When enhancing NWI maps/digits, codes should be applied to all mapped wetlands and deepwater habitats (including linears). At a minimum, landscape position (including lotic gradient), landform, and water flow path should be applied to wetlands, and waterbody type and water flow path to water to waterbodies. Wetland and deepwater habitat data for specific estuaries, lakes, and river systems could be added to existing digital data through use of geographic information system (GIS) technology.

Codes for Wetlands

Wetlands are typically classified by landscape position, landform, and water flow path. Landforms are grouped according to Inland types and Coastal types with the latter referring to tidal wetlands associated with marine and estuarine waters. Use of other descriptors tends to be optional. They would be used for more detailed investigations and characterizations.

<u>Landscape Position</u>

ES Estuarine
LE Lentic
LR Lotic river
LS Lotic stream
MA Marine
TE Terrene

<u>Lotic Gradient</u>

1 Low
2 Middle
3 High
4 Intermittent
5 Tidal
6 Dammed
  a lock and dammed
  b run-of-river dam
  c beaver
  d other dammed
7 Artificial (ditch)

Lentic Type

1	Natural deep lake (see also Pond codes for possible specific types)
a	main body
b	open empbayment
c	semi-enclosed embayment
d	barrier beach lagoon
2	Dammed river valley lake
a	reservoir
b	hydropower
c	other
3	Other dammed lake
a	former natural
b	artificial
4	Excavated lake
a	quarry lake
5	Other artificial lake

Estuary Type

1	Drowned river valley estuary
a	open bay (fully exposed)
b	semi-enclosed bay
c	river channel
2	Bar-built estuary
a	coastal pond-open
b	coastal pond-seasonally closed
c	coastal pond-intermittently open
d	hypersaline lagoon
3	River-dominated estuary
4	Rocky headland bay estuary
a	island protected
5	Island protected estuary
6	Shoreline bay estuary
a	open (fully exposed)
b	semi-enclosed
7	Tectonic
a	fault-formed
b	volcanic-formed
8	Fjord
9	Other

Inland Landform

SL	Slope	
SLpa		Slope, paludified
IL	Island*	
ILde		Island, delta
ILrs		Island, reservoir
ILpd		Island, pond
FR	Fringe*	
FRil		Fringe, island*
FRbl		Fringe, barrier island
FRbb		Fringe, barrier beach
FRpd		Fringe, pond
FRdm		Fringe, drowned river mouth
FP	Floodplain	
FPba		Floodplain, basin
FPox		Floodplain, oxbow
FPfl		Floodplain, flat
FPil		Floodplain, island
IF	Interfluve	
IFba		Interfluve, basin
IFfl		Interfluve, flat
BA	Basin	
BAcb		Basin, Carolina bay
BApo		Basin, pocosin
BAcd		Basin, cypress dome
BApp		Basin, prairie pothole
BApl		Basin, playa
BAwc		Basin, West Coast vernal pool
BAid		Basin, interdunal
BAwv		Basin, woodland vernal
BApg		Basin, polygonal
BAsh		Basin, sinkhole
BApd		Basin, pond
BAgp		Basin, grady pond
BAsa		Basin, salt flat
BAaq		Basin, aquaculture (created)
BAcr		Basin, cranberry bog (created)
BAwm		Basin, wildlife management (created)
BAip		Basin, impoundment (created)

BAfe	Basin, former estuarine wetland
BAff	Basin, former floodplain
BAfi	Basin, former interfluve
BAfo	Basin, former floodplain oxbow
BAdm	Basin, drowned river-mouth

FL Flat

FLsa	Flat, salt flat
FLff	Flat, former floodplain
FLfi	Flat, former interfluve

*Note: Inland slope wetlands and island wetlands associated with rivers, streams, and lakes are designated as such by the landscape position classification (e.g., lotic river, lotic stream, or lentic), therefore no additional terms are needed here to convey this association.

Coastal Landform

IL Island

ILdt	Island, delta
ILde	Island, ebb-delta
ILdf	Island, flood-delta
ILrv	Island, river
ILst	Island, stream
ILby	Island, bay

DE Delta

DEr	Delta, river-dominated
DEt	Delta, tide-dominated
DEw	Delta, wave-dominated

FR Fringe

FRal	Fringe, atoll lagoon
FRbl	Fringe, barrier island
FRbb	Fringe, barrier beach
FRby	Fringe, bay
FRbi	Fringe, bay island
FRcp	Fringe, coastal pond
FRci	Fringe, coastal pond island
FRhl	Fringe, headland
FRoi	Fringe, oceanic island
FRlg	Fringe, lagoon
FRrv	Fringe, river
FRri	Fringe, river island
FRst	Fringe, stream

FRsi Fringe, stream island

BA Basin
BAaq Basin, aquaculture (created)
BAid Basin, interdunal (swale)
BAst Basin, stream
BAsh Basin, salt hay production (created)
BAtd Basin, tidally restricted/road (not a management area)
BAtr Basin, tidally restricted/railroad (not a management area)
BAwm Basin, wildlife management (created)
BAip Basin, impoundment (created)

Water Flow Path

PA Paludified
IS Isolated
IN Inflow
OU Outflow
OA Outflow-artificial*
OP Outflow-perennial
OI Outflow-intermittent
TH Throughflow
TA Throughflow - artificial*
TN Throughflow - entrenched
TI Throughflow - intermittent
BI Bidirectional Flow - nontidal
BT Bidirectional Flow - tidal

*Note: To be used with wetlands connected to streams by ditches.

Other Modifiers (apply at the end of the code as appropriate)

br barren
bv beaver
ch channelized flow
cl coastal island (wetland on an island in an estuary or ocean including barrier islands)
cr cranberry bog
dd drainage divide
dr partly drained
ed freshwater wetland discharging directly into an estuary
fe former estuarine wetland
fg fragmented
fm floating mat
gd groundwater-dominated (apply to Water Flow Path only)

hi	severely human-induced
hw	headwater
li	lake island (wetland associated with a lake island)
md	freshwater wetland discharging directly into marine waters
ow	overwash
pi	pond island border
ri	river island (wetland associated with a river island)
sd	surface water-dominated (apply to Water Flow Path only)
sf	spring-fed
ss	subsurface flow
td	tidally restricted/road
tr	tidally restricted/railroad

(Note: "ho" was formerly used to indicate human-induced outflow brought about by ditch construction; now this is addressed by the water flow path "OA" Outflow-Artificial.)

Codes for Waterbodies (Deepwater Habitats and Ponds)

Besides Waterbody Type, waterbodies can be classified by water flow path (for lakes and ponds), estuary hydrologic type (for estuaries), and tidal range types (for estuaries and oceans).

Waterbody Type

RV River
- 1 low gradient
  - a connecting channel
  - b canal
- 2 middle gradient
  - a connecting channel
- 3 high gradient
  - a waterfall
  - b riffle
  - c pool
- 4 intermittent gradient
- 5 tidal gradient
- 6 dammed gradient
  - a lock and dammed
  - b run-of-river dammed
  - c other dammed

ST Stream
- 1 low gradient
  - a connecting channel
- 2 middle gradient
  - a connecting channel

3 high gradient
- a waterfall
- b riffle
- c pool

4 intermittent gradient
5 tidal gradient
6 dammed
- a lock and dammed
- b run-of-river dammed
- c beaver dammed
- d other dammed

7 artificial
- a connecting channel
- b ditch

LK Lake

1 natural lake (*see also Pond codes for possible specific types*)
- a main body
- b open empbayment
- c semi-enclosed embayment
- d barrier beach lagoon

2 dammed river valley lake
- a reservoir
- b hydropower
- c other

3 other dammed lake
- a former natural
- b artificial

4 other artificial lake

(Consider using a modifier to highlight specific lakes as needed, especially the Great Lakes, e.g., LK1E for Lake Erie or LK2O for Lake Ontario, and Lake Champlain, LK1C)

EY Estuary

1 drowned river valley estuary
- a open bay (fully exposed)
- b semi-enclosed bay
- c river channel

2 bar-built estuary
- a coastal pond-open
- b coastal pond-seasonally closed
- c coastal pond-intermittently open
- d hypersaline lagoon

3 river-dominated estuary

4 rocky headland bay estuary
- a island protected

5 island protected estuary
6 shoreline bay estuary
- a open (fully exposed)
- b semi-enclosed

7 tectonic
- a fault-formed
- b volcanic-formed

8 fjord
9 other

Note: If desired, you can also designate river channel (rc), stream channel (sc),and inlet channel (ic) by modifiers. *Examples*: EY1rc = Drowned River Valley Estuary river channel; EY2ic= Bar-built estuary inlet channel. If not, simply classify all estuarine water as a single type, e.g., EY1 for Drowned River Valley or EY2 for Bar-built Estuary.

OB Ocean or Bay
- 1 open (fully exposed)
- 2 semi-protected oceanic bay
- 3 atoll lagoon
- 4 other reef-protected waters
- 5 fjord

PD Pond
- 1 natural
  - a bog
  - b woodland-wetland
  - c woodland-dryland
  - d prairie-wetland (pothole)
  - e prairie-dryland (pothole)
  - f playa
  - g polygonal
  - h sinkhole-woodland
  - i sinkhole-prairie
  - j Carolina bay
  - k pocosin
  - l cypress dome
  - m vernal-woodland
  - n vernal-West Coast
  - o interdunal
  - p grady
  - q floodplain
  - r other

2	dammed/impounded	
a		agriculture
a1		cropland
a2		livestock
a3		cranberry
b		aquaculture
b1		catfish
b2		crayfish
c		commercial
c1		commercial-stormwater
d		industrial
d1		industrial-stormwater
d2		industrial-wastewater
e		residential
e1		residential-stormwater
f		sewage treatment
g		golf
h		wildlife management
i		other recreational
o		other
3	excavated	
a		agriculture
a1		cropland
a2		livestock
a3		cranberry
b		aquaculture
b1		catfish
b2		crayfish
c		commercial
c1		commercial-stormwater
d		industrial
d1		industrial-stormwater
d2		industrial-wastewater
e		residential
e1		residential-stormwater
f		sewage treatment
g		golf
h		wildlife management
i		other recreational
j		mining
j1		sand/gravel
j2		coal
o		other
4	beaver	
5	other artificial	

Water Flow Path

IN	Inflow
OU	Outflow
OA	Outflow-artificial*
OP	Outflow-perennial
OI	Outflow-intermittent
TH	Throughflow
TA	Throughflow-artificial*
TI	Throughflow-intermittent*
TN	Throughflow-entrenched
BI	Bidirectional-nontidal
IS	Isolated
MI	Microtidal
ME	Mesotidal
MC	Macrotidal

*Note: OA and TA are human-caused by ditches; TI is to be used with throughflow ponds along intermittent streams.

Estuarine Hydrologic Circulation Type

SW	Salt-wedge/river-dominated type
PM	Partially mixed type
HO	Homogeneous/high energy type

Other Modifiers (apply at end of code)

ch	Channelized or Dredged
dv	Diverted
ed	freshwater stream flowing directly into an estuary
fv	Floating vegetation (on the surface)
lv	Leveed
md	freshwater stream flowing directly into marine waters
sv	Submerged vegetation

Appendix D. Predicting Wetland Functions at the Landscape Level for Coastal Georgia Using NWIPlus Data. (Tiner 2011)

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U.S. Fish & Wildlife Service

Predicting Wetland Functions at the Landscape Level for Coastal Georgia Using NWIPLUS Data

Cover: Salt marsh on Little St. Simons Island (R. Tiner photograph).

Predicting Wetland Functions at the Landscape Level for Coastal Georgia Using NWIPlus Data

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Introduction

The Georgia Department of Natural Resources (GA DNR) has recently updated National Wetlands Inventory (NWI) data for the state's six coastal counties. The U.S. Fish and Wildlife Service (Service) has recognized the potential application of NWI data for watershed assessments, but realized that other attributes would have to be added to the data to facilitate functional analysis. In the early 1990s, Dr. Mark Brinson conceived a hydrogeomorphic approach to wetland functional assessment that uses comparison of field-verified properties of existing wetlands to those from a set of reference wetlands as a means of assessing a wetland's proximity to or departure from reference condition (Brinson 1993a). This approach provided the impetus for the Service to develop other attributes to expand the NWI database and make it more useful as a tool for landscape-level functional assessment of wetlands.

In the mid-1990s, the NWI developed a set of abiotic descriptors to describe a wetland's landscape position, landform, water flow path, and waterbody type (LLWW descriptors; Tiner 1995, 1996a, b). Use of the initial set of keys for pilot watershed projects led to a refinement and expansion of the keys in subsequent years (Tiner 1997a, b, 2000, 2002, 2003a). The expanded NWI database is called NWIPlus because it significantly increases the amount of information collected for mapped wetlands (Tiner 2010). These data allow for improved characterization of wetlands across the landscape and make it possible to predict wetland functions at the landscape, watershed, or regional scale. Numerous projects have created NWIPlus data and used the data to better describe wetlands in watersheds or other specific geographic areas and produce preliminary assessments of wetland functions (Table 1). In conducting these studies in the Northeast, the Service worked with local and regional wetland experts to develop relationships between wetland characteristics recorded in the database and wetland functions. The results reflect our best approximation of what types of wetlands are likely to perform certain functions at significant levels based on the characteristics in the NWIPlus database. Besides the Service's applications of these techniques, several states have been building NWIPlus or similar databases or have plans to conduct at least a pilot study including Kansas, Michigan, Minnesota, Montana, New Mexico, and Wisconsin (Tiner 2010). The State of Delaware has worked with the Service to update NWI data and create a statewide NWIPlus database, and will use the information to produce a series of reports on wetland status, recent and historic trends, wetland functions, and potential wetland restoration sites. *Note: NWIPlus databases are not a standard product of the NWI Program as the program's mapping funds are extremely limited. Creation of such databases is done where user-funded or as part of NWI updates by the Service on a case-by-case basis depending on available funding and regional priorities.*

Table 1. Areas where the Service created a NWIPlus database and where functions have been analyzed or are planned for analysis. (* - functional assessment planned for 2011.)

State	Project Area	Approximate Area (square miles)
Alaska	Anchorage C7 quadrangle*	232
California	Ventura River watershed	232
Connecticut	entire state (planned)*	4,900
Delaware	entire state*	1,900
	Nanticoke watershed	490
Maine	Casco Bay	1,216
Maryland	Coastal Bays watershed	296
	Nanticoke watershed	323
Massachusetts	Boston Harbor and vicinity	232
	Cape Cod and the Islands	665
Minnesota	Fond du Lac reservation*	158
Mississippi	Coastal zone*	1,450
New Jersey	entire state*	7,500
	Hackensack River watershed	197
New York	Greater Buffalo area*	1,200
	Catherine Creek watershed	100
	Catskill watershed	571
	Croton watershed	391
	Cumberland Bay watershed	55
	Delaware River watershed	1,013
	Hackensack River watershed	197
	Hudson River-Snook Kill watershed	254
	Peconic River watershed	92
	Post Creek-Sing Sing Creek watershed	59
	Salmon River-So. Sandy Creek watershed	117
	Sodus Creek watershed	54
	Sodus Bay-Wolcott Creek watershed	65
	Sucker Brook-Grass River watershed	124
	Upper Tioughnioga River watershed	270
	Upper Wappinger Creek watershed	136
	Long Island*	1,400
Pennsylvania	Delaware River and Lake Erie coastal zones	113
Rhode Island	entire state*	1,100
South Carolina	Horry and Jasper Counties*	3,100
Texas	Corpus Christi area*	1,900
Vermont	Southern part of state*	580
Wyoming	Shirley Basin*	290

The State of Georgia recently added LLWW descriptors to their updated wetland inventory data to create an NWIPlus database for six coastal counties. The NWIPlus data will be used to better characterize wetlands in this region and to be able to predict wetland functions at the landscape level. In order to do the latter, the relationships (formerly called correlations) developed for use in the northeastern United States were introduced to and reviewed by a group of Georgia scientists from federal, state, and local agencies, non-profit organizations, and academic institutions at an August 31, 2010 workshop on Little St. Simons Island. The peer group provided comments that were used to re-evaluate the relationships and tailor them to coastal Georgia. In cases where there were differences in opinions, the points were considered and decisions were made by consensus between the Coastal Resources Division of the Georgia Department of Natural Resources, Atkins North America (formerly PBS&J Inc., Raleigh, NC), and Ralph Tiner (U.S. Fish and Wildlife Service, Region 5, Hadley, MA).

The purpose of this report is to explain how the NWIPlus data could be and was used for predicting wetland functions at the landscape-level for coastal Georgia and the rationale for assigning certain biotic and/or abiotic characteristics to eleven wetland functions: 1) surface water detention, 2) coastal storm surge detention, 3) streamflow maintenance, 4) nutrient transformation, 5) carbon sequestration, 6) sediment and other particulate retention, 7) bank and shoreline stabilization, 8) provision of fish and aquatic invertebrate habitat, 9) provision of waterfowl and waterbird habitat, 10) provision of other wildlife habitat, and 11) provision of habitat for unique, uncommon or highly diverse wetland plant communities.

Creating the NWIPlus Database

A set of abiotic attributes have been developed to increase the information contained in the NWI database and to create a NWIPlus database. Four groups of attributes describe:

- landscape position (relationship of a wetland to a waterbody if present: marine—ocean, estuarine—tidal brackish, lotic—river/stream, lentic—lake/reservoir, and terrene—not significantly affected by such waters, or no waterbody present, or the source of a stream);
- landform (physical shape of the wetland—basin, flat, floodplain, fringe, island, and slope);
- water flow path (inflow, outflow, throughflow, isolated, bidirectional-nontidal, and bidirectional-tidal); and
- waterbody type (different types of estuaries, rivers, lakes, and ponds).

Collectively, they are known as LLWW descriptors, which represent the first letter of each descriptor (landscape position, landform, water flow path, and waterbody type). Dichotomous keys have been developed to interpret these attributes (Tiner 2003b; they will be amended in 2011 to reflect results of recent applications). Other modifiers are also included in these keys to further describe wetland characteristics. LLWW descriptors are added to the NWI database by interpreting topography from digital raster graphics (DRGs) or digital elevation model data (DEMs), stream courses from the National Hydrography Dataset (NHD) and/or aerial imagery, and waterbody types from aerial imagery (Figure 1). The interpretations are done by employing some automated GIS-routines coupled with manual review and interpretation by wetland specialists. This effort now increases the NWI workload by less than 10 percent.

The NWIPlus database adds value and increases the functionality of the original NWI database. Besides providing more features that can be used to predict wetland functions from the NWI database, NWIPlus makes it possible to better characterize the nation's wetlands. For example, all the palustrine wetlands, which account for 95 percent of the wetlands in the conterminous United States, can now be linked to rivers, streams, lakes, and ponds where appropriate, so that the acreage of floodplain wetlands, lakeside wetlands, and geographically isolated wetlands can be reported. The Wetlands Subcommittee of the Federal Geographic Data Committee (FGDC) recognized the value added by the LLWW descriptors and recommended that they be included in wetland mapping to increase the functionality of wetland inventory databases (FGDC Wetlands Subcommittee 2009).

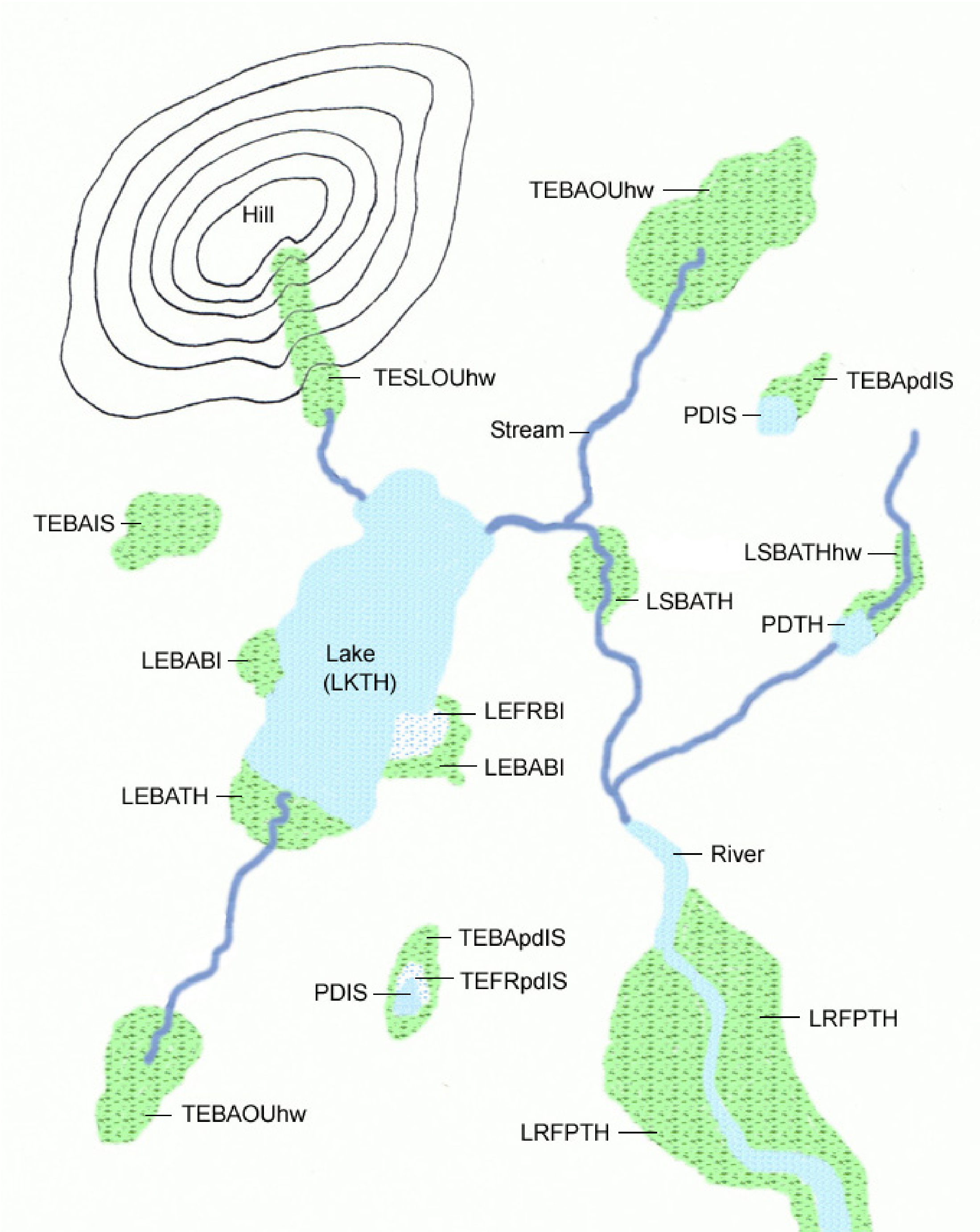

Figure 1. Examples of application of LLWW descriptors to nontidal wetlands. Coding: Landscape position = LE – Lentic, TE – Terrene, LR – Lotic River, LS – Lotic Stream; Landform = BA – Basin, FP – Floodplain, FR – Fringe, SL – Slope; Water Flow Path = BI – Bidirectional-nontidal, IS – Isolated, OU – Outflow, TH – Throughflow; Other descriptors: PD – Pond, LK – Lake, hw – headwater, and pd – pond-bordering wetland. Note: If desired, ponds and lakes can be further classified with landscape position resulting in codes of TEPDIS for the isolated ponds and LSLKTH for the lake shown in this figure.

Limitations of the Preliminary Wetland Functional Assessment

Source data are a primary limiting factor for landscape-level functional assessment. NWI digital data and existing stream data (e.g., National Hydrography Dataset) are used as the foundation for these assessments. All wetland and stream mapping has limitations due to scale, photo quality, date of the survey, and the difficulty of photointerpreting certain wetland types (especially evergreen forested wetlands and drier-end wetlands; see Tiner 1997c, 1999 for details) and narrow or intermittent streams especially those flowing through dense evergreen forests and beneath built-up lands.

Recognizing source data limitations, it is equally important to understand that this type of functional assessment is a preliminary one based on wetland characteristics interpreted through remote sensing and using the best professional judgment of various specialists to develop relationships between wetland characteristics in the database and wetland functions. It is designed for landscape- or watershed-level assessments covering large geographic areas.

Wetlands are rated based on their biotic or abiotic characteristics as having high or moderate potential for supporting a wetland function. Wetlands not assigned a rating are assumed to have little or no potential for providing such function at a significant level. The ratings are based on a review of the literature and best professional judgment by numerous scientists studying wetlands from public agencies, private non-government organizations, and academia. Also, no attempt is made to produce a more qualitative ranking for each function (comparing to a “reference” type representing a wetland of the type in the “best” condition, or on size or the degree to which it actually performs a function given opportunity and adjacent land uses) or for each wetland based on multiple functions as this would require more input from others and more data, well beyond the scope of this type of broad-scale evaluation. For a technical review of wetland functions, see Mitsch and Gosselink (2007) and for a broad overview, see Tiner (2005a).

Functional assessment of wetlands can involve many parameters. Typically such assessments have been done in the field on a case-by-case basis, considering observed features relative to those required to perform certain functions or by actual measurement of performance. The preliminary assessments based on remotely sensed information do not seek to replace the need for field evaluations since they represent the ultimate assessment of the functions for individual wetlands. Yet, for a watershed analysis, basin-wide field-derived assessments are not practical, cost-effective, or even possible given access considerations. For watershed planning purposes, a more generalized assessment (level 1 assessment) is worthwhile for targeting wetlands that may provide certain functions, especially for those functions dependent on landscape position, landform, hydrologic processes, and vegetative life form (Brooks et al. 2004). Subsequently, these results can be field-verified when it comes to actually evaluating particular wetlands for acquisition purposes (e.g., for conserving biodiversity or for preserving flood storage capacity) or for project impact assessment. Current aerial photography may also be examined to aid in further evaluations (e.g., condition of wetland/stream buffers or adjacent land use) that can supplement the preliminary assessment.

The landscape-level functional assessment approach -"Watershed-based Preliminary Assessment of Wetland Functions" (W-PAWF) - applies general knowledge about wetlands and their functions to develop a watershed overview that highlights possible wetlands of significance in terms of performance of various functions. To accomplish this objective, the relationships between wetlands and various functions are simplified into a set of practical criteria or observable characteristics. Such assessments may be further expanded to consider the condition of the associated waterbody and the neighboring upland or to evaluate the opportunity a wetland has to perform a particular function or service to society, for example.

W-PAWF does not account for the opportunity that a wetland has to provide a function resulting from a certain land-use practice upstream or the presence of certain structures or land-uses downstream. For example, two wetlands of equal size and like vegetation may be in the right landscape position to retain sediments. One, however, may be downstream of a land-clearing operation that has generated considerable suspended sediments in the water column, while the other is downstream from an undisturbed forest. The former should be actively performing sediment trapping in a major way, whereas the latter is not. Yet if land-clearing takes place in the latter area, the second wetland will likely trap sediments as well as the first wetland. The entire analysis typically tends to ignore opportunity since such opportunity may have occurred in the past or may occur in the future and the wetland is there to perform this service at higher levels when necessary.

W-PAWF also does not consider the condition of the adjacent upland (e.g., level of disturbance) or the actual water quality of the associated waterbody that may be regarded as important metrics for assessing the health of individual wetlands. Collection and analysis of these data may be done as a follow-up investigation, where desired.

It is important to re-emphasize that the preliminary assessment does not obviate the need for more detailed assessments of the various functions and assessment of wetland condition and opportunities to provide more benefits given the state of the contributing watershed and adjacent land use activities. This preliminary assessment should be viewed as a starting point for more rigorous assessments, since it attempts to cull out wetlands that may likely provide significant functions based on generally accepted principles and the source information used for this analysis. This assessment is most useful for regional or watershed planning purposes, for a cursory screening of sites for acquisition, and to aid in developing landscape-level wetland conservation and protection strategies. It can also be used to evaluate cumulative impacts on wetlands on key functions as was done for the Nanticoke River watershed on the Delmarva Peninsula (Tiner 2005b) or to consider the national and regional-scale impacts of policy changes on certain wetland types (e.g., geographically isolated wetlands or headwater wetlands, or determining significant nexus to waters of the United States). For site-specific evaluations, additional work will be required, especially field verification and collection of site-specific data for potential functions (e.g., following the hydrogeomorphic assessment approach as described by Brinson 1993a or other onsite evaluation procedures, e.g., rapid field assessment). This is particularly true for assessments of fish and wildlife habitats and biodiversity. Other sources of data may exist to help refine some of the findings of this report (e.g., state natural heritage data). Additional modeling could be done, for example, to identify habitats of likely significance to individual species of animals based on their specific life history requirements (see U.S. Fish and Wildlife Service 2003 for Gulf of Maine habitat analysis).

Also note that the criteria used for the relationships were based on Georgia's application of the Service's wetland classification (Cowardin et al. 1979). Regional applications of this system may differ slightly depending on regional priorities, level of field effort, and knowledge of wetland ecology. Use of the relationships in other regions of the country therefore may require some adjustment based on these considerations.

Through this analysis, numerous wetlands are predicted to perform a given function at a significant level presumably important to a watershed's ability to provide that function. "Significance" is a relative term and is used in this analysis to identify wetlands that are likely to perform a given function at a high or moderate level. It is also emphasized that the assessment is limited to wetlands (i.e., areas classified as wetlands on NWI maps). Deepwater habitats and streams were not included in the assessment, although their inherent value to wetlands and many wetland-dependent organisms is apparent.

Rationale for Preliminary Functional Assessments

The W-PAWF approach ("watershed-based preliminary assessment of wetland functions") is intended to produce a more expansive characterization of wetlands and their likely functions and data that can be used to help rank wetlands for acquisition, protection, or other purposes. Presently, a maximum of eleven functions may be evaluated: 1) surface water detention, 2) coastal storm surge detention, 3) streamflow maintenance, 4) nutrient transformation, 5) carbon sequestration, 6) sediment and other particulate retention, 7) bank and shoreline stabilization, 8) provision of fish and aquatic invertebrate habitat, 9) provision of waterfowl and waterbird habitat, 10) provision of other wildlife habitat, and 11) provision of habitat for unique, uncommon, or highly diverse wetland plant communities. The criteria used for identifying wetlands of significance for each of these functions using Georgia's NWIPlus database are discussed below. The criteria and ratings were initially developed for northeastern wetlands by the author of this report based on his knowledge of wetland characteristics and functions. The draft criteria were then reviewed and modified for various watersheds based on comments from wetland specialists working on specific watersheds in four Northeast states (Maine, New York, Delaware, and Maryland). While many of the criteria are universally applicable, when applying NWIPlus data to other regions for landscape-level functional assessment, the criteria and ratings should be reviewed. For coastal Georgia, a workshop sponsored by the Georgia Department of Natural Resources was conducted on August 31, 2010 to get input from local experts on the applicability of these relationships for tidal and nontidal wetlands in six coastal counties (see Acknowledgments for participants). The actual application of the Cowardin et al. (1979) classification also needed to be considered as there may be differences in the level of classification for individual projects, such as the use of water regime indicators that could affect functional ratings.

In developing a protocol for designating wetlands of potential significance, wetland size was generally disregarded from the criteria, with few exceptions (i.e., other wildlife habitat and biodiversity functions). This approach was followed because it was felt that individual agencies and organizations using the digital database and charged with setting priorities should make the decision on appropriate size criteria as a means of limiting the number of priority wetlands as necessary. There is no science-based size limit to establish significance for any function. However, it is obvious that, all things being equal, a larger wetland will have a higher capacity to perform a given function than a smaller one of the same type, although it is recognized that certain wildlife species (e.g., amphibians) require a multitude of small wetlands to maintain their local populations given vagaries of weather and its effect on habitat suitability.

After discussing a particular function and the wetland types that are likely to perform that function, a list of wetland types is given for two levels of function. These types were determined to have the potential to perform the subject function at a significant level.
ATTENTION: *The types that are underlined are types that were actually mapped during the inventory and will be displayed on the wetland function maps for coastal Georgia. The other types (not underlined) are other wetlands that may perform that function at the specified level, however no wetlands were classified as these types during this survey.*

Surface Water Detention

This function is important for reducing downstream flooding and lowering flood heights, both of which aid in minimizing property damage and personal injury from such events. In a landmark study on the relationships between wetlands and flooding at the watershed scale, Novitzki (1979) found that watersheds with 40 percent coverage by lakes and wetlands had significantly reduced flood flows -- lowered by as much as 80 percent -- compared to similar watersheds with no or few lakes and wetlands in Wisconsin. The same principles apply to Georgia where studies have shown that watersheds with an abundance of wetlands moderate flood flows more than those with less wetland (Wharton 1970). After heavy rains, the former watersheds take longer to reach peak water levels and have less fluctuation than the latter watersheds which reach their peaks more quickly, produce higher peaks, and tend to have more swift flows.

For purposes of landscape-level functional assessment following W-PAWF, this function will be restricted to surface water storage of nontidal waters. Floodplain wetlands and other lotic wetlands (basin and flat types) provide this function at significant levels. While tidal wetlands along rivers serve at times to attenuate freshwater flood flows from upstream watersheds, they are excluded from this function because they are subjected to frequent tidal flooding. The water storage function of tidal wetlands for detaining storm surges is evaluated separately via the coastal storm surge detention function. Stormwater detention ponds are designed for temporary storage of surface water and are recognized as having a high level of performance for this function.

Wetlands dominated by trees and/or dense stands of shrubs could be deemed to provide a higher level of this function than emergent wetlands, since woody vegetation (with higher frictional resistance) may further aid in flood desynchronization. However, emergent wetlands along waterways provide significant flood storage, so no distinction is made regarding the type of vegetative cover. Floodplain width could also be an important factor in evaluating the significance of performance of this function by individual wetlands (e.g., for acquisition or strengthened protection), but there is no scientifically based criterion for establishing a significance threshold based on size. Drier-end wetlands (e.g., flats), and isolated basins are rated as having moderate potential.

For this function, the following relationships are used:

High	Lentic Basin, Lentic Fringe, Lentic Island (basin and fringe), Lentic Flat associated with reservoirs and flood control dams, Lotic Stream Basin, Lotic Floodplain-basin, Lotic River Fringe, Lotic Stream Fringe (not "A" water regime), Lotic River Island-basin, Ponds Throughflow (in-stream) and associated Fringe and Basin wetlands, Terrene Throughflow Basin, Stormwater Treatment Ponds

Moderate — Lotic River Floodplain-flat, Lotic River Fringe (other than above), Lotic Stream Fringe (other than above), Lotic Stream Flat, Lotic River Island-flat, Lentic Flat, Other Terrene Basins, Other Ponds and associated wetlands (excluding sewage treatment ponds and isolated impoundments), Terrene wetland associated with ponds (TE__pd__, excluding isolated diked ponds), Terrene Flat

Note: Exclude the following: 1) artificially flooded wetlands ("K" water regime, unless they are in a reservoir or dammed lake), 2) isolated impounded ponds and associated wetlands, 3) any freshwater tidal wetlands that are in the Lotic landscape position, and 4) any seasonally saturated wetlands ("B" water regime) from this function.

Coastal Storm Surge Detention

This function is listed separately from Surface Water Detention to highlight the importance of tidal wetlands and adjacent lowland wetlands at storing tidal waters brought into estuaries by storms (e.g., tropical storms and hurricanes). Estuarine and freshwater tidal wetlands are important areas for temporary storage of this water. Some nontidal wetlands contiguous to these wetlands (e.g., low-lying terrene outflow basins - flatwoods) may also provide this function, but do so only during the most extreme storm events, so they were rated as moderate for this function. Note that tidal wetlands along rivers may also be important for attenuating freshwater floodwaters resulting from heavy precipitation events upstream in the watershed.

For this function, the following relationships are used:

High — Estuarine Basin, Estuarine Fringe, Estuarine Island, Lotic Tidal Fringe, Lotic Tidal Island, Lotic Tidal Floodplain, Marine Fringe, Marine Island

Moderate — Other tidal wetlands not included above plus any Terrene wetland (excluding SL – slope wetland) with "ed" modifier (nontidal wetlands contiguous with estuarine wetlands discharging and likely subject to infrequent or occasional flooding by storm tides) or with "ow" modifier (overwash)

Streamflow Maintenance

There are four main sources of water to support stream flow: 1) groundwater, 2) interflow through the soil, 3) precipitation, and 4) surface water runoff. Groundwater provides water for base flows. Many wetlands are sources of groundwater discharge and those located in headwater positions either the source of streams or along low-order perennial streams contribute significantly to sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. The importance of maintaining natural streamflow patterns is important to riparian vegetation as well as to resident aquatic species and altering those patterns can negatively impact local biodiversity (Cowell and Stoudt 2002).

All wetlands classified as headwater wetlands are important for streamflow. Terrene headwater wetlands, by definition, are sources of streams. They contribute groundwater (base flow) from local unconfined aquifers and regional confined aquifers to support streamflow (Priest 2004). Other headwater wetlands include lotic wetlands along 1st-order streams and lentic wetlands associated with outflow lakes. Wetlands along 2nd-order streams in mountainous areas may be classified as headwater wetlands as they probably are sites of groundwater discharge, but these conditions do not apply to the Georgia coastal region since Georgia's mountains are much further inland. Ditched headwater wetlands are rated as moderate, since this alteration typically results in faster release of water, thereby reducing the period of outflow. Outflow from groundwater-fed wetlands (lacking a stream) may discharge directly into streams and thereby contribute variable quantities of water for sustaining baseflows. These wetlands were rated as moderate for this function. Lakes may also be important regulators of streamflow, so lentic wetlands may be designated as significant to streamflow, with those in headwater positions being rated high and others as moderate.

Floodplain wetlands are known to store water in the form of bank storage, later releasing this water to maintain baseflows (Whiting 1998). Among several key factors affecting bank storage are porosity and permeability of the bank material, the width of the floodplain, and the hydraulic gradient (steepness of the water table). It is recognized that the wider the floodplain, the more bank storage given the same soils. Gravel floodplains drain in days, sandy floodplains in a few weeks to a few years, silty floodplains in years, and clayey floodplains in decades. In good water years, wide sandy floodplains may help maintain baseflows. Bank stratigraphy is another factor that could be considered important for streamflow maintenance (Christopher Cirmo, pers. comm. 2006). For example, the presence of a "sand" layer between clay layers (such as in a system where there have been historical floods) may affect the transmissivity of the bank. Bank storage may serve to maintain streamflow in some fringe or floodplain wetlands, however a rudimentary knowledge of the surficial stratigraphy is not normally available based solely on remote data interpretation. Despite the variability in floodplain properties, the W-PAWF assessment treats all nontidal floodplain wetlands and stream basins as having potential to support streamflow, since remote sensing data does not include soil examinations or bank stratigraphy and there is no recognized floodplain width designated to separate high from moderate potential.

While diked ponds may contribute to streamflow when water overflows spillways or exceeds height of water-control structures, these ponds typically reduce streamflow (McMurray 2007, Van Liew 2004). However, some ponds may extend storm-flow over longer durations by reducing peak flows (Bosch et al. 2003). Since impounded ponds are artificially created waters that substantially alter natural streamflow characteristics they are not included as significant for streamflow maintenance.

For this function, the following relationships are used:

High	<u>Unaltered Headwater Wetlands and Headwater Ponds (latter are natural ponds not created or altered)</u>

Moderate Ditched or excavated Headwater Wetlands (not impounded), Lotic River (nontidal) Floodplain (excluding impounded or ditched), Lotic Stream (nontidal) Basin (excluding impounded or ditched), Terrene Basin Outflow wetlands (associated with streams not major rivers; excluding impounded or ditched)

Note: Diked wetlands and ponds and excavated ponds should be excluded from this function.

Special Note: All wetlands important for streamflow maintenance should be considered to also be important for fish and aquatic invertebrates as they are vital to sustaining streamflow necessary for the survival of these aquatic organisms.

Nutrient Transformation

All wetlands recycle nutrients, but those having a fluctuating water table and corresponding changes from aerobic to anaerobic conditions are best able to recycle nitrogen and other nutrients. While vegetation slows the flow of water causing deposition of mineral and organic particles with adsorbed nutrients (nitrogen and phosphorus), hydric soils are the places where chemical transformations occur (Carter 1996). Microbial action in the soil is the driving force behind chemical transformations in wetlands. Microbes need a food source to survive and reproduce and in wetlands organic matter provides this needed sustenance. Wetlands with high amounts of organic matter should have an abundance of microflora to perform the nutrient cycling function. Wetlands are so effective at filtering and transforming nutrients that artificial wetlands are constructed for water quality renovation (e.g., Hammer 1992). Natural wetlands performing this function help improve local water quality of streams and other watercourses. Oyster reefs are also recognized as important components for nitrogen cycling in estuaries (Dame et al. 1985, Dame and Libes 1993, Fulford et al. 2010).

Numerous studies have demonstrated the importance of wetlands in denitrification. Simmons et al. (1992) found high nitrate removal (greater than 80%) from groundwater during both the growing season and dormant season in Rhode Island streamside (lotic) wetlands. Groundwater temperatures throughout the dormant season were between 6.5 and 8.0 degrees C, so microbial activity was not limited by temperature. Even the nearby upland, especially transitional areas with somewhat poorly drained soils, experienced an increase in nitrogen removal during the dormant season. This was attributed to a seasonal rise in the water table that exposed the upper portion of the groundwater to soil with more organic matter (nearer the ground surface), thereby supporting microbial activity and denitrification. Riparian forests dominated by wetlands have a greater proportion of groundwater (with nitrate) moving within the biologically active zone of the soil that makes nitrate available for uptake by plants and microbes (Nelson et al. 1995). Riparian forests on well-drained soils are much less effective at removing nitrate. In a Rhode Island study, Nelson et al. (1995) found that November had the highest nitrate removal rate due to the highest water tables in the poorly drained soils, while June experienced the lowest removal rate when the deepest water table levels occurred. Similar results can be expected to occur elsewhere. For bottomland hardwood wetlands, DeLaune et al. (1996) reported decreases in nitrate from 59-82 percent after 40 days of flooding wetland soil cores taken from the Cache River floodplain in Arkansas. Moreover, they surmised that denitrification in these soils appeared to be carbon-limited: increased denitrification took place in soils with more organic matter in the surface layer. Nitrogen removal rates for freshwater wetlands are very high (averaging from 20-80 grams/square meter) (Bowden 1987).

Nitrogen fixation has been attributed to blue-green algae in the photic zone at the soil-water interface and to heterotrophic bacteria associated with plant roots (Buresh et al. 1980). In working with rice, Matsuguchi (1979) believed that the significance of heterotrophic fixation in the soil layer beyond the roots has been underrated and presented data showing that such zones were the most important sites for nitrogen fixation in a Japanese rice field. This conclusion was further supported by Wada et al. (1978). Higher fixation rates have been found in the rhizosphere of wetland plants than in dryland plants. Nitrogen fixation converts atmospheric nitrogen to a usable form for plants and helps enrich soils. Plants with the ability to fix nitrogen (e.g., with symbiotic bacteria on root nodules) can thereby grow in otherwise inhospitable nutrient-poor soils.

From the water quality standpoint, wetlands associated with watercourses are probably the most noteworthy. Numerous studies have found that forested wetlands along rivers and streams ("riparian forested wetlands") are important for nutrient retention and sedimentation during floods (Whigham et al. 1988; Yarbro et al. 1984; Simpson et al. 1983; Peterjohn and Correll 1982). This function by forested riparian wetlands is especially important in agricultural areas. Brinson (1993b) suggested that riparian wetlands along low-order streams may be more important for nutrient retention than those along higher order streams.

Most of the groundwater flux from uplands to surface waters occurs in the non-growing season in the Northeast and reasonable denitrification rates occur in spring and fall making sites that are wet during these times important for nutrient retention (Art Gold, pers. comm. 2003). Wetlands with seasonally flooded and wetter water regimes (including tidal regimes - seasonally flooded-tidal, irregularly flooded, and regularly flooded) are identified as having potential to recycle nutrients at high levels of performance. The soils of these wetlands should have substantial amounts of organic matter near the surface to promote microbial activity and denitrification when wet. Based on field observations, in general, there is a positive correlation between the amount of organic matter and the degree of wetness as reflected by the NWI's water regime classification in wetlands of the Nanticoke River watershed in Delaware (Amy Jacobs, pers. comm. 2003). Periodically flooded soils also retain sediments and their adsorbed nutrients.

Drier-end wetlands -- those with a temporarily flooded water regime (including temporarily flooded-tidal) and others with a seasonally saturated water regime -- are considered as having moderate potential for performing this function, since they are relatively dry for most of the year.

For this function, relationships are the following:

High	<u>Vegetated wetlands</u> (and mixes with nonvegetated wetlands or unconsolidated bottom; only where vegetated predominates) <u>with seasonally flooded (C), semipermanently flooded (F), semipermanently flooded-tidal (T), seasonally flooded-tidal (R), irregularly flooded (P), regularly flooded (N), and permanently flooded (H or L) water regimes</u>, estuarine intertidal oyster reefs, <u>Vegetated wetlands with a *permanently saturated* water regime</u>
Moderate	<u>Vegetated wetlands with *seasonally saturated* (B *on the coastal plain*), temporarily flooded (A) or temporarily flooded-tidal (S)</u>

water regimes; nonvegetated/vegetated wetlands (where nonvegetated predominates) with seasonally flooded (C), semipermanently flooded (F), semipermanently flooded-tidal (T), seasonally flooded-tidal (R), irregularly flooded (P), regularly flooded (N), and permanently flooded (H or L) water regimes

Carbon Sequestration

Concern over rising global temperatures and climate change has directed attention to wetlands since they are recognized as important carbon sinks. Drainage of wetlands releases carbon to the atmosphere in the form of carbon dioxide, one of several greenhouse gases influencing global temperatures. In wetlands, organic matter (carbon) accumulates in the soils as well as in vegetation. Woody plants, thereby, store carbon for longer periods than annual herbaceous plants. While the above-ground biomass of perennial herbs is released back into the aquatic ecosystem seasonally, the below-ground biomass remains in the substrate and contributes to longer-term storage. Temperate and subtropical wetlands are recognized as important for attenuating global warming (Whiting and Chanton 2001).

Interestingly, tidal salt marshes sequester up to fifty times more carbon per acre than is sequestered by tropical forests (Pidgeon 2009). Salt marshes, unlike freshwater wetlands, do not release significant quantities of methane (a recognized greenhouse gas contributing to global warming) to the atmosphere (Chmura 2009). Studies in Georgia have found that among tidal wetlands, the tidal freshwater wetlands and brackish marshes sequester more carbon and retain more nutrients than salt marshes (Loomis and Craft 2010). In fact, tidal fresh and brackish marshes sequestered 66 percent of the carbon and 69 percent of the nitrogen stored in all tidal wetlands in the three-river system studied (Ogeechee, Altamaha, and Satilla) even though they represent only 41 percent of the marsh area. Anaerobic conditions resulting from prolonged flooding or soil saturation typically lead to an accumulation of organic matter. Therefore, wetlands that experience longer duration of soil saturation should accumulate more organic matter. Northern bogs that are nearly continuous saturated in boreal to arctic climates where low evapotranspiration rates occur are recognized as major global carbon sinks. Consequently, wetlands with the wetter water regimes (i.e., seasonally flooded and wetter) should store more carbon than wetlands in the same region with drier water regimes that promote more oxidation and decomposition of organic matter. Seasonally flooded and wetter vegetated wetlands are rated as high for the carbon sequestration function, while drier wetlands (temporarily flooded and seasonally saturated) are assigned a moderate rating. Tidal flats (unconsolidated shores, mudflats in particular, except sandy beaches and sand flats) are listed as moderate because they sequester carbon at lower rates than vegetated coastal wetlands (Duarte et al. 2005). Ponds were also designated as moderate because recent studies have indicated the cumulative importance of small ponds in sequestering carbon through sedimentation processes (Downing 2010). Several types of ponds that are not likely to be capture organic-enriched sediment from local watersheds are excluded from this function: aquaculture, commercial, industrial, residential-stormwater, sewage treatment, and isolated diked ponds (impoundments).

High	Tidal vegetated wetlands (including mixed with unconsolidated shore), Nontidal vegetated wetlands that are seasonally flooded, semipermanently flooded, or intermitttently exposed, Nontidal vegetated wetlands that are permanently saturated

Moderate — Nontidal vegetated wetlands that are temporarily flooded or seasonally saturated, Tidal unconsolidated shore wetlands (including mixes with vegetated types; focus on mudflats and organic substrates for purely nonvegetated types; exclude sandy beaches, sand flats, and flats with other substrates), Nontidal nonvegetated/vegetated wetlands, Ponds (excluding aquaculture, commercial, industrial, residential-stormwater, and sewage treatment ponds plus isolated impoundments)

Retention of Sediment and Other Particulates

Many wetlands owe their existence to being located in areas of sediment deposition. This is especially true for floodplain and estuarine wetlands. This function supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals as in and downstream of urban areas (e.g., Gambrell 1994). Estuarine and floodplain wetlands plus lotic (streamside) and lentic (lakeshore) fringe and basin wetlands including lotic (in-stream) ponds are likely to trap and retain sediments and particulates at significant levels. Terrene throughflow basins should function similarly. Vegetated wetlands will likely favor sedimentation over nonvegetated wetlands and therefore they received a high rating versus moderate for the nonvegetated types. Lotic flat wetlands are flooded only for brief periods and less frequently than the wetlands listed above due to their elevation; they are classified as having moderate potential for sediment retention. Throughflow (in-stream) ponds and associated fringe and basin vegetated wetlands are rated as high, since they occur within the stream network where they trap water-borne sediments. Stormwater treatment ponds are designed specifically to perform this function, so they are rated as high. Other ponds and terrene basins may be locally significant in retaining such materials, and are therefore designated as moderate. However, commercial, industrial, residential, sewage treatment, golf, and mining ponds were not rated as significant since many are isolated diked impoundments. Terrene flats are not rated as potentially significant because they are level landscapes that do not appear to trap substantial amounts of sediment from surrounding areas.

For this function, the following relationships are used:

High — Estuarine vegetated (not floating mats), Lentic vegetated (not Flat and not floating mats), Lotic vegetated (not Flat, not Floodplain-flat, and not floating mats), Throughflow Ponds and Lakes (in-stream; designated as PUB... on NWI) and associated vegetated wetlands, Bidirectional-tidal Ponds and associated vegetated wetlands, Terrene Throughflow Basin, Stormwater Treatment Ponds

Moderate — Estuarine nonvegetated (excluding rocky shore), Lotic nonvegetated, Lotic Flat, Lotic Floodplain-flat, Lentic Flat, Marine Fringe (excluding rocky shore), Marine Island (excluding rocky shore), Other Terrene Basins, Terrene wetlands associated with ponds (excluding some types of ponds - commercial, industrial, sewage treatment, and mining), Other Ponds and Lakes (classified as PUB... on NWI) and associated wetlands (excluding some types of ponds – commercial, industrial, sewage treatment, and mining and slope wetlands)

Bank and Shoreline Stabilization

Vegetation colonizing banks and shorelines stabilizes the soil or substrate and diminishes wave action, thereby reducing shoreline erosion potential and increasing bank stability. Vegetated wetlands along all flowing or large standing waterbodies (e.g., estuaries, lakes, rivers, and streams) therefore provide this function at high levels. Intertidal oyster reefs when located along shorelines help protect the shorelines from erosion and are therefore rated as high. Vegetated wetlands along ponds are designated as moderate for this function since there is less wave or erosive action along these shores. Since island wetlands are surrounded by water, they are not considered significant for this function. It is recognized that some wetland islands may when positioned offshore in close proximity to the shoreline reduce wave action and contribute to shoreline stabilization.

For this function, the following relationships are used:

High	Estuarine vegetated wetlands (except island types), Estuarine nonvegetated irregularly flooded, Lotic wetlands (vegetated except island and isolated types and floating mats), Lentic wetlands (vegetated except island types and floating mats)
Moderate	Other Estuarine nonvegetated wetlands (except island), Terrene vegetated wetlands associated with ponds (e.g., Fringe-pond, Flat-pond, and Basin-pond), Estuarine intertidal oyster reefs (along the shoreline), Marine Unconsolidated Shore, Terrene Outflow Headwater wetlands

Provision of Fish and Aquatic Invertebrate Habitat[1]

Wetlands are widely recognized as important habitats for many species of fish and wildlife and there is a wide body of literature to support this claim (e.g., Mitsch and Gosselink 2007, Tiner 2005a). The assessment of potential habitat for fish and aquatic invertebrates is based on generalities that could be refined for particular species of interest by others at a later date if desirable. Regional and local variations will need to be accounted for on a watershed-by-watershed basis. The criteria selected below are useful for the Georgia coastal zone and many may be applicable nationwide, but they should be re-examined for each project area beyond the Georgia coast to ensure accuracy and completeness. Although focused on fish and aquatic invertebrates, wetlands identified as significant for these species are likely also significant for other aquatic-dependent animals such as muskrat, turtles, water snakes, and numerous amphibians.

For tidal areas, the assessment emphasizes estuarine wetlands, palustrine and riverine tidal emergent wetlands, unconsolidated shores (tidal flats), and intertidal oyster reefs. For nontidal regions, palustrine aquatic beds and permanently flooded and semipermanently flooded wetlands

[1] This assessment is focused on wetlands, not deepwater habitats, hence the exclusion of the latter from this analysis, despite widespread recognition that rivers, streams, and lakes are the primary habitats for fish and shellfish.

are ranked higher than seasonally flooded types due to the longer duration of surface water. Semipermanently flooded wetlands along permanent waterbodies may serve as fish spawning grounds during high flows. Many ponds (excluding wastewater ponds, for example) and the shallow marsh-open water zone of impoundments are identified as wetlands having moderate potential for fish and aquatic invertebrate habitat.

Shading by trees and tall shrubs moderates water temperatures for streams (Ghermandi et al. 2009, Wilkerson et al. 2006). Since water temperature is an important factor influencing fish use of streams as well as providing food (through leaf drop) for aquatic organisms that are an important part of the diet of juvenile and some adult fishes, forested and shrub wetlands along streams have been rated as moderate for fish and shellfish. The streamside wetlands also serve as vital buffers that help maintain good water quality.

Other wetlands providing significant fish habitat or benefits to their habitat may exist, but are not identified. Such wetlands may be identified based on actual observations or culled out from site-specific fisheries information that may be available from other sources. Moreover, all wetlands rated as significant for the streamflow maintenance function are already considered vital to sustaining the watershed's ability to provide lotic aquatic habitat. While these wetlands may not serve as significant fish and shellfish habitat, they support base flows essential to keeping water in streams for aquatic life. Terrene outflow wetlands and Lotic basin wetlands along low order streams (e.g., orders 1-2 in Coastal Plain) often discharge cool groundwater to streams which keeps these streams cooler in summer. Such wetlands are important for providing summer refuges for some species.

For this function, the following relationships are used:

High	Estuarine Emergent Wetland (including mixtures with other types where emergent is the dominant class), Estuarine Unconsolidated Shore (not irregularly flooded type), Estuarine Intertidal Reef (oyster), Estuarine Aquatic Bed, Lacustrine Littoral semipermanently flooded or permanently flooded (excluding wetlands along intermittent streams), Lacustrine Littoral Aquatic Bed, Lacustrine Littoral Unconsolidated Bottom/Vegetated Wetland, Marine Intertidal Unconsolidated Shore (not irregularly flooded), Palustrine semipermanently flooded (excluding wetlands along intermittent streams; *must be contiguous with a permanent waterbody* such as PUBH, L1UBH, or R2/R3UBH *or be a semipermanently flooded slough*), Palustrine Aquatic Bed, Palustrine Unconsolidated Bottom/Vegetated Wetland, Palustrine Vegetated Wetland with a permanently flooded water regime, Palustrine Tidal Emergent Wetland (excluding S water regime), Ponds (PUBH… on NWI; not PUBF) associated with semipermanently flooded or permanently flooded Vegetated Wetland, Riverine Tidal Emergent Wetland, Riverine Tidal Unconsolidated Shore (excluding those with an S water regime), Riverine Tidal Aquatic Bed, Riverine Lower Perennial Aquatic Bed, Riverine Lower Perennial Aquatic Bed

Moderate — Estuarine Wetlands where Forested or Scrub-Shrub Wetland is mixed with Emergent Wetland, Lentic wetlands that are PEM1C (and contiguous with a waterbody), Lotic River or Stream wetlands that are PEM1C (including mixtures with Scrub-Shrub or Forested wetlands; and contiguous with a waterbody), Other Ponds and associated Fringe wetlands (i.e., one acre or larger; specify pond types: natural ponds, beaver ponds, and excavated or impounded ponds that are used for aquaculture and wildlife management), Lotic River Floodplain Basin Wetlands, Palustrine Tidal Forested or Scrub-Shrub Wetlands mixed with Emergent Wetland with seasonally flooded-tidal (R) or semipermanently flooded-tidal (T) water regimes

Note: Industrial, commercial, and wastewater treatment ponds should be excluded from this function.

Provision of Waterfowl and Waterbird Habitat

Wetlands designated as important for waterfowl (e.g., ducks, geese, and loons) and waterbirds (e.g., wading birds, shorebirds, rails, marsh wrens, and red-winged blackbirds) are generally those used for nesting, reproduction, or feeding. The emphasis is on the wetter wetlands and ones that are frequently flooded for long periods. Other birds dependent on and/or living in other wetlands (e.g., waterthrushes, veery, eastern kingbird, vireos, and warblers) are not included in this function; they are included in the large group of animals referred to as “other wildlife” in this assessment.

The selected wetlands include estuarine wetlands (vegetated or not), riverine emergent wetlands, estuarine and riverine unconsolidated shores (excluding temporary flooded-tidal), palustrine tidal and riverine tidal emergent wetlands (including emergent/shrub mixtures), semipermanently flooded wetlands, mixed open water-emergent wetlands (palustrine and lacustrine), and aquatic beds. Seasonally flooded lotic wetlands that are forested or mixtures of trees and shrubs (excluding those along intermittent streams) are designated as having high potential because they offer prime habitats for wood ducks. For this analysis, palustrine tidal scrub-shrub/emergent wetlands and tidal forested/emergent wetlands were designated as having moderate significance for waterfowl and waterbirds. Similar mixed wetlands dominated by emergent species, however, are listed as having high significance, since the emergents typically represent wetter conditions in Georgia’s tidal zone. Ponds one acre and larger were considered to have moderate potential for providing waterfowl and waterbird habitat.[2] Semipermanently flooded vegetated wetlands that were not associated with a waterbody were rated as moderate for this function as were seasonally flooded emergent wetlands (including mixtures with shrubs) contiguous with water bodies.

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[2] Ponds on wildlife management areas (e.g., refuges) should be considered to be of high significance due to their management. Since we do not presently have the location of refuges recorded in our digital database, these ponds may not be separated from the rest of the ponds. Hence, all ponds except industrial, commercial, stormwater detention, wastewater treatment, and similar ponds, are designated as having moderate potential for this function.

For this function, the following relationships are used:

High — Estuarine Aquatic Bed, Estuarine Emergent wetlands (including mixtures with other vegetated types where EM dominates, e.g., EM/SS), Estuarine Unconsolidated Shore (except S water regime), Estuarine Intertidal Reef, Lacustrine Semipermanently Flooded, Lacustrine Littoral Aquatic Bed (and mixes where AB dominates), Lacustrine Littoral Vegetated wetlands with an H water regime, Lacustrine Unconsolidated Shores (F, E, or C water regimes), Marine Unconsolidated Shore, Palustrine Semipermanently Flooded and adjacent to a waterbody or along a slough; Palustrine Semipermanently Flooded-Tidal, Palustrine Aquatic Bed, Palustrine Vegetated wetlands with an H water regime, Seasonally Flooded Palustrine wetlands impounded (all vegetation types and associated PUB waters – natural ponds, waterfowl/wildlife impoundments, and beaver ponds), Lotic River or Stream wetlands that are PEM1C (including mixtures with Scrub-Shrub or Forested wetlands), Ponds associated with Semipermanently Flooded Vegetated wetlands, Palustrine Tidal Emergent wetlands (PEM1R and PEM1T and mixes with other EM and with SS and FO), Riverine Tidal Emergent wetlands, Riverine Tidal Unconsolidated Shores (except with S water regime), Ponds associated with all of the above wetland types, Lotic Basin or Fringe or Floodplain-basin wetlands (excluding those along intermittent streams) that are Forested or Scrub-shrub or mixtures of these types with C, F, R, or H water regime; Lotic wetlands that are mixed Forested/Emergent or Unconsolidated Bottom/Forested with a F, R, or H water regime; Palustrine Tidal Forested or Scrub-shrub wetlands (and mixes with other types like the Lotic types) in Estuarine reach with R or N water regime and contiguous with open Water, Wildlife Impoundments ("wi")

Moderate — Estuarine Scrub-Shrub/Emergent wetland Oligohaline, Seasonally Flooded-Tidal Palustrine Wetland where EM is the subordinate mixed class (e.g., PFO1/EM1R), Ponds 1 acre or greater in size (excluding industrial, commercial, stormwater detention, wastewater treatment, and similar ponds), Palustrine Emergent wetlands (including mixtures with Scrub-shrub) that are Seasonally Flooded and associated with permanently flooded waterbodies, Other Palustrine vegetated (AB, EM, SS, FO) wetlands that are Semipermanently Flooded, Other Lacustrine Littoral Unconsolidated Bottom wetlands

Note: All waterfowl impoundments and associated wetlands that should be marked with "wi" should be rated as high for this function. Ponds used for aquaculture are excluded since management will likely deter use of these ponds; associated wetlands should also be excluded from this function. Industrial, commercial, and wastewater treatment ponds, lakes, and associated wetlands should be excluded from this function.

Provision of Other Wildlife Habitat

The provision of other wildlife habitat by wetlands was evaluated in general terms. Species-specific habitat requirements were not considered. In developing an evaluation method for wildlife habitat in the glaciated Northeast, Golet (1972) designated several types as outstanding wildlife wetlands including: 1) wetlands with rare, restricted, endemic, or relict flora and/or fauna, 2) wetlands with unusually high visual quality and infrequent occurrence, 3) wetlands with flora and fauna at the limits of their range, 4) wetlands with several seral stages of hydrarch succession, and 5) wetlands used by great numbers of migratory waterfowl, shorebirds, marsh birds, and wading birds. Golet subscribed to the principle that in general, as wetland size increases so does wildlife value, so wetland size was important factor for determining wildlife habitat potential in his approach. Other important variables included dominant wetland class, site type (bottomland vs. upland; associated with waterbody vs. isolated), surrounding habitat type (e.g., natural vegetation vs. developed land), degree of interspersion (water vs. vegetation), wetland juxtaposition (proximity to other wetlands), and water chemistry.

For this analysis, wetlands important to waterfowl and waterbirds are identified in a separate assessment. Emphasis for assessing "other wildlife" was placed on conditions that would likely provide significant habitat for other vertebrate wildlife (mainly interior forest birds, amphibians, reptiles, and non-aquatic mammals).

Opportunistic species that are highly adaptable to fragmented landscapes are not among the target organisms, since there seems to be more than ample habitat for these species now and in the future. Rather, animals whose populations may decline as wetland habitats become fragmented by development are of key concern. For example, breeding success of neotropical migrant birds in fragmented forests of Illinois was extremely low due to high predation rates and brood parasitism by brown-headed cowbirds (Robinson 1990). Newmark (1991) reported local extinctions of forest interior birds in Tanzania due to fragmentation of tropical forests. Fragmentation of wetlands is an important issue for wildlife managers to address. Some useful references on fragmentation relative to forest birds are Askins et al. (1987), Robbins et al. (1989), Freemark and Merriam (1986), and Freemark and Collins (1992). The latter study includes a list of area-sensitive or forest interior birds for the eastern United States. The work of Robbins et al. (1989) addressed area requirements of forest birds in the Mid-Atlantic states and may be useful further south along the coastal plain. They found that species such as the black-throated blue warbler, cerulean warbler, Canada warbler, and black-and-white warbler required very large tracts of forest for breeding. Ground-nesters, such as veery, black-and-white warbler, worm-eating warbler, ovenbird, waterthrushes, and Kentucky warbler, are particularly sensitive to predation which may be increased in fragmented landscapes. Robbins et al. (1989) suggest a minimum forest size of 7,410 acres to retain all species of the forest-breeding avifauna in the Mid-Atlantic region. Schroeder (1996) noted that to conserve regional biodiversity, maintenance of large-area habitats for forest interior birds is essential. As mentioned previously, Robbins et al. (1989) suggest a minimum forest size of 7,410 acres to retain all species of the forest-breeding avifauna in the Mid-Atlantic region. Consequently, forested areas 7,000 acres and larger that contained contiguous palustrine forested wetlands and upland forests are important for maintaining regional biodiversity of avifauna on the Atlantic Coastal Plain based on recommendations by Robbins et al. (1989). Forested wetlands within large forest blocks 7,000 acres or more were rated as having potential for providing high value habitat for other wildlife.

While many amphibians are strictly aquatic animals living in water, salamanders, spring peepers, and chorus frogs spend most of their adult lives in other wetlands and upland habitats, but use open-water wetlands (including vernal pools) for breeding. For these species, small isolated permanently flooded or semipermanently flooded wetlands (including ponds) in an upland forest matrix (e.g., woodland vernal pools) have been rated as having high habitat value and other wetlands contiguous to or within 100m of these wetlands have also been similarly rated. Although this assessment focuses on wetlands, it is important to recognize that upland forests adjacent to these breeding ponds are prime habitats for the juveniles and adults of these species.

Many terrestrial mammals make use of wetlands including rabbits, raccoons, and deer. For these animals, large wetlands ($\geq$ 20 acres) regardless of vegetative cover but excluding pine plantations and smaller diverse wetlands (10-20 acres with multiple cover types) have been rated as high value. Freshwater wetlands on or near back-barrier islands (including major hammocks) are particularly valuable habitat for numerous island wildlife. Any remaining vegetated wetlands are designated as having moderate value for providing wildlife habitat.

Please note that with the exception of vernal pools (woodland ponds), ponds are not listed as important as significant for "other wildlife." Wildlife species living in ponds, such as several species of frogs and turtles, are mentioned in the discussion of fish and aquatic invertebrate habitat, since wetlands designated as important for fish and invertebrates provide required habitat for these species.

High	*Forested wetlands within 7000-acre blocks of forest, vegetated wetlands >20 acres (excluding open water, nonvegetated areas, and pine plantations), small diverse wetlands (10-20 acres with 2 or more covertypes; excluding open water as one of the covertypes), *small isolated permanently flooded or semipermanently flooded wetlands within an upland forest matrix (including small ponds that may be vernal pools) and contiguous wetlands, small vegetated wetlands on or near coastal back-barrier islands (including those on major hammocks)
Moderate	Other vegetated wetlands

*Not identified for the coastal county project.

Given the general nature of this assessment of "other wildlife habitat," other individuals may want to refine this assessment in the future by having biologists designate "target species" that may be used to identify important wildlife habitats in a particular watershed. After doing this, they could identify criteria that may be used to identify potentially significant habitat for these species in the watershed.

Provision of Unique, Uncommon, or Highly Diverse Wetland Plant Communities

This function is used to identify wetlands that are unique or uncommon wetland types in a watershed or other study area, or that represent highly diverse plant communities. All riverine and palustrine tidal emergent and scrub-shrub wetlands (regularly flooded, seasonally flooded-tidal, and semipermanently flooded-tidal) and estuarine oligohaline vegetated wetlands are identified as significant for this function because they often possess some of the most diverse wetland plant communities along the Atlantic Coast. While Phragmites-dominated wetlands are generally excluded from this listing, any wetland supporting stands of the native species should be recognized as a significant habitat. While this type was not mapped during the updated inventory, it may be added from documented occurrences if desirable. Generally, however, the use of Natural Heritage Program data and other data are beyond the scope of this remotely sensed approach to wetland functional analysis. Consequently, wetlands designated as potentially significant for this function by the W-PAWF assessment are simply a starting point or, in other words, a foundation to build upon. Local knowledge of significant wetlands and Natural Heritage Program data can be applied by others to further refine the list of wetlands important for this function for specific geographic areas.

The following are examples of wetland types viewed as potentially significant for the provision of habitat for unique or diverse wetland plant communities in coastal Georgia (Note: The ones underlined were identified during the inventory):

Significant

- Estuarine oligohaline vegetated wetlands
- Riverine tidal emergent wetlands (including tidal flats that are often colonized by nonpersistent plants during the growing season)
- Palustrine tidal emergent wetlands (regularly flooded, seasonally flooded tidal, and semipermanently flooded-tidal water regimes)
- Palustrine tidal scrub-shrub wetlands (regularly flooded, seasonally flooded-tidal, and semipermanently flooded-tidal water regimes)
- Freshwater vegetated wetlands on barrier islands (semipermanently flooded, semipermanently flooded-tidal, and permanently flooded)
- Brackish marshes at upper edge of salt marshes
- Stands of native Phragmites (Note: These stands have not been identified in the wetland mapping, but can be identified from our sources.)
- Carolina bay wetlands (relatively intact)
- Palustrine vegetated wetlands permanently flooded

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Summary

The State of Georgia has added descriptors for landscape position, landform, and water flow path to its updated wetland digital database for six coastal counties. When LLWW descriptors are combined with typical NWI attributes from Cowardin et al. 1979 (system, subsystem, class, subclass, water regime, and special modifiers), a NWIPlus database is created. It contains many properties for each wetland that can be used to produce a preliminary landscape-level assessment of wetland functions for large geographic areas. The subject report provides the rationale for the criteria used to identify wetlands of potential significance for eleven functions. These functions include: 1) surface water detention, 2) coastal storm surge detention, 3) streamflow maintenance, 4) nutrient transformation, 5) carbon sequestration, 6) sediment and other particulate retention, 7) bank and shoreline stabilization, 8) provision of fish and aquatic invertebrate habitat, 9) provision of waterfowl and waterbird habitat, 10) provision of other wildlife habitat, and 11) provision of habitat for unique, uncommon, or highly diverse wetland plant communities. The preliminary nature of this type of functional assessment must be emphasized and while it provides a valuable landscape-level perspective on wetland functions, field investigations are required to refine these findings for specific wetlands or areas of interest.

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The draft document was reviewed by personnel from Atkins North America and the GA DNR's Coastal Resources Division. Rainor Gresham provided a listing of the wetland types that were mapped in the study area for each wetland function. This information was used to highlight those wetlands in the listing of potential wetlands of significance for each function.

The foundation for the wetland characteristics-function relationships was laid over the past 15 years and many people had a hand in the process and were recognized in the 2003 correlation report for the Northeast (Tiner 2003b). Since then additional peer review comments were subsequently provided by Dr. Robert Brooks (Pennsylvania State University), Dr. Christopher Cirmo (Cortland State University), Dr. Andrew Baldwin (University of Maryland), Dr. Mark Brinson (East Carolina University), Dr. Donald Leopold (State University of New York-Syracuse), Matt Schweisberg (U.S. EPA, Region 1), Dr. Charles Roman (U.S. Geological Survey, University of Rhode Island), and Dr. Aram Calhoun (University of Maine). Their comments were helpful in improving the document.

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Appendix E. GIS User Guide.

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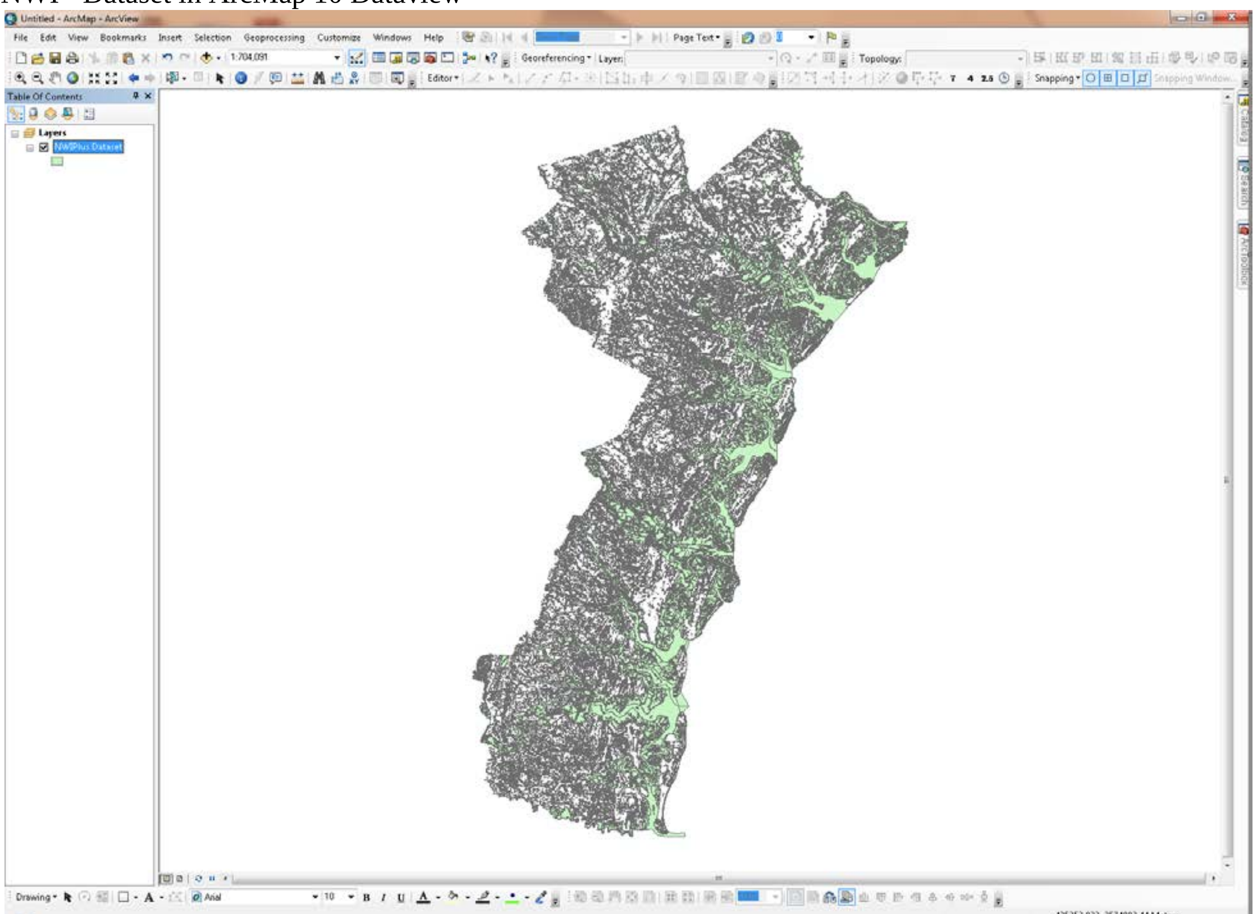
Introduction

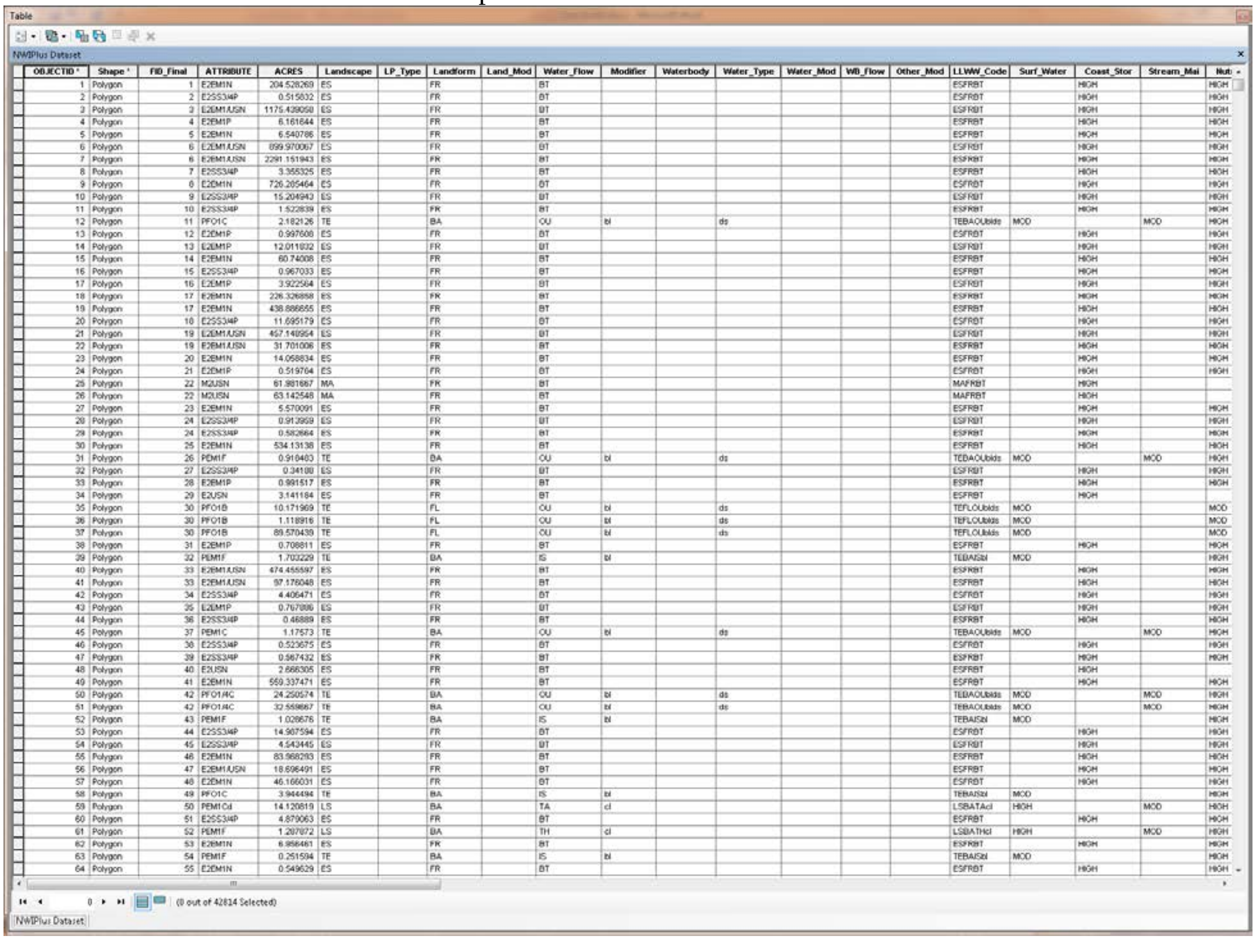
This user guide demonstrates how the NWI+ database can be used in conjunction with GIS to answer questions related to size, location, type, and functional values of coastal Georgia wetlands. The NWI+ database consists of two feature classes: Final_Coastal_Counties and Final_Intersect. The feature classes are distinguished by the fields used to attribute Hydrologic Unit (HU) names and County location. For the purposes of this document, the "NWI+ dataset" will refer to the Final_Coastal_Counties feature class within the NWI+ feature dataset (shown as NWIPlus in the GIS database).

This document assumes the reader has basic knowledge of ESRI's ArcGIS 10 platform. The user guide will detail the steps necessary to answer example questions, but will not always explain or show the methods involved. Additionally, all examples here are performed solely as desktop analyses. Field verification by the user is suggested to confirm any conclusions.

NWI+ Dataset in ArcMap 10 Dataview



NWI+ Dataset Attribute Table in ArcMap 10



OBJECTID *	Shape *	FID_Final	ATTRIBUTE	ACRES	Landscape	LP_Type	Landform	Land_Mod	Water_Flow	Modifier	Waterbody	Water_Type	Water_Mod	WB_Flow	Other_Mod	LLWW_Code	Surf_Water	Coast_Stor	Stream_Mai	Nut
1	Polygon	1	E2EM1N	204.528269	ES		FR		BT							ESFRBT		HIGH		HIGH
2	Polygon	2	E2SS3/4P	0.515832	ES		FR		BT							ESFRBT		HIGH		HIGH
3	Polygon	3	E2EM1/USN	1175.439058	ES		FR		BT							ESFRBT		HIGH		HIGH
4	Polygon	4	E2EM1P	6.161644	ES		FR		BT							ESFRBT		HIGH		HIGH
5	Polygon	5	E2EM1N	6.540786	ES		FR		BT							ESFRBT		HIGH		HIGH
6	Polygon	6	E2EM1/USN	899.970067	ES		FR		BT							ESFRBT		HIGH		HIGH
7	Polygon	6	E2EM1/USN	2291.151943	ES		FR		BT							ESFRBT		HIGH		HIGH
8	Polygon	7	E2SS3/4P	3.355325	ES		FR		BT							ESFRBT		HIGH		HIGH
9	Polygon	8	E2EM1N	726.285464	ES		FR		BT							ESFRBT		HIGH		HIGH
10	Polygon	9	E2SS3/4P	15.204943	ES		FR		BT							ESFRBT		HIGH		HIGH
11	Polygon	10	E2SS3/4P	1.522839	ES		FR		BT							ESFRBT		HIGH		HIGH
12	Polygon	11	PFO1C	2.182126	TE		BA		OU	bl		ds				TEBAOUblds	MOD		MOD	HIGH
13	Polygon	12	E2EM1P	0.997608	ES		FR		BT							ESFRBT		HIGH		HIGH
14	Polygon	13	E2EM1P	12.011832	ES		FR		BT							ESFRBT		HIGH		HIGH
15	Polygon	14	E2EM1N	60.74008	ES		FR		BT							ESFRBT		HIGH		HIGH
16	Polygon	15	E2SS3/4P	0.967033	ES		FR		BT							ESFRBT		HIGH		HIGH
17	Polygon	16	E2EM1P	3.922564	ES		FR		BT							ESFRBT		HIGH		HIGH
18	Polygon	17	E2EM1N	226.326858	ES		FR		BT							ESFRBT		HIGH		HIGH
19	Polygon	17	E2EM1N	438.886655	ES		FR		BT							ESFRBT		HIGH		HIGH
20	Polygon	18	E2SS3/4P	11.695179	ES		FR		BT							ESFRBT		HIGH		HIGH
21	Polygon	19	E2EM1/USN	457.140954	ES		FR		BT							ESFRBT		HIGH		HIGH
22	Polygon	19	E2EM1/USN	31.701006	ES		FR		BT							ESFRBT		HIGH		HIGH
23	Polygon	20	E2EM1N	14.058834	ES		FR		BT							ESFRBT		HIGH		HIGH
24	Polygon	21	E2EM1P	0.519704	ES		FR		BT							ESFRBT		HIGH		HIGH
25	Polygon	22	M2USN	61.981667	MA		FR		BT							MAFRBT		HIGH		
26	Polygon	22	M2USN	63.142548	MA		FR		BT							MAFRBT		HIGH		
27	Polygon	23	E2EM1N	5.570091	ES		FR		BT							ESFRBT		HIGH		HIGH
28	Polygon	24	E2SS3/4P	0.913969	ES		FR		BT							ESFRBT		HIGH		HIGH
29	Polygon	24	E2SS3/4P	0.582664	ES		FR		BT							ESFRBT		HIGH		HIGH
30	Polygon	25	E2EM1N	534.13138	ES		FR		BT							ESFRBT		HIGH		HIGH
31	Polygon	26	PEM1F	0.918483	TE		BA		OU	bl		ds				TEBAOUblds	MOD		MOD	HIGH
32	Polygon	27	E2SS3/4P	0.34188	ES		FR		BT							ESFRBT		HIGH		HIGH
33	Polygon	28	E2EM1P	0.991517	ES		FR		BT							ESFRBT		HIGH		HIGH
34	Polygon	29	E2USN	3.141184	ES		FR		BT							ESFRBT		HIGH		
35	Polygon	30	PFO1B	10.171969	TE		FL		OU	bl		ds				TEFLOUblds	MOD			MOD
36	Polygon	30	PFO1B	1.118916	TE		FL		OU	bl		ds				TEFLOUblds	MOD			MOD
37	Polygon	30	PFO1B	89.570439	TE		FL		OU	bl		ds				TEFLOUblds	MOD			MOD
38	Polygon	31	E2EM1P	0.708811	ES		FR		BT							ESFRBT		HIGH		HIGH
39	Polygon	32	PEM1F	1.703229	TE		BA		IS	bl						TEBAISbl	MOD			HIGH
40	Polygon	33	E2EM1/USN	474.455597	ES		FR		BT							ESFRBT		HIGH		HIGH
41	Polygon	33	E2EM1/USN	97.176048	ES		FR		BT							ESFRBT		HIGH		HIGH
42	Polygon	34	E2SS3/4P	4.406471	ES		FR		BT							ESFRBT		HIGH		HIGH
43	Polygon	35	E2EM1P	0.767086	ES		FR		BT							ESFRBT		HIGH		HIGH
44	Polygon	36	E2SS3/4P	0.46889	ES		FR		BT							ESFRBT		HIGH		HIGH
45	Polygon	37	PEM1C	1.17573	TE		BA		OU	bl		ds				TEBAOUblds	MOD		MOD	HIGH
46	Polygon	38	E2SS3/4P	0.523675	ES		FR		BT							ESFRBT		HIGH		HIGH
47	Polygon	39	E2SS3/4P	0.567432	ES		FR		BT							ESFRBT		HIGH		HIGH
48	Polygon	40	E2USN	2.666305	ES		FR		BT							ESFRBT		HIGH		
49	Polygon	41	E2EM1N	559.337471	ES		FR		BT							ESFRBT		HIGH		HIGH
50	Polygon	42	PFO1/4C	24.250574	TE		BA		OU	bl		ds				TEBAOUblds	MOD		MOD	HIGH
51	Polygon	42	PFO1/4C	32.559867	TE		BA		OU	bl		ds				TEBAOUblds	MOD		MOD	HIGH
52	Polygon	43	PEM1F	1.028676	TE		BA		IS	bl						TEBAISbl	MOD			HIGH
53	Polygon	44	E2SS3/4P	14.907594	ES		FR		BT							ESFRBT		HIGH		HIGH
54	Polygon	45	E2SS3/4P	4.543445	ES		FR		BT							ESFRBT		HIGH		HIGH
55	Polygon	46	E2EM1N	83.968293	ES		FR		BT							ESFRBT		HIGH		HIGH
56	Polygon	47	E2EM1/USN	18.696491	ES		FR		BT							ESFRBT		HIGH		HIGH
57	Polygon	48	E2EM1N	46.166031	ES		FR		BT							ESFRBT		HIGH		HIGH
58	Polygon	49	PFO1C	3.944494	TE		BA		IS	bl						TEBAISbl	MOD			HIGH
59	Polygon	50	PEM1Cd	14.120819	LS		BA		TA	cl						LSBATAcl	HIGH		MOD	HIGH
60	Polygon	51	E2SS3/4P	4.879063	ES		FR		BT							ESFRBT		HIGH		HIGH
61	Polygon	52	PEM1F	1.207072	LS		BA		TH	cl						LSBATHcl	HIGH		MOD	HIGH
62	Polygon	53	E2EM1N	6.956461	ES		FR		BT							ESFRBT		HIGH		HIGH
63	Polygon	54	PEM1F	0.251594	TE		BA		IS	bl						TEBAISbl	MOD			HIGH
64	Polygon	55	E2EM1N	0.549629	ES		FR		BT							ESFRBT		HIGH		HIGH

Table E-1. NWI+ Field Descriptions in GIS Database.

Field	Description
ATTRIBUTE	Cowardin wetland code
ACRES	Size in acres
Landscape	Landscape Position
LP_Type	Lotic Gradient, Lentic Type, or Estuary Type
Landform	Landform Position
Land_Mod	Landform Modifier (sl-slough, rs-reservior, pd-pond)
Water_Flow	Water Flow Path
Modifier	Other Modifiers (dr-partially drained, hw-headwater, td- tidally restricted by road)
Waterbody	Waterbody Type
Water_Type	Waterbody Descriptor (1-low gradient/natural lake, 3-excavated pond, 5- tidal gradient)
Water_Mod	Waterbody Modifier (a- agriculture, c- commercial, e-residential)
WB_Flow	Waterbody Flow Path
Other_Mod	Other Modifiers (ch-channelized, fv-floating vegetation)

Table E-1 (cont'd).

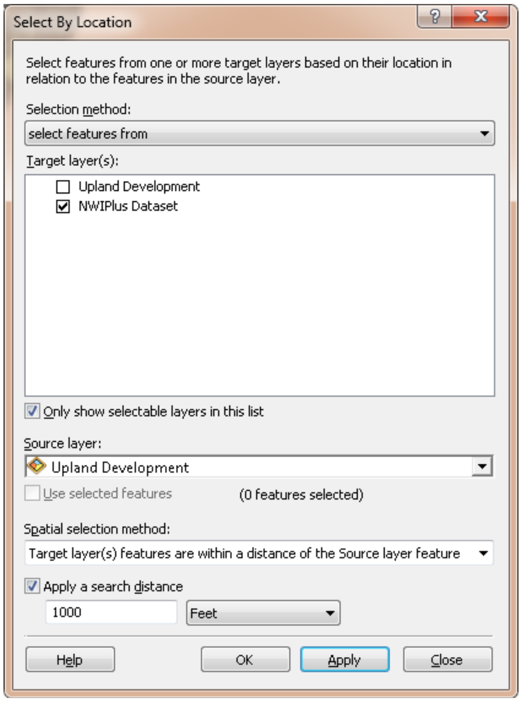
Field	Description
LLWW_Code	Combined LLWW code, which is all previous fields put together for either Landscape, Landform, Water Flow, or Waterbody
Surf_Water	Surface Water Detention
Coast_Stor	Coastal Storm Surge Detention
Stream_Mai	Streamflow Maintenance
Nutrnt_Tra	Nutrient Transformation
Carbon_Seq	Carbon Sequestration
Sed_Part_R	Retention of Sediment and Other Particulates
Bank_Shore	Bank and Shoreline Stabilization
Prov_Fish_	Provision of Fish and Aquatic Invertebrate Habitat
Prov_WFowl	Provision of Waterfowl and Waterbird Habitat
Prov_Other	Provision of Other Wildlife Habitat
Prov_Hab_U	Provision of Habitat for Unique, Uncommon, or Highly Diverse Plant Communities
Unique_ID	Unique Identifiyer used to create summary tables
HUC_12	12-digit HU code
HU_12_NAME	12-digit HU name
COUNTY	County Name
LLW	Landscape Position, Landform, Water Flow Path descriptors used in summary tables of wetlands only
System	Cowardin System code, used in summary tables
Class	Cowardin Class code, used in summary tables
State	State Name (All wetlands are in Georgia for the 6-county area, though some wetlands for overall project are in SC or FL)
Deepwater	Yes/No Field to describe whether the polygon is deepwater (Yes) or wetland/pond (No)

GIS Examples

Problem 1: Find all wetlands within 1,000 feet of the upland development site (from Problem 1).

Solution 1:

1. Choose Selection>Select by Location
2. Selection method: select features from
3. Target layer: NWI+ Dataset
4. Source layer: Upland Development layer
5. Spatial selection method: Target layer(s) features are within a distance of the Source layer feature
6. Apply a search distance: 1,000 Feet
7. Select Ok

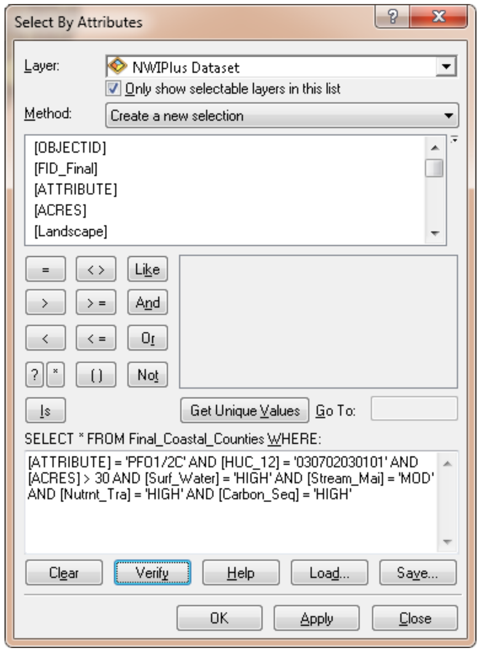


Now all wetland polygons that are within 1,000 feet of the upland development are selected and can be summarized.

Problem 2: For a project that impacts a 10-acre bottomland hardwood wetland that provides a High function for Surface Water Detention, Moderate function for Streamflow Maintenance, and High function for Nutrient Transformation and Carbon Sequestration, find a similar wetland type with comparable functions, that is within the same 12-digit Hydrologic Unit (HU), 030702030101 for this example, that is at least three times the size to mitigate impacts with preservation.

Solution 2: The bottomland hardwood wetland being impacted can be described using the Cowardin code PFO1/2C, meaning that it is a seasonally flooded hardwood forest.

1. Selection>Select by Attributes
2. Layer: NWI+ Dataset
3. [ATTRIBUTE] = 'PFO1/2C' AND [HUC_12] = '030702030101' AND [ACRES] > 30 AND [Surf_Water] = 'HIGH' AND [Stream_Mai] = 'MOD' AND [Nutrnt_Tra] = 'HIGH' AND [Carbon_Seq] = 'HIGH'

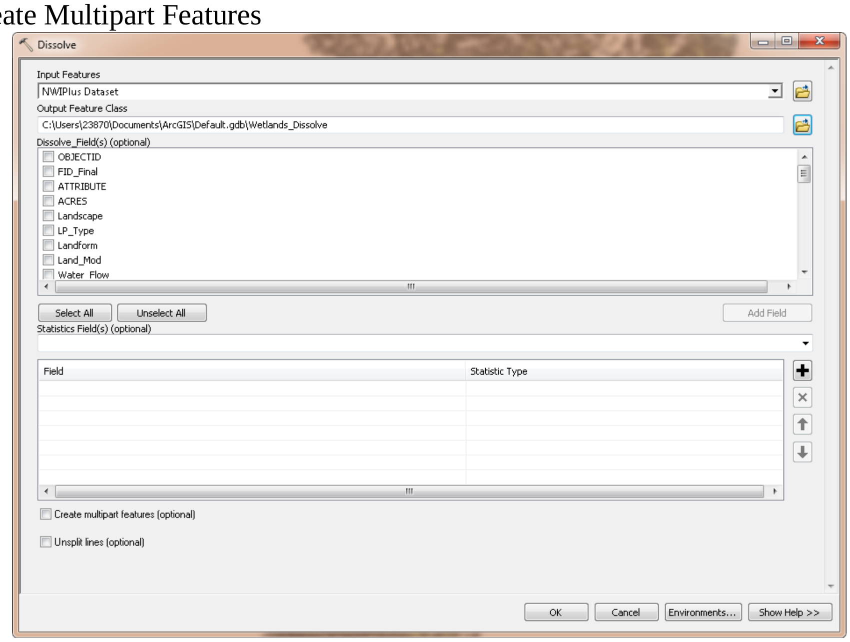


This gives two results, one is almost 35 acres in size, and the other is 38 acres in size.

Problem 3: Find the largest contiguous block of wetlands in coastal Georgia.

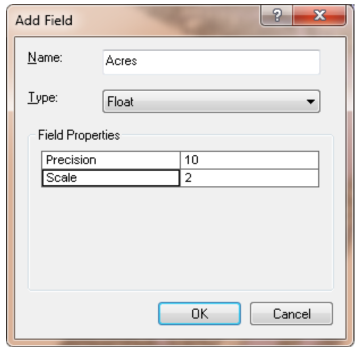
Solution 3 Part 1: Wetlands could be considered contiguous if they touch other wetlands or open water that touches other wetlands.

1. Select Analysis Tools>Data Management Tools>Generalization>Dissolve
2. Input Feature: Final_Coastal_Counties
3. Output Feature Class: Wetlands_Dissolve
4. Dissolve Fields: Do not select any fields
5. Deselect Create Multipart Features



6. Right-click the resulting layer that is added to the table of contents and select Open Attribute table

7. Select Table Options>Add Field
8. Name: Acres
9. Type: Float
10. Precision: 10
11. Scale: 2
12. Select OK

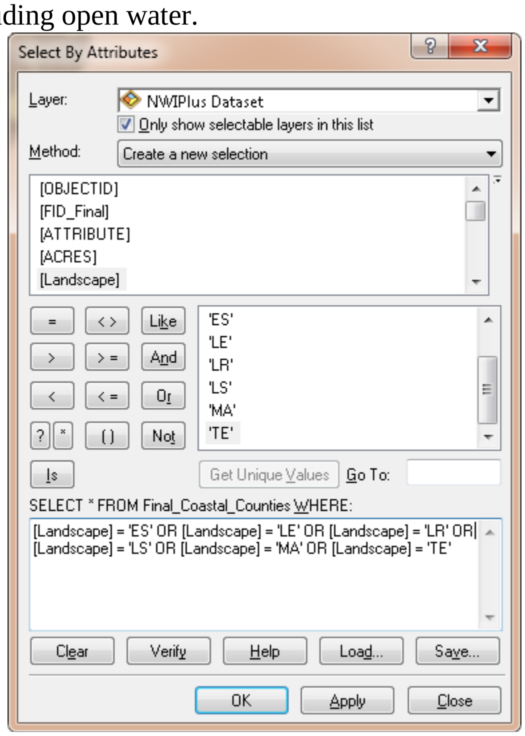


13. Right-click the Acres field in the attribute table
14. Select Calculate Geometry and recalculate area in acres
15. Right-click the Acres field and sort descending to place the largest wetland on top

Solution 3 Part 2: The solution changes when considering only wetlands contiguous to other wetlands.

1. Selection>Select by Attribute
2. Layer: NWI+ Dataset
3. [Landscape] = 'ES' OR [Landscape] = 'LE' OR [Landscape] = 'LR' OR [Landscape] = 'LS' OR [Landscape] = 'MA' OR [Landscape] = 'TE'

This selects all wetlands, excluding open water.



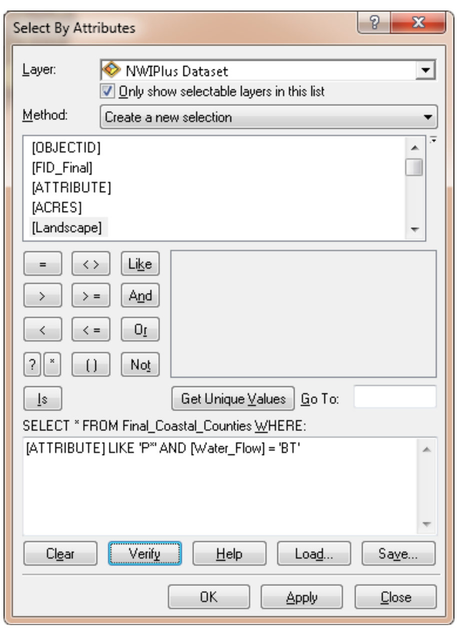
4. Keeping features selected, Select Analysis Tools>Data Management Tools>Generalization>Dissolve

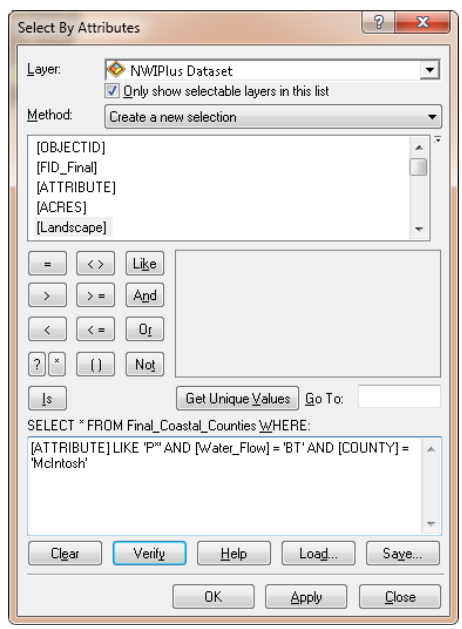
5. Input Feature: Final_Coastal_Counties
6. Output Feature Class: Wetlands_only_Dissolve
7. Dissolve Fields: Do not select any fields
8. Deselect Create Multipart Features
9. Right-click the resulting layer that is added to the table of contents and select Open Attribute table
10. Select Table Options>Add Field
11. Name: Acres
12. Type: Float
13. Precision: 10
14. Scale: 2
15. Select OK
16. Right-click the Acres field in the attribute table
17. Select Calculate Geometry and recalculate area in acres
18. Right-click the Acres field and sort descending to place the largest wetland on top

Problem 4: Find Freshwater Tidal wetlands within each county.

Solution 4: Freshwater Tidal wetlands are Palustrine wetlands with a tidal water regime.
1. Selection>Select by Attributes
2. Layer: NWI+ Dataset
3. [ATTRIBUTE] LIKE 'P*' AND [Water_Flow] = 'BT'

This selects all wetlands that are Palustrine (freshwater) and Bi-directional tidal. The LIKE operator with a wildcard (*) selects any value in the field that begins with the characters preceding (*).



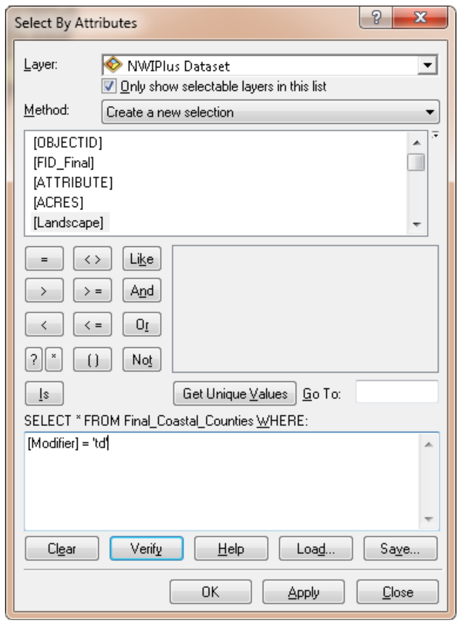


To select only one county, add a county restriction.
1. Selection>Select by Attributes
2. [ATTRIBUTE] LIKE 'P*' AND [Water_Flow] = 'BT' AND [COUNTY] = 'McIntosh'

Problem 5: Find tidal marshes in coastal Georgia which are potentially suitable for wetland restoration.

Solution 5: The database includes specific codes for estuarine wetlands that are tidally restricted by a road.

1. Selection>Select by Attributes
2. Layer: NWI+ Dataset
3. [Modifier] = 'td'

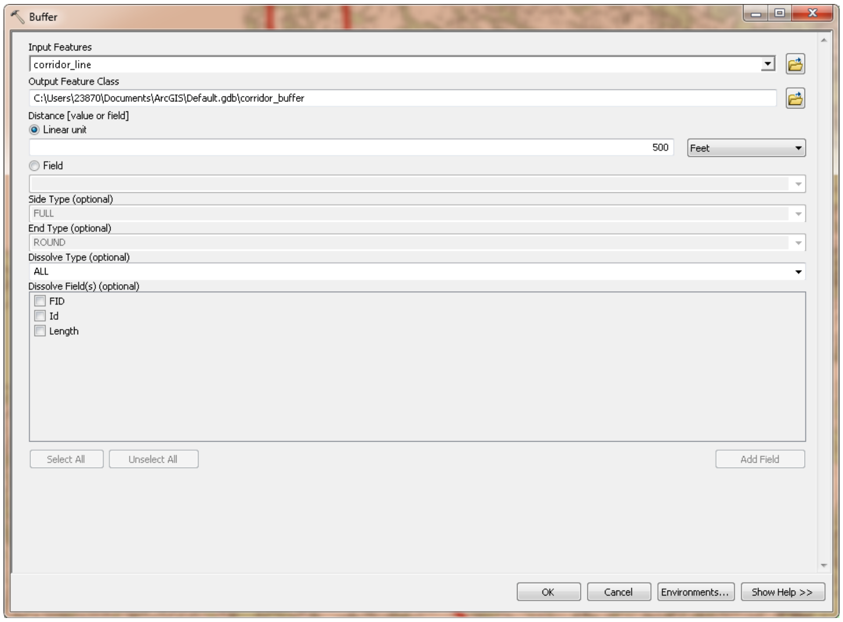


These estuarine wetlands indicate evidence of water flow being restricted and impounded by a road. There could be potential to increase the water flow through the road embankment, improving the condition of the wetland.

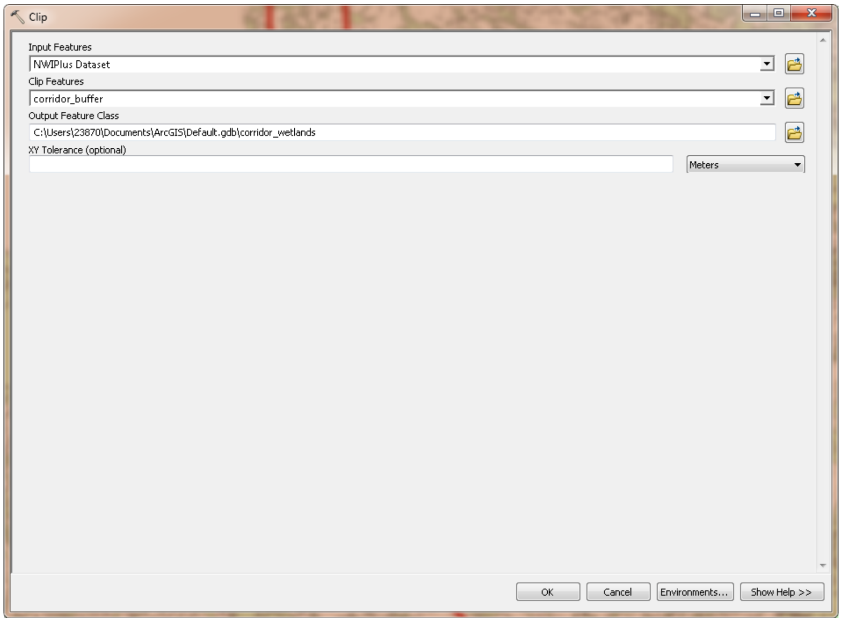
Problem 6: Find the impacts to wetlands for a proposed site. One is a 1,000 ft. wide road corridor and the other is a shopping center site, 30 acres in size.

Solution 6:

1. Use an existing line to define the proposed road path, or create a new line shapefile to draw the road.
2. Select Geoprocessing Tools from the top menu
3. Select Buffer
4. Use distance of 500 feet for each side
5. Use or create a polygon shapefile for the shopping center site



6. Geoprocessing Tools>Clip
7. Input layer: NWI+ Dataset
8. Clip layer: road_corridor_buffer
9. Output layer: corridor_wetlands
10. Ok



The resulting wetland layer will need to be recalculated for acreage, allowing summaries and reports to be generated. The same clip process should be repeated for the shopping center site. To summarize the assumed wetland functions of the impacted wetlands, export the attribute table to a .dbf file and import this into Microsoft Excel. In Excel, use pivot tables to sum the acreages of each function class.

Appendix F. FGDC Metadata for NWI+.

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CITATION
CITATION INFORMATION
ORIGINATOR Atkins - Raleigh, NC
PUBLICATION DATE 2011-12-31
PUBLICATION TIME Unknown
TITLE
Final_Coastal_Counties
EDITION Version 1
GEOSPATIAL DATA PRESENTATION FORM vector digital data
PUBLICATION INFORMATION
PUBLICATION PLACE Raleigh, NC
PUBLISHER Atkins
ONLINE LINKAGE

DESCRIPTION
ABSTRACT
The NWIPlus created additional descriptors for landscape position, landform, water flow path, and waterbody type (LLWW descriptors) to expand wetland classification. The enhanced classification, referred to as NWIPlus allowed for more detailed classification of types that could be used to perform a preliminary assessment of functions for wetlands in the region.
PURPOSE
The data provide consultants, planners, and resource managers with information on wetland location, type and function.

TIME PERIOD OF CONTENT
TIME PERIOD INFORMATION
MULTIPLE DATES/TIMES
SINGLE DATE/TIME
CALENDAR DATE 2006
TIME OF DAY unknown
SINGLE DATE/TIME
CALENDAR DATE 2004
TIME OF DAY unknown
SINGLE DATE/TIME
CALENDAR DATE 2007
TIME OF DAY unknown
CURRENTNESS REFERENCE
ground condition

STATUS
PROGRESS Complete
MAINTENANCE AND UPDATE FREQUENCY Unknown

SPATIAL DOMAIN
BOUNDING COORDINATES
WEST BOUNDING COORDINATE -82.147705
EAST BOUNDING COORDINATE -80.692182
NORTH BOUNDING COORDINATE 32.328462
SOUTH BOUNDING COORDINATE 30.525867

KEYWORDS
THEME
THEME KEYWORD THESAURUS ISO 19115 Topic Category
THEME KEYWORD boundaries
THEME KEYWORD environment
THEME KEYWORD inlandWaters

THEME
THEME KEYWORD THESAURUS EPA GIS Keyword Thesaurus
THEME KEYWORD Ecology
THEME KEYWORD Ecosystem
THEME KEYWORD Environment
THEME KEYWORD Estuary
THEME KEYWORD Natural Resources
THEME KEYWORD Water

PLACE
PLACE KEYWORD THESAURUS None
PLACE KEYWORD Georgia

ACCESS CONSTRAINTS
None.

USE CONSTRAINTS
Federal, State, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, State, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, State, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

POINT OF CONTACT
CONTACT INFORMATION
CONTACT PERSON PRIMARY
CONTACT PERSON David O'Loughlin
CONTACT ORGANIZATION Atkins
CONTACT POSITION Senior Scientist
CONTACT ADDRESS
ADDRESS TYPE mailing address
ADDRESS 1616 E. Millbrook Road, Suite 310
CITY Raleigh
STATE OR PROVINCE NC
POSTAL CODE 27609
COUNTRY United States

CONTACT VOICE TELEPHONE 919-876-6888
CONTACT FACSIMILE TELEPHONE 919-876-6843
CONTACT ELECTRONIC MAIL ADDRESS David.O'Loughlin@atkinsglobal.com

SECURITY INFORMATION
SECURITY CLASSIFICATION SYSTEM FIPS Pub 199
SECURITY CLASSIFICATION No Confidentiality
SECURITY HANDLING DESCRIPTION Standard Technical Controls

NATIVE DATA SET ENVIRONMENT
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 3; ESRI ArcCatalog 10
CROSS REFERENCE
CITATION INFORMATION
ORIGINATOR Atkins
PUBLICATION DATE 12/31/2011
PUBLICATION TIME Unknown

TITLE

Coatal Georgia NWIPlus

EDITION Version 1

GEOSPATIAL DATA PRESENTATION FORM vector digital data

SERIES INFORMATION

SERIES NAME NWIPlus

ISSUE IDENTIFICATION Coastal Georgia

PUBLICATION INFORMATION

PUBLICATION PLACE Brunswick, GA

PUBLISHER GA Coastal Resources Division

Hide Identification ▲

ATTRIBUTE ACCURACY

ATTRIBUTE ACCURACY REPORT

The source data was checked using standard review procedures. Attributes were checked by using visual inspection as well as automated verification routines (USFWS NWI Wetland Verification Tool version 9). Quality of the attribute information varies with age and mapping protocols used when individual maps were prepared

LOGICAL CONSISTENCY REPORT

Polygons intersecting the neatline are closed along the border. Segments making up the outer and inner boundaries of a polygon tie end-to-end to completely enclose the area. Line segments are a set of sequentially numbered coordinate pairs. No duplicate features exist nor duplicate points in a data string. Intersecting lines are separated into individual line segments at the point of intersection. Point data are represented by two sets of coordinate pairs, each with the same coordinate values. All nodes are represented by a single coordinate pair which indicates the beginning or end of a line segment. The neatline is generated by connecting the four corners of the digital file, as established during initialization of the digital file. All data crossing the neatline are clipped to the neatline and data within a specified tolerance of the neatline are snapped to the neatline. Tests for logical consistency are performed by USFWS-NWI Wetland Verification Tool 9 .

COMPLETENESS REPORT

All photo-interpretable wetlands are mapped. In general, the minimum mapping unit is from 0.5 acre but some small wetlands and those obscured by dense forest cover may not be included in this data set. This data set represents the extent of wetlands and deepwater habitats that can be determined with the use of remotely sensed data and within the timeframe for which the maps were produced.

POSITIONAL ACCURACY

HORIZONTAL POSITIONAL ACCURACY

HORIZONTAL POSITIONAL ACCURACY REPORT

Horizontal positional accuracy for the digital data is tested by visual comparison of the source with collateral GIS data.

VERTICAL POSITIONAL ACCURACY

VERTICAL POSITIONAL ACCURACY REPORT

None.

LINEAGE

SOURCE INFORMATION

SOURCE CITATION

CITATION INFORMATION

ORIGINATOR USGS

PUBLICATION DATE 2006

Publication Time Unknown
Title
GA_CoastalNorth_0.5m_Color
Geospatial Data Presentation Form raster digital data
Series Information
Series Name USGS_EDC_Ortho_Coastal
Publication Information
Publication Place
http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_Coastal
Publisher USGS
Online Linkage
http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_Coastal

Type of Source Media seamless digital data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 2006
Source Currentness Reference
ground condition
Source Citation Abbreviation
USGS High Resolution Orthoimagery for Coastal Georgia - Mar. 2006
Source Contribution
The United States Geological Survey High Resolution Orthoimagery for Coastal Georgia dataset, dated 2006, is used as base photography.

Source Information
Source Citation
Citation Information
Originator Florida Bureau of Survey and Mapping
Publication Date 2004
Publication Time Unknown
Title
Florida Bureau of Survey and Mapping-LABINS High Resolution Color Infrared Imagery, dated 2004.
Geospatial Data Presentation Form seamless digital data
Series Information
Series Name LABINS High Resolution Color Infrared Imagery
Issue Identification 2004 Digital Orthographic Quarter-Quad
Publication Information
Publication Place
http://data.labins.org/2003/MappingData/DOQQ/doqq_04_utm_cir.cfm
Publisher Florida Bureau of Survey and Mapping
Online Linkage
http://data.labins.org/2003/MappingData/DOQQ/doqq_04_utm_cir.cfm

Type of Source Media seamless digtial data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 2004
Time of Day unknown
Source Currentness Reference
ground condition
Source Citation Abbreviation

Florida Bureau of Survey and Mapping-LABINS High Resolution Color Infrared Imagery, dated 2004.

SOURCE CONTRIBUTION

Where USGS 2006 imagery was unavailable, Florida Bureau of Survey and Mapping-LABINS High Resolution Color Infrared Imagery, dated 2004, was used as base photography

SOURCE INFORMATION

SOURCE CITATION

CITATION INFORMATION

ORIGINATOR USGS

PUBLICATION DATE 2007

PUBLICATION TIME Unknown

TITLE

National Agriculture Imagery Program imagery, dated 2007

GEOSPATIAL DATA PRESENTATION FORM raster digital data

SERIES INFORMATION

SERIES NAME USGS_EDC_Ortho_NAIP

PUBLICATION INFORMATION

PUBLICATION PLACE

http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_NAIP?

PUBLISHER USGS

ONLINE LINKAGE

http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_NAIP?

TYPE OF SOURCE MEDIA seamless digital data

SOURCE TIME PERIOD OF CONTENT

TIME PERIOD INFORMATION

SINGLE DATE/TIME

CALENDAR DATE 2007

TIME OF DAY unknown

SOURCE CURRENTNESS REFERENCE

ground condition

SOURCE CITATION ABBREVIATION

National Agriculture Imagery Program imagery, dated 2007

SOURCE CONTRIBUTION

Base photgraphy where USGS 2006 and Florida 2004 data was not available. Collateral data.

SOURCE INFORMATION

SOURCE CITATION

CITATION INFORMATION

ORIGINATOR USGS

PUBLICATION DATE 2009

PUBLICATION TIME Unknown

TITLE

National Hydrography Datase

GEOSPATIAL DATA PRESENTATION FORM vector digital data

SERIES INFORMATION

SERIES NAME High resolution National Hydrography Dataset

ISSUE IDENTIFICATION NHDH0306 and NHDH0307

PUBLICATION INFORMATION

PUBLICATION PLACE http://nhd.usgs.gov/data.html

PUBLISHER USGS

ONLINE LINKAGE http://nhd.usgs.gov/data.html

LARGER WORK CITATION

Citation Information
Publication Date 2009
Title
National Hydrography Dataset
Geospatial Data Presentation Form vector digital data
Series Information
Series Name National Hydrography Dataset
Online Linkage http://nhd.usgs.gov/data.html

Type of Source Media seamless digital data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 2009
Source Currentness Reference
publication date
Source Citation Abbreviation
National Hydrography Datase
Source Contribution
The USGS National Hydrography Dataset is used to depict streams. Collateral data.

Source Information
Source Citation
Citation Information
Originator USGS
Publication Date 1999
Publication Time Unknown
Title
USGS Digital Orthophoto Quadrangle CIR
Geospatial Data Presentation Form raster digital data
Series Information
Series Name USGS_EDC_Ortho_DOQQ
Issue Identification DOQQ_Z17_1.0m_Color
Publication Information
Publication Place
http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_DOQQ?
Publisher USGS
Online Linkage
http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_DOQQ?

Type of Source Media seamless digital data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 1999
Source Currentness Reference
ground condition
Source Citation Abbreviation
USGS 1999 Digital Orthophoto Quadrangle color-infrared (CIR) images with 1-meter ground resolution.
Source Contribution
1999 Color Infrared aerial photography used as collateral data.

Source Information
Source Citation

Citation Information
Originator USGS
Publication Date Unknown
Title
USGS 24K Topoquads
Geospatial Data Presentation Form raster digital data
Series Information
Series Name USGS_EDC_Ortho_DRG
Issue Identification DRG_Z17_24K
Publication Information
Publication Place
http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_DRG?
Publisher USGS
Online Linkage
http://ims.cr.usgs.gov:80/wmsconnector/com.esri.wms.Esrimap/USGS_EDC_Ortho_DRG?

Type of Source Media seamless digital data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date unknown
Source Currentness Reference
publication date
Source Citation Abbreviation
USGS 24KTopoquads
Source Contribution
Collateral data

Source Information
Source Citation
Citation Information
Originator USFWS
Publication Date 1983
Publication Time Unknown
Title
Original NWI
Geospatial Data Presentation Form vector digital data
Series Information
Series Name NWI
Publication Information
Publication Place
http://wetlandswms.er.usgs.gov/wmsconnector/com.esri.wms.Esrimap?ServiceName=USFWS_WMS_CONUS_Wetlands&
Publisher USFWS
Online Linkage
http://wetlandswms.er.usgs.gov/wmsconnector/com.esri.wms.Esrimap?ServiceName=USFWS_WMS_CONUS_Wetlands&

Type of Source Media seamless digital data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 1983
Source Currentness Reference
ground condition
Source Citation Abbreviation

Original National Wetlands Inventory
Source Contribution
Collateral data

Source Information
Source Citation
Citation Information
Originator NRCS
Publication Date 2009
Publication Time Unknown
Title
National Resource Conservation Service (NRCS) Soil Data
Geospatial Data Presentation Form vector digital data
Online Linkage http://SDMDataAccess.nrcs.usda.gov/Spatial/SDM.wms

Type of Source Media seamless digital data
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 2009
Source Currentness Reference
publication date
Source Citation Abbreviation
SSURGO soils
Source Contribution
Collateral data

Source Information
Source Citation
Citation Information
Publication Date Unpublished Material
Publication Time Unknown
Title
LiDAR Elevation Data - Glynn County
Geospatial Data Presentation Form raster digital data
Publication Information
Online Linkage none

Type of Source Media disc
Source Time Period of Content
Time Period Information
Single Date/Time
Calendar Date 2009
Source Currentness Reference
publication date
Source Citation Abbreviation
LiDAR Elevation Data - Glynn County
Source Contribution
Collateral data

Source Information
Source Citation
Citation Information
Publication Date Unpublished Material
Publication Time Unknown
Title
Georgia DNR - Wildlife Resources Division Vegetation data for Glynn County National Vegetation Classificatin System

GEOSPATIAL DATA PRESENTATION FORM vector digital data
ONLINE LINKAGE none

TYPE OF SOURCE MEDIA disc
SOURCE CITATION ABBREVIATION
Georgia DNR - Wildlife Resources Division NVCS data - Glynn County
SOURCE CONTRIBUTION
Collateral data

PROCESS STEP
PROCESS DESCRIPTION
LLWW descriptors are added to the project's wetland database by interpreting topography from USGS topographic maps (DRGs) or by analyzing more detailed topographic data. Stream courses are obtained from the NHD and waterbody types are determined by interpreting aerial imagery.
PROCESS DATE 2011

PROCESS CONTACT
CONTACT INFORMATION
CONTACT ORGANIZATION PRIMARY
CONTACT ORGANIZATION Atkins
CONTACT PERSON David O'Loughlin
CONTACT POSITION Senior Scientist
CONTACT ADDRESS
ADDRESS TYPE mailing address
ADDRESS 1616 E. Millbrook Rd., Suite 310
CITY Raleigh
STATE OR PROVINCE NC
POSTAL CODE 27609

CONTACT VOICE TELEPHONE 919-876-6888

Hide Data Quality ▲
HORIZONTAL COORDINATE SYSTEM DEFINITION
PLANAR
PLANAR COORDINATE INFORMATION
PLANAR COORDINATE ENCODING METHOD coordinate pair
COORDINATE REPRESENTATION
ABSCISSA RESOLUTION 0.000156
ORDINATE RESOLUTION 0.000156
PLANAR DISTANCE UNITS meters

GEODETIC MODEL
HORIZONTAL DATUM NAME North American Datum of 1983
ELLIPSOID NAME Geodetic Reference System 80
SEMI-MAJOR AXIS 6378137.000000
DENOMINATOR OF FLATTENING RATIO 298.257222

VERTICAL COORDINATE SYSTEM DEFINITION
ALTITUDE SYSTEM DEFINITION
ALTITUDE RESOLUTION 0.000100
ALTITUDE ENCODING METHOD Explicit elevation coordinate included with horizontal coordinates

Hide Spatial Reference ▲
DETAILED DESCRIPTION

ENTITY TYPE
ENTITY TYPE LABEL Final_Coastal_Counties

ATTRIBUTE
ATTRIBUTE LABEL OBJECTID
ATTRIBUTE DEFINITION
Internal feature number.
ATTRIBUTE DEFINITION SOURCE ESRI
ATTRIBUTE DOMAIN VALUES
UNREPRESENTABLE DOMAIN
Sequential unique whole numbers that are automatically generated.

ATTRIBUTE
ATTRIBUTE LABEL Shape
ATTRIBUTE DEFINITION
Feature geometry.
ATTRIBUTE DEFINITION SOURCE ESRI
ATTRIBUTE DOMAIN VALUES
UNREPRESENTABLE DOMAIN
Coordinates defining the features.

ATTRIBUTE
ATTRIBUTE LABEL GLOBALID
ATTRIBUTE DEFINITION
USFWS internal database id

ATTRIBUTE
ATTRIBUTE LABEL ATTRIBUTE
ATTRIBUTE DEFINITION
Cowardin classfication
ATTRIBUTE DEFINITION SOURCE Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31.

ATTRIBUTE
ATTRIBUTE LABEL ACRES
ATTRIBUTE DEFINITION
wetland polygon area

ATTRIBUTE
ATTRIBUTE LABEL WETLAND_TY
ATTRIBUTE DEFINITION
English definition of Cowardin classification. Unused.
ATTRIBUTE DEFINITION SOURCE Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31.

ATTRIBUTE
ATTRIBUTE LABEL Landscape
ATTRIBUTE DEFINITION
Landscape Position

ATTRIBUTE
ATTRIBUTE LABEL LP_Type
ATTRIBUTE DEFINITION
Lotic Gradient, Lentic Type, or Estuary Type

ATTRIBUTE
ATTRIBUTE LABEL Landform
ATTRIBUTE DEFINITION
Landform Position

ATTRIBUTE
ATTRIBUTE LABEL Land_Mod
ATTRIBUTE DEFINITION
Landform Modifier (sl-slough, rs-reservior, pd-pond)

ATTRIBUTE
ATTRIBUTE LABEL Water_Flow
ATTRIBUTE DEFINITION
Water Flow Path

ATTRIBUTE
ATTRIBUTE LABEL Modifier
ATTRIBUTE DEFINITION
Other Modifiers (dr-partially drained, hw-headwater, td-tidally restricted by road)

ATTRIBUTE
ATTRIBUTE LABEL Waterbody
ATTRIBUTE DEFINITION
Waterbody Type

ATTRIBUTE
ATTRIBUTE LABEL Water_Type
ATTRIBUTE DEFINITION
Waterbody Descriptor (1-low gradient/natural lake, 3-excavated pond, 5-tidal gradient)

ATTRIBUTE
ATTRIBUTE LABEL Water_Mod
ATTRIBUTE DEFINITION
Waterbody Modifier (a- agriculture, c- commercial, e- residential)

ATTRIBUTE
ATTRIBUTE LABEL WB_Flow
ATTRIBUTE DEFINITION
Waterbody Flow Path

ATTRIBUTE
ATTRIBUTE LABEL Other_Mod
ATTRIBUTE DEFINITION
Other Modifiers (ch-channelized, fv-floating vegetation)

Hide Entities and Attributes ▲

DISTRIBUTOR
CONTACT INFORMATION
CONTACT PERSON PRIMARY
CONTACT PERSON David O'Loughlin
CONTACT ORGANIZATION Atkins
CONTACT POSITION Senior Scientist
CONTACT ADDRESS
ADDRESS TYPE mailing address
ADDRESS 1616 E. Millbrook Road, Suite 310
CITY Raleigh
STATE OR PROVINCE NC

Postal Code 27609

Contact Voice Telephone 919-876-6888
Contact Facsimile Telephone 919-876-6848
Contact Electronic Mail Address David.O'Loughlin@atkinsglobal.com

Resource Description Downloadable Data
Distribution Liability
None

Hide Distribution Information ▲

Metadata Date 2010-02-15
Metadata Contact
Contact Information
Contact Person Primary
Contact Person David O'Loughlin
Contact Organization Atkins
Contact Position Senior Scientist
Contact Address
Address Type REQUIRED: The mailing and/or physical address for the organization or individual.
City REQUIRED: The city of the address.
State or Province REQUIRED: The state or province of the address.
Postal Code REQUIRED: The ZIP or other postal code of the address.

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Metadata Standard Name FGDC Content Standards for Digital Geospatial Metadata
Metadata Standard Version FGDC-STD-001-1998
Metadata Time Convention local time

Metadata Access Constraints None
Metadata Use Constraints
None
Metadata Security Information
Metadata Security Classification Unclassified