U.S. Fish & Wildlife Service

HABITAT MANAGEMENT PLAN FOR

ROANOKE RIVER NATIONAL WILDLIFE REFUGE

Bertie County, North Carolina

Southeast Region

Roanoke River National Wildlife Refuge

Habitat Management Plan

U.S. Department of the Interior
Fish and Wildlife Service
Southeast Region

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Executive Summary

Habitat management plans are dynamic working documents that provide refuge managers with a decision-making process; and long-term vision, continuity, and consistency for habitat management on refuge lands. This habitat management plan (HMP) incorporates the role of the refuge habitat in national, regional, state, ecosystem, and refuge goals and objectives; guides analysis and selection of specific habitat management strategies to achieve habitat goals and objectives; and utilizes key data, scientific literature, expert opinion, and staff expertise.

Refuge staff solicited comments on this HMP by requesting a scientific peer review from several of its partners. Representatives of the North Carolina Wildlife Resources Commission (NCWRC), The North Carolina Chapter of the Nature Conservancy (TNC), and researchers from the U.S. Geological Survey (USGS) and universities that have an intimate knowledge of refuge resources were consulted and given an opportunity to review and comment on the goals and objectives presented in this HMP. The Fish and Wildlife Service (Service) offices that reviewed this HMP include: Division of Ecological Services - Raleigh Field Office; South Atlantic Fisheries Office; and the National Wildlife Refuge System, Southeast Region.

This HMP is designed to guide the refuge in its management of habitat for the next 15 years. A foundation is provided with the vision of the Roanoke River National Wildlife Refuge (NWR), as stated in its Comprehensive Conservation Plan, an outline of the legal mandates that the Roanoke River NWR is charged with, and how this HMP fits with the other plans developed by other agencies and organizations with similar functions. A discussion of the strategic habitat conservation process by which refuge's plan and revise plans is provided to inform the reader of how this HMP will be used and updated over time.

Physical characteristics of the landscape are provided, including descriptions of the habitats found on Roanoke River NWR. The historical uses and human induced impacts are outlined to provide a context for the current state of Roanoke River NWR's natural resources. This information supports the goals of the refuge and the objectives and strategies that have been developed to provide long-term management of refuge habitats and those wildlife species that are dependent on them.

Finally, a prescription is provided for the objectives specific to each management unit on the refuge and the strategies designed to achieve those objectives.

I. Introduction

SCOPE AND RATIONALE

In September 2005, the Fish and Wildlife Service (Service) published the Comprehensive Conservation Plan (CCP) for the Roanoke River National Wildlife Refuge (NWR). The Record of Decision was signed and the Environmental Impact Statement for the Roanoke River NWR CCP was completed. As part of the planning, and National Environmental Policy Act (NEPA) processes associated with the CCP, the Service evaluated the effects of implementing a broad range of fish, wildlife, and habitat management programs and techniques to achieve refuge purposes, goals, and objectives; address FWS trust resource responsibilities; maintain and, where appropriate, restore biological integrity, diversity, and environmental health; and support achievement of the National Wildlife Refuge System (Refuge System) mission over the next 15 years.

This HMP is one of several step-down plans that provide refinement of the Roanoke River NWR CCP. This HMP puts forth more specific guidance for habitat management to support legal mandates, as well as the conservation, management, and, where appropriate, restoration of local, regional, and ecosystem fish, wildlife, and habitat resources. The statutory authority for conducting habitat management planning on national wildlife refuges is derived from the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), 16 U.S.C. 668dd-668ee. Section 4(a) (3) of the Improvement Act states: "With respect to the System, it is the policy of the United States that each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established" and Section 4(a)(4) states: "In administering the System, the Secretary shall monitor the status and trends of fish, wildlife, and plants in each refuge." The Improvement Act provides the Service with the authority to establish policies, regulations, and guidelines governing habitat management planning within the Refuge System.

This HMP was prepared in accordance with guidance for developing HMPs provided by the Service's Habitat Management Plan policy (620 FW 1). This HMP will provide direction for the next 15 years. Subsequent reviews every five years, and an adaptive management approach, will assess and modify management activities as research, monitoring, and priorities require.

REFUGE VISION

The vision for Roanoke River NWR as stated in the CCP is as follows:

"Roanoke River National Wildlife Refuge will protect, enhance, and manage high-quality habitat for a diversity and abundance of migratory birds, fish, and other wildlife. Through new and existing partnerships, the refuge will foster and practice sound conservation in land management and river flow management to assure the physical and biological integrity and diversity of the Roanoke River floodplain. The refuge will provide compatible wildlife-dependent public use opportunities, including environmental education, interpretation, and recreation. The refuge will provide increased opportunities to learn about the ecological and cultural importance of the Roanoke River floodplain. The refuge will become a national destination, and activities on the refuge will contribute to the local economy."

LEGAL MANDATES

The purposes of a national wildlife refuge, as established by Congress or the Executive Branch, are the barometer by which all actions on that designated public land are measured. Habitat management, public use, and all other programs are required to fulfill the established purposes of the refuge.

The purpose of Roanoke River NWR, as reflected in the authorizing legislation, is to protect and conserve migratory birds, and other wildlife resources through the protection of wetlands, in accordance with the following laws:

> "the conservation of wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions" (16 U.S.C., Sec. 3901(b), 100 Stat. 3583) (Emergency Wetlands Resources Act of 1986);
>
> "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds" 16 U.S.C. Sec. 664 (Migratory Bird Conservation Act of 1929);
>
> "for the development, advancement, management, conservation, and protection of fish and wildlife resources" 16 U.S.C. Sec 742f(a)4; and
>
> "for the benefit of the United States Fish and Wildlife Service, in performing its activities and services" 16 U.S.C. Sec. 742f(b)1 (Fish and Wildlife Act of 1956).

RELATIONSHIP TO OTHER PLANS

National Wildlife Refuge System Improvement Act:

In addition to the specific purposes that were established for each refuge, Congress passed the Improvement Act in 1997. This legislation provides clear guidance for the mission of the Refuge System and priorities for wildlife-dependent public uses. The Improvement Act states that each refuge will:

- Fulfill the mission of the Refuge System;
- Fulfill the individual purposes of each refuge;
- Consider the needs of wildlife first;
- Fulfill requirements of comprehensive conservation plans that are prepared for each unit of the Refuge System;
- Maintain the biological integrity, diversity, and environmental health of the Refuge System; and
- Recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation are legitimate and priority public uses; and allow refuge managers authority to determine compatible public uses.

The purpose of this HMP is to provide more specific guidance that will facilitate the selection of prescriptions for implementing the goals and objectives of the CCP. In order to maintain

consistent strategies for managing wildlife and habitats on the refuge on a local, regional, and national scale, several other planning documents were used in the development of this HMP.

THE NORTH AMERICAN WATERFOWL MANAGEMENT PLAN

The North American Waterfowl Management Plan (NAWMP) of 1986 brings together international teams of biologists from private and government organizations from Canada and the United States. Regional partnerships, called joint ventures, work to restore waterfowl and other migratory bird populations to the levels of the early 1970s by protecting about 6 million acres of priority wetland habitats from the Gulf of Mexico to the Canadian Arctic. The Atlantic Coast Joint Venture focus is that of the middle and upper Atlantic coast where it manages and operates programs of regional scope within the NAWMP.

Priority species identified in the NAWMP that occur within the lower Roanoke River Basin were considered when identifying focal species and when developing habitat management objectives.

THE SOUTH ATLANTIC MIGRATORY BIRD INITIATIVE IMPLEMENTATION PLAN

From the NAWMP came the South Atlantic Migratory Bird Initiative (SAMBI), which integrates bird conservation planning and implementation of the Management Board of the Atlantic Coast Joint Venture; a step-down to the implementation of the ideas in the NAWMP. This HMP provides a regional scale framework for the conservation of waterfowl, shorebirds, waterbirds, landbirds, and upland game birds. The framework utilizes existing national and regional plans of the NAWMP, United States Shorebird Conservation Plan, Partners in Flight, North American Waterbird Conservation Plan, and the Northern Bobwhite Conservation Initiative, to build a framework for regional bird conservation. This framework seeks to integrate common goals and objectives of these national and regional plans, providing conservationists a strategy for meeting the challenge of sustaining healthy ecosystems and healthy bird populations in the midst of increasing threats along the Atlantic coast. The SAMBI identifies priority species, priority habitats, priority areas, and strategies to achieve the conservation of “all birds across all habitats” in this region. It is a result of the collaboration of federal, state, non-governmental, and private interests to build a cohesive strategy for bird conservation in the southeastern United States.

Priority species and habitats were considered in the development of the resources of concern section and habitat goals and objectives section of this HMP.

PARTNERS IN FLIGHT PLAN

The South Atlantic Coastal Plain serves as primary migration and nesting habitat for migratory songbirds returning from Central and South America. It also provides wintering, breeding, and migration habitat for mid-continental wood duck and colonial bird populations. Restoration of migratory songbird populations is a high priority of the Partners in Flight Plan.

The Partners in Flight Plan emphasizes land bird species as a priority for conservation. Habitat loss, population trends, and the vulnerability of species and habitats to threats are all factors used in the priority ranking of species. The conservation priorities set forth in the Partners in Flight Plan were considered when the habitat, goals, and objectives were developed for this HMP.

NORTH CAROLINA WILDLIFE ACTION PLAN

State Wildlife Action Plans (SWAP) emerged from a mandate by the Congress that each state develop a comprehensive conservation strategy to be eligible for federal funding under the State Wildlife Grants program. The North Carolina Wildlife Resources Commission (NCWRC) is a critical partner in the effort to implement conservation strategies. In 2005, NCWRC published its SWAP that identifies 371 priority species, ranging from birds, mammals, reptiles, amphibians, fish, mollusks, and crustaceans that are targeted for conservation action in North Carolina. The North Carolina SWAP was consulted during the development of this HMP and its species of conservation priority were considered in the development of the resources of concern section.

NORTH AMERICAN WATERBIRD CONSERVATION PLAN

This HMP provides a framework for the conservation and management of 210 species of waterbirds in 29 nations. Threats to waterbird populations include destruction of inland and coastal wetlands, introduced predators and invasive species, pollutants, mortality from fisheries, industries, disturbance, and conflicts arising from abundant species. Particularly important habitats of the Service's Southeast Region include pelagic areas, marshes, forested wetlands, and barrier and sea island complexes. A key objective of this HMP is to ensure that adequate and suitable habitat is available for nesting and migratory waterbirds that utilize the habitats on the lower Roanoke River. The North American Waterbird Conservation Plan was consulted during the development of this HMP and its species of conservation priority were considered in the development of the resources of concern section.

STRATEGIC HABITAT CONSERVATION

Due to a rapidly changing world, and growing threats to conservation that were unimaginable just a few short years ago, there is an increasingly urgent need to embrace a strategic approach to landscape conservation. In addition to the continually expanding dual threats of human development of wild places and invasive exotic species' direct and indirect impacts on wild things, there is also an additional 21st century "perfect storm" of an increasingly disengaged public and a climate warming to the point of changing where wildlife and their habitats appear and disappear. The former warrants quick action, with the latter demanding that the Service move forward strategically. The problems before the conservation community are global in nature, and the Service must adapt a framework capable of dealing with the issues at the global scale.

Strategic habitat conservation (SHC) is a science-based framework for making management decisions about where and how to deliver conservation efficiently to achieve specific biological outcomes. It is an approach to conservation management that the Service has recently adopted. Although originally focused on habitat conservation, this strategic conservation approach addresses both habitat and non-habitat factors limiting fish and wildlife populations. The SHC approach is a way of thinking and of doing business that requires a set of specific biological goals that will assist the Service in making strategic decisions about its work on refuges and across the landscapes for which it has responsibility. The approach encourages conservation managers to constantly reassess and improve their actions. Thus, it is vital that partners be informed and engaged in a dialog about SHC and about how the Service and its partners each apply their resources and authorities to conserve landscapes capable of sustaining all fish and wildlife species.

The SHC model is an adaptive management model with its elements being tailored to resource management. The framework of the SHC model consists of an iterative cycle of five mutually supporting elements. The five elements that make up the SHC model are described below, followed by a schematic:

1. Biological planning - usually the first step in the SHC approach. This is where resource managers assemble the biological foundation for conserving their priority or trust species. Identification of priority species and a subset of focal species are designated here, along with population objectives and models that describe expected focal species-habitat relationships.

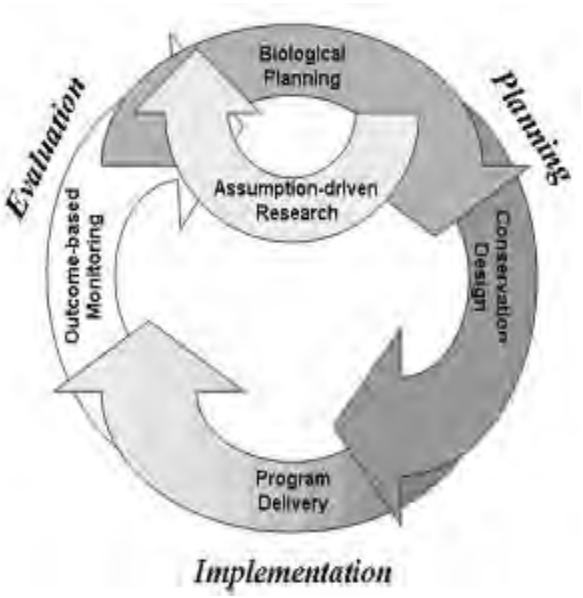
2. Conservation design - involves applying models to spatial data that culminates in the designation of priority management areas and coarse estimates of the amount of habitat that will be needed to attain a suite of population objectives for identified priority species.

3. Conservation delivery - involves implementing management actions (e.g., prescribed burning, thinning a stand of trees, water control, etc.) with the goal of efficiently affecting populations.

4. Outcome based monitoring - this is the point at which resource managers assess the effects of their management actions on habitats and individuals and determine whether focal species representing the target species guild(s) are benefiting from the prescribed management action. Inferences at multiple scales that have a bearing on future management decisions are also made based on monitoring results. Monitoring can be in the form of avian point counts, waterfowl surveys, forest inventories, winter waterfowl surveys, etc., depending on resource targets. Most importantly, emphasis should be placed on ensuring that other priority species within the focal species guild are not being adversely affected from the prescribed management actions and the focal species are still a good indicator for the guild it is representing.

5. Assumption driven research - this step involves evaluating the information collected during monitoring and feeds back into the biological planning step. It is at this point resource managers face the reality of whether their management actions are benefiting identified priority wildlife species and influences future conservation decisions and actions.

Figure 1. Diagram of the strategic habitat conservation model that shows the five elements and how they interact with one another



The five elements of the SHC model can be found woven throughout this HMP. Biological planning is addressed in Table 2, which outlines the species guilds and associated habitats found on the refuge. Priority species have been identified from a number of regional conservation plans along with a subset of focal species for each associated habitat. The conservation design element has been addressed in defining where the Roanoke River NWR fits into the larger landscape within the lower Roanoke River Basin as well as that of eastern North Carolina. The habitat types identified to support the selected focal species will augment those found on state and TNC lands and, to a lesser extent, on private lands. The goals and objectives outlined in Section IV and Table 2 identify the habitat types that will be managed or maintained on refuge lands in order to support the focal species selected in the biological planning element. The management prescriptions and strategies to be implemented in order to attain the set of habitat attributes outlined in the objectives is the conservation delivery component of the SHC model. Most importantly, a monitoring component has been built into each objective in order to track the effectiveness of each habitat management action in meeting the stated objectives. Information gathered in the monitoring component will feed back into the appropriateness and effectiveness of a management action.

The ever-increasing challenges before natural resource managers today and the complexities associated with addressing each one are an overwhelming task. No one agency has the tools on hand to take on the challenges singlehandedly. The SHC model is an approach the Service is taking in an effort to apply the best science to the conservation challenges of the 21st Century and allow the Service to make informed conservation decisions together with its partners. To ensure the science is being put in the right place and to fulfill the information needs among partners with different missions, the Service and USGS have developed a national geographic framework for implementing SHC at landscape scales. Landscape conservation cooperatives (LCCs) are public-private partnerships that recognize the various challenges before managers today and realize these challenges transcend political and jurisdictional boundaries that cover a given geographic area. The United States as well as parts of Canada and Mexico have been divided

into 21 different geographical landscapes and are based on ecosystem boundaries on a very broad scale. Examples include: The Great Plains, Desert, Appalachian, North Pacific, North Atlantic, Upper Midwest, and Great Lakes. The Roanoke River NWR fits into the South Atlantic Landscape Conservation Cooperative (SALCC). To ensure the sustainability of America's land, water, wildlife and cultural resources, a more networked approach to conservation through the implementation of the SHC model across the LCCs will ensure a holistic, collaborative, adaptive approach that is grounded in science over a large geographic range.

CLIMATE CHANGE PREDICTIONS

Climate change is already having visible impacts in the United States and its coastal waters--reduced sea ice in the Arctic, longer summer droughts, reduced availability of water, rapidly retreating glaciers, earlier springs resulting in certain plants and animals pushing further north, and changes in salinity and the distribution of algae and fish in oceans, lakes, and streams. Here in North Carolina the greatest concern will be sea level rise, increase in temperatures, and changes in precipitation patterns. Climate change is a real threat to the natural communities that we know today. The challenge of the Service and its conservation partners is to plan for how these natural communities will change and to ensure that sufficient habitat is available for those species that will be moving to new locations in an effort to seek more favorable habitat conditions. As mentioned earlier, the Service is working with numerous partners to address the challenge that climate change will bring. The LCCs give the conservation community a geographic framework to implement the SHC model in an effort to address the challenges that climate change will bring to the conservation community by ensuring that the energy placed in present and future planning and management efforts are put in the right place at the right time.

SEA LEVEL RISE

A recent study out of the University of Pennsylvania has found the rate of sea level rise along the Atlantic coast of the United States to be greater now than it has been at any other point in the past two millennia (Kemp et al. 2011). Conservative estimates from the Intergovernmental Panel on Climate Change (IPCC) indicate that coastal North Carolina has over one million acres of land below one meter of elevation and over 1.4 million acres of land in North Carolina are below 1.5 meters (Titus and Richman 2001) -- the third largest low-lying region in the U.S. after Louisiana and Florida (IPCC 2007). A valuable tool for assessing the vulnerability of low-lying areas to sea level rise is the use of Light Detection and Ranging (LiDAR) data. LiDAR is an optical remote sensing technology that can measure the distance to a target, in this case the earth's surface, by illuminating the target with light, often using pulses from a laser. With an accuracy of 20 cm for the state, resource managers are able to determine how and where they will need to concentrate their conservation efforts. The North Carolina Coastal Resources Commission Science Panel predicts a sea level rise for North Carolina from a minimum of 0.50 meters to a maximum of 1.4 meters by 2100. A delayed positive feedback may result in an underestimation of the contribution from land use resulting in a total sea level rise above 1.4 meters (DeWan 2010; NCDENR 2010). If higher than predicted rates of ice sheet melting occurs, it is estimated that eastern North Carolina could see up to a 2-meter rise in sea level. For conservation interests in eastern North Carolina, this means that thousands of acres of conservation lands will be converted to either open water or marsh habitats with the capacity of the land to provide habitat for terrestrial dwelling species lost. Much of the lower Roanoke River floodplain up to Jamesville may be inundated along with significant areas in Bertie County, in the vicinity of Williamston. If the influence of the Outer

Banks is lost, the Roanoke River may be influenced by lunar tides and increases in salinity. This would have profound implications for aquatic and terrestrial resources in the lower Roanoke River. It is estimated that 7,800 acres of refuge lands will be affected by sea level rise. A map of the lower and middle reaches of the Roanoke River showing predicted inundation at 0.5 meters and 1.0 meters of sea level rise can be found in Appendix A.

INCREASED TEMPERATURES

Increased temperatures may also cause shifts in the geographic distribution of species in places where temperature increases exceed a species physiological tolerances. It is predicted that species more typical to the southern latitudes will likely move into North Carolina as the summers become longer and warmer to the south. Species, such as wood stork, white ibis, spoonbills, and eventually marsh birds may become a common occurrence along the Roanoke River as sea level rise brings wetter, marsh-like conditions along with milder winters. In addition, those species of reptiles and amphibians currently common to more southern states will work their way to North Carolina, displacing current native species; local species may be lost as they shift north in response to climate change. It is expected that there will be significant shifts in ecosystem type, dynamics, and structure.

II. Background and Environmental Setting

GEOGRAPHICAL SETTING

Roanoke River NWR is one of ten national wildlife refuges in eastern North Carolina and those ten refuges – Alligator River, Cedar Island, Currituck, Great Dismal Swamp, Mackay Island, Mattamuskeet, Pea Island, Pocosin Lakes, Roanoke River, and Swanquarter, and Back Bay National Wildlife Refuge in Virginia – are all in the watersheds of the Roanoke, Chowan, Tar, Neuse, and Cape Fear Rivers, that lie in the northern most part of the South Atlantic Landscape Conservation Cooperative.

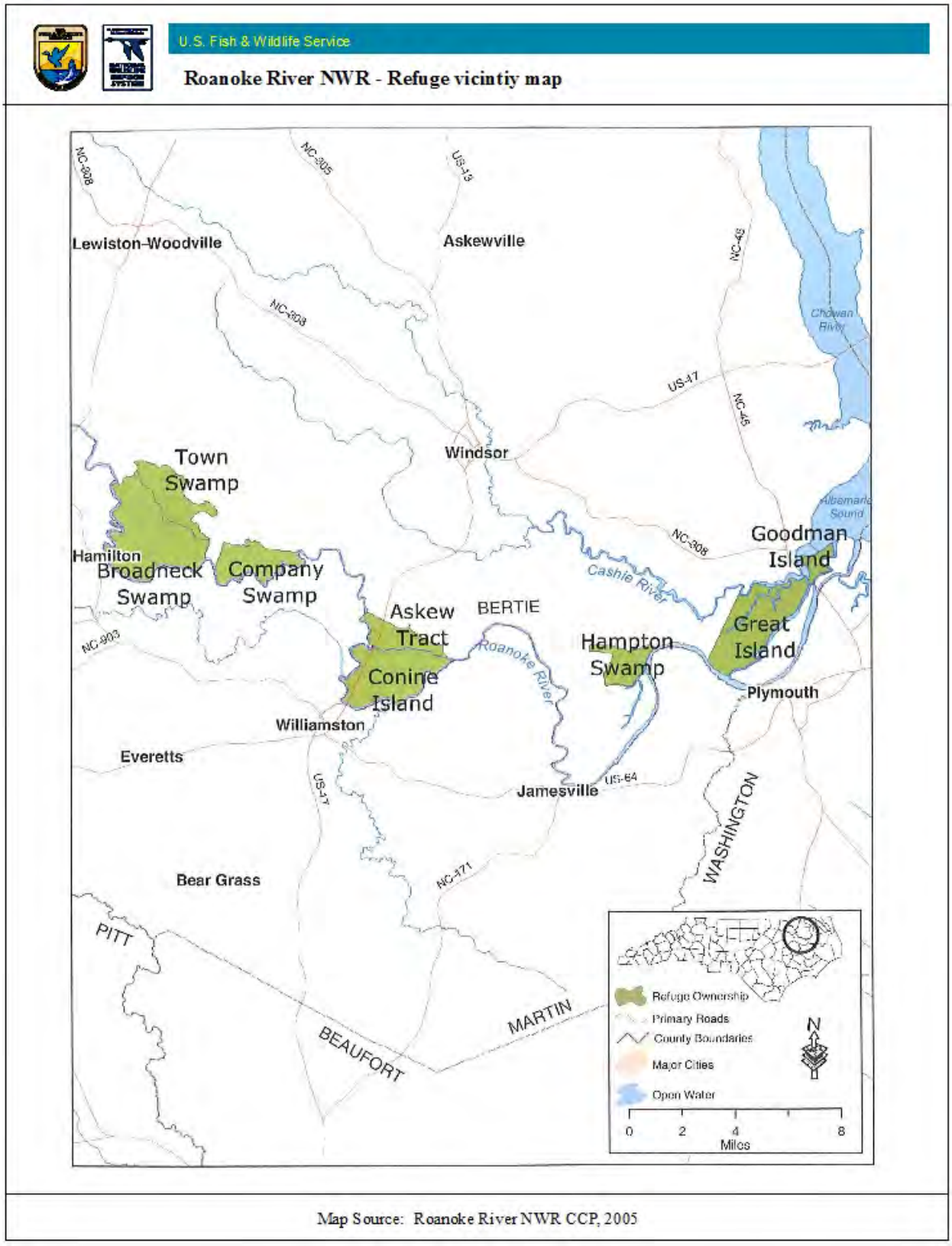
REFUGE LOCATION

Roanoke River NWR is in Bertie County, North Carolina. The refuge is named for the Roanoke River, a 442-mile-long river with 9,875 square miles of drainage area in North Carolina and Virginia. The approved acquisition boundary for the refuge lies in Bertie, Martin, and Halifax Counties; The Service has so far acquired land only in Bertie County. The city of Windsor (population 2,056) is 10 miles northeast of the refuge, and the city of Williamston (population 5,503) lies just southwest of the refuge (Figure 2). Roanoke River NWR covers a total of 20,978 acres of the approved 33,000 acres, and its southeastern end is at the outlet of the Roanoke River where it enters the Albemarle Sound. This region is part of the physiographic area known as the South Atlantic Coastal Plain and the Service's administrative ecosystem is the northeast North Carolina/southeast Virginia Strategic Habitat Conservation Planning area.

MANAGEMENT UNITS

An essential part of a habitat management program is having well-defined management areas. These clearly defined areas are necessary to carry out refuge management objectives and to ensure communication and understanding among refuge personnel, while implementing management strategies. Roanoke River NWR is divided up into tracts, units, compartments, and stands. There are seven distinct tracts identified: Broadneck, Town Swamp, Company Swamp, Askew, Conine Island, Hampton Swamp, and the Islands (Great, Goodman, and Sunken). The tracts are broken down into units that are easily delineated by roads, refuge boundaries, or bodies of water. Compartments nested within a unit are differentiated between the forest community currently present (e.g., plantations, impoundments, or natural areas). Natural areas consist of bottomland hardwood forests, tupelo/cypress swamps, hydrologically disconnected floodplain forests, and swamp blackgum/mixed peatland forests. The stand number assigns a unique identifier to a compartment for the purpose of forest prescription development. As management actions are carried out, stands and/or compartments will be consolidated into larger similar units or compartments. A table listing the tracts and the corresponding units and compartments can be found in Appendix B.

Figure 2. Location and tracts of Roanoke River NWR in Bertie County, North Carolina



Map Source: Roanoke River NWR CCP, 2005

PHYSICAL FEATURES

CLIMATE

The flow of air over North Carolina is predominantly from west to east. The continental influence is much greater than the ocean or marine influence, therefore, the area where Roanoke River NWR falls experiences a fairly large variation in temperature from winter to summer.

The Gulf Stream current flows only a short distance off the North Carolina coast. One might think this "river" of warm water would have a profound effect on the climate; however, the prevalence of westerly winds limits its direct effects.

Winter storms bring prolonged periods of steady rain and are responsible for most of the winter precipitation. The average seasonal snowfall is about 6 inches. The greatest snow depth at any one time during the period of record was 14 inches. The forms of precipitation in spring begin to change from these steady rains to occasional thunderstorms. The warm, moist air that comes up from the Gulf of Mexico produces warm, humid weather throughout the summer when rainfall comes from occasional thunderstorms. Autumn is the driest season with occasional tropical storms providing significant rainfall. Table 1 lists the average monthly precipitation and temperatures by month over a 10-year period.

Impacts of occasional hurricanes in Bertie County are secondary; the storms usually pass off the coast east of the area. The most recent hurricanes that scored direct hits were Floyd in 1999, Isabel in 2003, and Irene in 2011. Most of the tornadoes that occur in North Carolina occur in the Piedmont and the interior of the coastal plain, which spares Bertie and Martin Counties. However, tornadoes have touched down four times since 1992, causing damage to refuge lands and, in one case, maintenance facilities.

Table 1. Monthly average max/min temperature is tabulated along with monthly average rainfall amounts from January 1, 2000, through December 31, 2010

The annual average precipitation and average maximum/minimum temperature is listed in the far right column. Data were compiled and collected at the North Carolina Department of Agriculture's Peanut Belt Research Station located in Lewiston, North Carolina, approximately 10 miles from the refuge's Broadneck Tract.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	50.6	53.8	62.6	72.1	78.4	86.7	88.3	88.5	81.9	72.5	63.4	53.0	**70.9**
Average Min. Temperature (F)	31.4	32.7	39.9	48.6	57.0	66.0	68.7	68.6	61.8	50.1	41.3	33.5	**49.9**
Average Total Precipitation (in.)	2.28	1.67	6.07	1.21	2.07	3.49	5.32	4.09	3.25	0.81	6.61	5.83	**43.26**

GEOLOGY

The Roanoke-Albemarle system can be divided into three distinctive parts: upper Roanoke River, lower Roanoke River, and Albemarle Sound estuarine system. The upper Roanoke River (above the Roanoke Rapids Dam) constitutes 65 percent of the river drainage system and is located within the Mountain geologic province of Virginia and the Piedmont province of Virginia and North Carolina. The lower Roanoke River Basin (below the Roanoke Rapids Dam to about 5 miles northeast of Plymouth) constitutes a much smaller portion of the river drainage basin (35 percent) and is within the Coastal Plain Province. With an average flow of six-billon-gallons per day, the Roanoke River drains into the western end of the Albemarle Sound, supplying more than 50 percent of the water to the Sound (Bales et al. 1993).

The Coastal Plain begins at the "Fall Line," which is a broad transition zone where the crystalline rocks of the Piedmont (i.e., the igneous and metamorphic rocks that cause the rapids in the Roanoke River at Roanoke Rapids) become buried by the marine sediments of the Coastal Plain. Refuge lands are underlain with Miocene deposits consisting of gray or greenish-gray sands, drab clays, and shell marl. These soils are located beneath a thin covering of sand and sandy loams which makeup the Pleistocene terrace formations. Along the Roanoke River, the compact, drab or greenish drab clays and gray, arkosic sands of the Patuxent formations (Lower Cretaceous) rise a few feet above the water level and immediately underlie the Chowan formation, which borders the river. The Miocene layer is readily visible on the steep bluffs that make up the river channel in Martin and Halifax Counties. Here one can observe clam shells, sharks teeth, and corals in the Miocene marl deposits that date back more than 5 million years. Thin beds of Quaternary sediments were deposited on the surface of the Coastal Plain during the past three million years (Riggs and Belknap 1988). This Quaternary history and the resulting surface veneer of unconsolidated sediments directly dictates the general characteristics of the Coastal Plain, including the regional morphology and character of the drainage systems and flooded estuaries, soil types, and potential land use. The Quaternary sediments range from a few meters in thickness in places along the lower Roanoke River up to 70 meters in the outer Albemarle area (Riggs et al. 1992.). The Quaternary history continues today.

HYDROLOGY

Present on the river today approximately70 miles upstream of the Broadneck tract is a series of dams that have a significant effect on the River's Coastal Plain hydrology. From downstream to upstream are Roanoke Rapids, Gaston, and John H. Kerr Dams. The Roanoke Rapids dam, which became operational in 1955, is 3,050 feet long and forms an eight-mile-long reservoir with a surface area of 4,600 acres and 47 miles of shoreline. It took 245,000 cubic yards of concrete to build the dam — the equivalent of a sidewalk six feet wide and 189 miles long. The power house rests atop a rock foundation 70 feet above sea level, and rises at its crest to an elevation of 142 feet above sea level. A submerged weir — an underwater dam — is located within the reservoir just before the dam's intakes to direct surface water from the lake into the station. The weir rises to within 25 feet of the surface to ensure that high-quality water is discharged from the power station to benefit the aquatic life and provide recreational opportunities and economic growth in the lower Roanoke River Basin. Gaston Dam, completed in 1963, has four generators that can produce up to 56 megawatts each, or a total capacity of 224 megawatts. The 3,600-foot-long and 105-foot-high Gaston dam lies about eight miles upstream from the Roanoke Rapids Dam. Lake Gaston is 34 miles long with more than 20,000 acres of surface area and 350 miles of shoreline. Like Roanoke Rapids, a submerged weir at Lake Gaston, directs surface water from the lake into the station. The weir rises to within 15 feet of the surface. Both Roanoke Rapids and Gaston

Dams are owned and operated by Dominion Power Company, a private, for-profit utility. John H. Kerr Dam is located about 179 river miles above the mouth of the Roanoke River. The dam was first opened in 1953. The top elevation of Kerr Dam is 322 feet above mean sea level (msl) and has an overall length of 2,785 feet. The maximum height above the streambed is 144 feet. The powerhouse has six vertical shaft Francis turbines for a total installed capacity of 206,000 kw. Kerr Reservoir is a U.S. Army Corps of Engineers (USACE) flood control project with an elevation of 300 feet above msl, covers an area of 48,900 acres, and has a shoreline length of 800 miles.

These three dams, all constructed in the piedmont province of the Roanoke River Basin (Figure 3), have markedly altered the hydrologic characteristics of the lower portion of the river by reducing the frequency of low- and high-flows and increasing the frequency and duration of moderate flows (Figure 4). Water is the driving force in creating and maintaining the ecological integrity of bottomland forest communities. When these flows are significantly altered from what the floodplain and riverine ecosystem evolved with, the potential for ecological degradation of the natural communities' results in a loss to the natural system by reducing the range of natural variance and extremes that helps to maintain the diversity and integrity of bottomland systems. More on the river's hydrology and influences on floodplain flora and fauna can be found in Section II.D.2., III.B.

A glimpse into the distant past gives an indication of historical hydrologic conditions on the lower Roanoke River. Using pollen assemblages found in floodplain deposits on the lower Roanoke River, soil cores were collected and carbon dated. Findings indicate that there were sustained multi-century periods of wet and dry conditions throughout the last 2,400 years (Willard et al. 2011). During this time, floodplain hydroperiods varied by an order of magnitude. One important note to take away from these findings is that although recent anthropogenic alterations of the landscape and river discharge have affected forest composition throughout the watershed, the resulting hydrologic changes are minor compared to the natural hydrologic variability of the last 2,400 years. In other words, pre-colonial hydrologic variation greatly exceeded the hydrologic variability resulting from the dam management today. This leaves one to believe in the resilience of natural communities. However, one cannot help to think about the scale throughout the southeast that floodplain habitats have been degraded or converted to agricultural fields or residential dwellings since settlers arrived. More specialized plant, fish, and wildlife species now rely on much smaller patches to survive and sustain viable populations. Because of this, protecting the integrity and ecological functionality of the lower Roanoke River floodplain system is necessary in order to help ensure the future existence of those species that rely on it.

Figure 3. Map of Roanoke River Basin with the locations of the three dams - John H. Kerr (USACE); Gaston and Roanoke Rapids (Dominion Power) indicated along with proximity to Roanoke River NWR lands

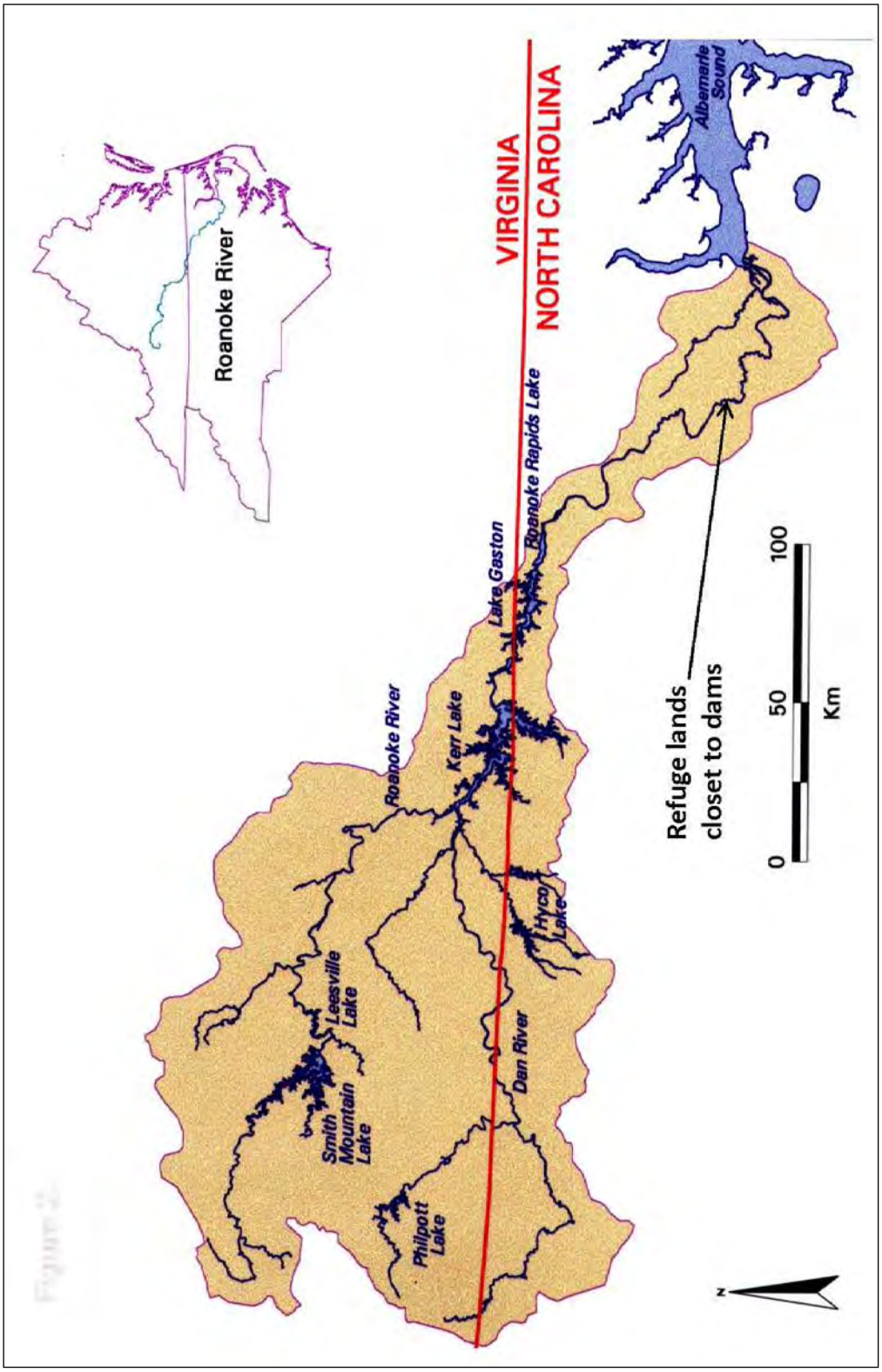
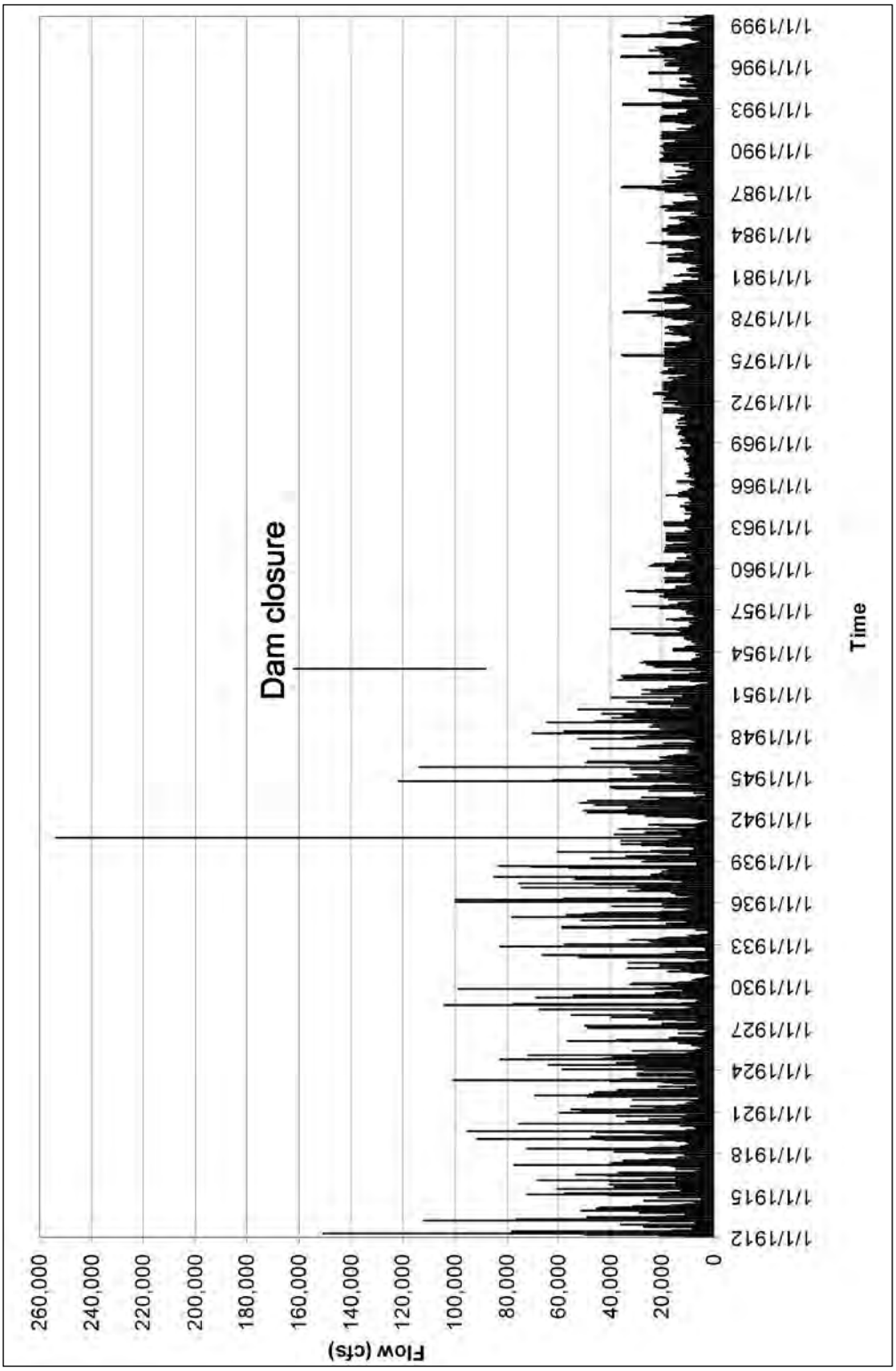


Figure 4. Daily average discharges from Roanoke Rapids Dam from 1912 through 1999, showing the effect the USACE's flood control project has at regulating the Coastal Plain reach of the river



FLUVIAL GEOMORPHOLOGY AND TOPOGRAPHY

Fluvial geomorphology is the study of the processes and pressures operating on river systems that define the geometry of a river channel. The Roanoke River has been carving its path through the Coastal Plain for over one million years. The brown-water classification identifies the Coastal Plain province of the Roanoke River as an alluvial river in which the bed and banks are made up of mobile sediment and/or soil that are carried down from the Mountain and Piedmont geologic provinces and deposited on the floodplain. The size of the sediments being deposited and where they are deposited on the floodplain depends on the magnitude and frequency of the floods the river experiences and the ability of these floods to erode, deposit, and transport sediment. Natural levees, alluvial flats, large swamp interiors, a ridge-swale topography resulting from a migrating river channel, and floodplain valley walls are the major floodplain features present. These features create a diverse micro topography that can be found throughout the lower Roanoke River floodplain. Each feature can support a unique forest community relative to the hydrologic gradient on the floodplain. For example, a relief as little as three inches can mean the difference between an oak forest and a red maple/green ash forest. The result is a diversely rich ecosystem that can support a variety of ecological niches and provide numerous ecological services.

Since the construction of the dams, accelerated rates of bank erosion have been an ongoing occurrence downstream. The upper reach most likely began eroding soon after dam completion in 1953. Presently, it is believed that the channel in the upper reach has reached some semblance of equilibrium (Hupp et al. 2010). That is, starting at the base of the last dam to approximately 70 miles downstream, the river channel has conformed to the regulated flow regime. The upper reach has a wider channel (not the typical trend on alluvial rivers) and higher banks than downstream. Presently, the impetus for erosion has lessened in the upper reach and has migrated downstream to the middle reaches (Hupp et al. 2009a). In the middle reach where the banks are actively eroding, the highly regulated dam-release patterns concentrate flow on the middle and lower bank surfaces and facilitate bank erosion.

Bank erosion below the dams on the Roanoke River is apparent in both particle-by-particle removal and mass wasting along most channel features, including straight, inside and outside bends. Currently, bank erosion rates are highest in the middle reach of the river, which spans from a bit upstream of Hamilton to Williamston, river miles 67 to 35 respectively (Hupp et al. 2009a). The current flow regime is causing the river channel in the middle reach of the river to become wider and deeper. The banks are eroding at an accelerated rate with large chunks of bank falling into the river after the waters have receded from prolonged flood events. These mass wasting events are quite evident in this reach. The result is a vertical drop to the bank on which no vegetation - that would provide refuge for fish or foraging habitat for aquatic macro invertebrates and birds - can become established. More than two-thirds of the refuge lies within this stretch of river.

In addition to changing the morphology of the banks, the managed flow regime on the river has significantly dampened the magnitude of short duration floods by creating long duration moderate floods. These post-dam flood events don't have the energy associated with them to scour floodplain drainages and build levees from overbank flooding. Recent studies have indicated that the micro topography on the floodplain is slowly being diminished. The sediment laden floodwaters that meander on to the floodplain via guts and creeks deposit their sediment in the backswamps gradually filling in these low-lying areas (Hupp et al.

2009b). Loss of topographic relief will lead to the loss of some forest communities, reducing the number of ecological niches and associated wildlife species resulting in simplifying an otherwise complex ecological system.

SOILS

Hydrology is the driving force in bottomland systems. Annual floods over the centuries have overtopped the riverbanks, dropping suspended sediments from upriver to form the levees and ridges of the floodplain. The coarser, heavier sediments fall out closest to the river, forming the natural levees immediately adjacent to the river channel, while the finer, lighter sediments (silts and clays) gradually settle in the slack water areas ponded behind the levees. These sediments are supplemented each year by humus from abundant leaf litter decay, resulting in deep, rich soils. The presence of the three dams upstream has reduced the amount of sediment deposition in recent years.

Soil types identified from the Roanoke River floodplain include Altavista, Augusta, Bibb*, Chewacla, Conetoe, Congaree, Dorovan*, various Hapludults, Roanoke*, Una*, Wahee, Wehadkee*, and Wickham. Soils with an asterisk are listed as hydric in “Hydric Soils of the United States” (U.S. Department of Agriculture, Soil Conservation Service 1985). Hydric soils are “soils that in their undrained condition are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic (water-loving) vegetation” (U.S. Department of Agriculture, Soil Conservation Service 1985). Maps showing the distribution of soils throughout the refuge can be found in Appendix C.

Soils on Roanoke River NWR are predominately of the Wehadkee and Chewacla series, that are nearly level, poorly drained (high water table 6 to 12 inches below the surface), somewhat poorly drained (high water table 12 to 18 inches below the surface), and have a loamy surface layer and subsoil. The soils from North Carolina Highway 11/42 downstream, to and including Conine Island and the Askew Tracts, are frequently flooded Wehadkee loams on the lowest elevations and frequently flooded Chewacla loams on the natural levees and hardwood flats. The soil on Great, Goodman, and Sunken Islands is the frequently flooded (flood at least once every two years) Dorovan mucky peat.

HISTORICAL PERSPECTIVE

PRE-EUROPEAN SETTLEMENT CONDITIONS

Information on pre-European settlement conditions of the lower Roanoke River floodplain forests is sparse. The landscape before Europeans arrived, that resembles the pre-dam hydrologic conditions of present day, most likely was not a continuous closed canopy forest. Instead, it is thought that the forest was a mixture of patches ranging in age from very young to very old (Pashley and Barrow 1992) that were the result of natural disturbance (e.g., hurricanes, tornadoes, and the occasional, but rare, ice storms or fire). Such disturbance created gaps in the canopy that were prevalent throughout the landscape. Larger significant openings made by American Indians, common in many southern floodplain forests (Hamel and Buckner 1998; Bartram 1791; Dickson 1991), were also prevalent within the floodplain forests in the southeast. The Roanoke floodplain was most likely no exception since the presence of Native Americans within the lower Roanoke River floodplain forests is well documented (Smallwood 1997).

The wilderness of bottomlands was a washboard of ridges and sloughs created by the constantly changing river. The forested lands undoubtedly once covered tens of thousands more acres than today. Evidence of American Indian dwellings along the Roanoke River date back over 12,500 years (Harry Thompson per comm.). Because of the river's tendency for producing big floods, particularly during the spring, the Roanoke River was referred to by the American Indians as the "River of Death." In many ways, however, the river was the giver of life. The silt-laden floodwaters would blanket the floodplain with rich alluvial soils. The American Indians took advantage of the fertile soils and grew crops on the higher fertile ridges. Middens found along the river's levee are thought to be remains of seasonal fishing camps where the Indians would take advantage of massive spring fish runs of striped bass, shad, river herring, sturgeon, and perch. Turkey, black bear, deer, and furbearers, such as mink and raccoon, were common residents in the lowlands and these animals were also most likely hunted by the Indians. One can say with confidence that the footprint the American Indians left on the floodplain ecosystem was minor compared to that of the European settlers.

POST-EUROPEAN SETTLEMENT AND TRACT HISTORY

The mindset of Europeans toward nature was very different than that of American Indians (Nash 1982). Unlike other cultures of the time, Western Europeans saw wilderness as the root cause of their difficulties. The physical character of the "primeval" forest proved baffling and frustrating to settlers. Their approach was to conquer and exploit the wilderness they had before them. This mindset was evident throughout our nation as the settlers migrated from east to west. In North Carolina, literally tens of millions of acres of forests were cleared for agriculture. The long- and short-leaf pine forests were harvested for timber and tapped for their turpentine. While some of these resources were being sent to their homelands, most stayed here to supply the demand of the thousands of people establishing new homesteads, necessitating the need to clear more and more land.

The first successful and permanent settlement of North Carolina by Europeans began in earnest in 1653. There were two contingents of the Tuscarora Indian Tribe that inhabited eastern North Carolina. The Northern Tuscarora Indians inhabited the northeastern part of the state and the Southern Tuscarora occupied the area south of the Pamlico River. When the first settlers arrived in Bertie County, they settled along the Chowan River, building their plantations, causing the Indian tribes to relocate to the Roanoke River along the southern border of Bertie County. The encroachment of the white man into their territory was a source of conflict between the Tuscarora and the settlers. The Northern Tuscarora, however, lived in peace with the European settlers for over 50 years while nearly every other colony in America was actively involved in some form of conflict with Native Americans. This peaceful co-existence was due to the diplomacy of Chief Tom Blunt who was a close friend and neighbor of the Blount family of Bertie County.

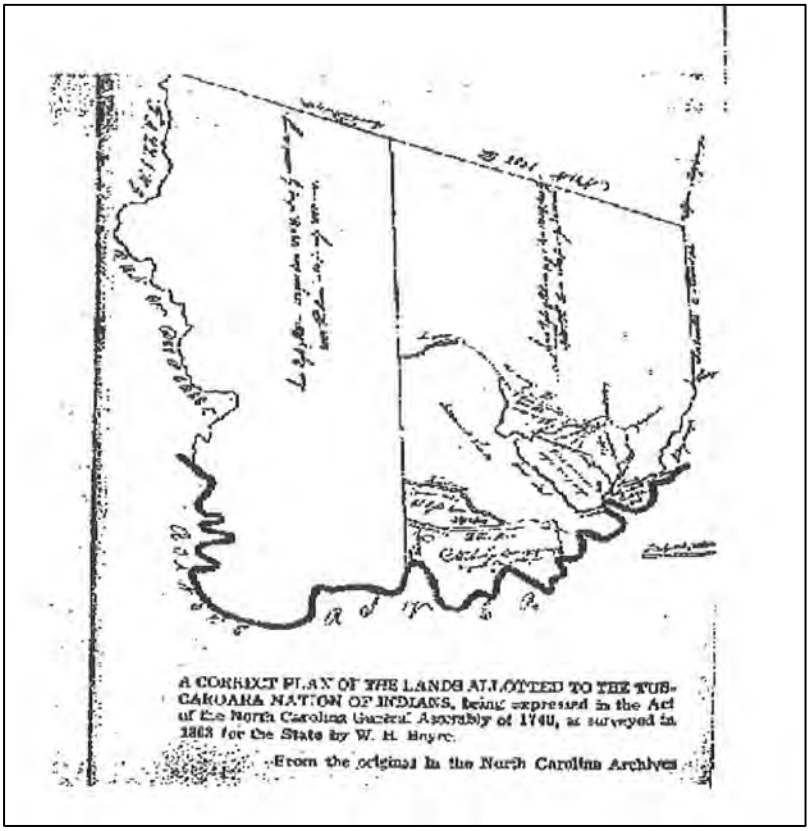
The Southern Tuscarora, under the leadership of Chief Hancock, did not share the same peaceful co-existence when the settlers moved into their territory. Instead, the people of Chief Hancock were rapidly having their lands stolen by the encroaching settlers, their villages were raided, and people were frequently kidnapped and sold into slavery. Ultimately, Chief Hancock felt there was no alternative but to attack the settlers. In September 1711, the Tuscarora War began. Chief Blunt refused to allow his people to take sides in it and warned the southern branch not to bring the war into his territory. After a vicious war with the Southern Tuscarora (1711-1715), during which then Governor Edward Hyde called out the militia of North Carolina to attack the Southern Tuscarora, Chief Hancock was defeated with the help of Chief Blunt. At the defeat of the southern band of the Tuscarora, as a reward for his loyalty to the settlers, Blunt

was acceded by the Legislature the title of “King of the Tuscarora” and in 1717 was awarded 56,000 acres located between Quitsna Landing and Indian Creek along the Roanoke River and an unknown boundary to the north as a reservation in perpetuity. Figure 6 shows a map of the Bertie Reservation. Over the years many of the Tuscarora people moved back to their ancestral lands in New York State where they still live today in Lewiston, Niagara County.

With many of the Tuscarora no longer living in Bertie County, the Tuscarora lands diminished as the remaining tribesmen sold off land in deals with speculators that took advantage of them. This, along with the encroachment of neighboring landowners onto reservation lands, resulted in the majority of the remaining Tuscarora departing for New York in 1803. Those Indians that remained in Bertie County blended into the surrounding population.

Without representation in Bertie County, seven Tuscarora Chiefs requested that Governor Tyron appoint three trustees to arrange for the sale of their lands to pay the tribe’s debts. In 1831, a deed was drawn up in which the Tuscarora gave up their rights to the land in Bertie County. With the lands now controlled by England, some were sold to settlers while other lands were granted to settlers by the Queen. The Broadneck Swamp, Town Swamp, and Company Swamp Tracts of the refuge fall within what was part of the 56,000 acre reservation. Information on the Tuscarora War and Bertie County settlement was gathered from the following website: Native American History and Research, Bertie County, North Carolina. http://www.rootsweb.ancestry.com/~ncbertie/tuscarra.htm and Smallwood 1997.

Figure 5. Map of the lands allocated to the Tuscarora in 1748 by the North Carolina General Assembly (North Carolina Archives)



Many of the high ridges on the floodplain were farmed by settlers, with the forests of the lowlands left alone. At one time, locals avoided the lowlands believing the mist coming off the lands there was the cause of malaria. Cypress was the first tree species to be harvested out of the Roanoke bottoms. Small-scale cypress timber operations began in the mid- to late-1860s and picked up as the market demand increased.

After the Civil War, the lumber industry in the area was the salvation of the region. Sawmills sprang up throughout the region in order to rebuild buildings damaged during the war as well as meeting the demand of settlers who continued to carve out their niches across the landscape creating towns, cities, and farmsteads. The hardwoods in the bottomlands of the Roanoke River were spared for the most part. The vast timber resources in the surrounding area seemed to satisfy the demand at the time.

World War II brought the country out of the Great Depression and began a very prosperous era. It was during this time of economic prosperity that the bottomland hardwoods along the Roanoke River were under siege. Bald cypress and valuable hardwoods (e.g., oaks, hickories, green ash, and maple) were harvested and used to make everything from plywood, barrels, wooden beams, and shingles to tool handles. Intense logging on lands that would become the Roanoke River NWR was thought to occur between the 1940s through the early 1980s. Today, there are no known stands of virgin timber remaining along the Roanoke River; however, if one looks hard enough, old ancient cypress close to one thousand years of age can still be found.

Remnants of a narrow gage train engine and a rail system that was constructed on the levee of the Rainbow unit can be found along with pilings in the river of what appear to be the remains of old loading decks for timber. Old logging artifacts such as these can be found in several locations throughout the lower Roanoke River. Hardwood trees that date back 100 years are quite common, with the average age of the mid-successional trees between 65-80 years. The floodplain forest communities were significantly altered by logging, with secondary growth dominating the forested areas of the lower Roanoke River floodplain. Much of the floodplain forest was obliterated and converted to agricultural fields, pine plantations, and urban dwellings (e.g., towns of Plymouth, Jamesville, Williamston, Hamilton, Lewiston, and Halifax) from the time the European settlers arrived to the present. A series of aerial photos from the late 1930s were located in the National Archives in Washington D.C. The photos serve as a reference to the vast, un-fragmented, forested floodplain that existed before the commercial exploitation of the timber. The historic photos, along with the 2010 aerial photos, can be found in Appendix D for a comparison of past and present conditions.

Prior to the acquisition of refuge lands by The Nature Conservancy or the State of North Carolina, all the tracts with the exception of the Rhodes Tract were managed by timber companies [e.g., Georgia Pacific Corporation, Atlas Plywood, International Paper Corporation, and True Temper Corporation (a major manufacturer of hand tools that began as the American Fork and Hoe Company)]. The Rhodes tract stayed with the family that owned it until it was purchased by the Service in 1997. Appendix E outlines, in some detail, the historic ownership of each refuge tract back until the late 1800s. Ownership before the late 1800s was difficult to decipher from the county deed books. This information gives land managers an idea of how the forest resources were exploited. For example, the big timber producers most likely selectively harvested sawlogs of a variety of species while green ash and hickory were preferred on those lands under management by the American Fork and Hoe Company and True Temper Corporation. Cypress was continuously harvested throughout the lower floodplain beginning in the mid- to late-1800s,

well into the 1980s. One thing is certain, harvest practices back then were more environmentally friendly and sustainable then the clear-cutting practices that are used today.

Besides logging, there are three other anthropogenic changes that occurred in the past that continue to impact the structure and function of the downstream ecosystem. They are: man-made levee breaches, post-colonial sediment deposition, and construction of upstream dams.

MAN-MADE LEVEE BREACHES

In order to facilitate the removal of cypress from the backswamp areas, man-made silvicultural canals were dug to drain the swamps. These canals breach the natural river levee and were built to drain water from the swamps to facilitate the removal of cypress. They are straight ditches at depths equal or slightly greater than the elevation of the swamp they connect to. Seven canals are present on refuge lands. Three, located on the Broadneck Tract, were permanently plugged in 2008, using National Wetlands Conservation Act Funds; another on the same tract is still present, but slowly filling in at the mouth. Two others are located on the Askew Tract; one has been incorporated into a forested impoundment system and the other remains open and functioning. Downstream of Williamston on the Conine Island Tract is another canal that may have been a natural drainage that was dug deeper to drain the swamp more effectively. The canals disrupt the floodplain hydrology in the locality they occur. The natural dynamic between the floodplain and river channel is affected by increasing the rate of floodplain inundation and drainage. This, in turn, affects the hydroperiod of effected floodplain vegetation, changing the natural dynamic between the floodplain and river channel.

POST-COLONIAL SEDIMENT DEPOSITION

The clearing of the Piedmont forests by European settlers came with consequences to the coastal plain reach of the river. With hundreds of thousands of acres of land having been cleared in the mountain and piedmont provinces, eroded materials were deposited on the floodplain below the fall line where the gradient of the river decreases. Sediment deposits in excess of 4-6 meters have been documented on the upper coastal plain reach of the Roanoke River approximately 58 river miles from the nearest refuge tract (Hupp et al. 2009a).

The majority of the anthropogenic sediment deposition on the floodplain occurred between 1700 and1950, before dam construction (Townsend et al. 2000). The rapid rate of deposition has caused important changes in the geomorphology of the lower Roanoke River landscape. Specifically, post-colonial sediment deposition appears to have stabilized the position of the river channel and vastly altered both the relative abundance and position of major geomorphic surfaces. The upper reach of the river (Weldon to Scotland Neck) is considered to be incised. It has cut down through the sediment, building the levees so high that the river is no longer connected to the floodplain, leaving floodplain forests disconnected from the river. Before dam closure in 1953, big flood events redistributed the post-colonial sediment throughout much of the downstream floodplain. The redistribution of the sediments caused a reduction in the topographic relief on the floodplain, causing levees to be broader in some areas, sloughs shallower, and ridges lower in elevation. Soil cores collected throughout the downstream floodplain system indicate that significant deposition has occurred in the upper and middle portions of the coastal plain reach, with minimal deposition having been documented downstream of Williamston before the dams were constructed (Townsend and Richter, unpublished). It's been estimated levees on the Broadneck and Company Swamp tracts would be 0.5 to 1 meter lower than if this influx of post-colonial sediment would not have occurred.

These artificially high rates of deposition may have fundamentally changed the vegetation pattern of the floodplain landscape. Extensive sedimentation influences water movement and the duration of flooding, which in turn strongly affects forest composition, productivity and functioning. It is hypothesized that overtime, with no dams, big floods would have transported the majority of the sediment out of the system and eventually into the Albemarle Sound. However, the construction of a series of large dams above this “plug” of sediment has slowed and confined the movement of sediment through the system. The combined trap efficiency of the three lowest dams is approximately 95 percent of pre-dam levels, and none of the bed load downstream from the lowest dam is currently contributed by upstream sources (Simmons 1988). The sediment starved waters are recharged by this sediment “plug” that is gradually being reworked and redistributed downstream.

Current sedimentation processes have been examined by placing 28 clay pads along transects that encompass the levee to backswamp transition. Early data suggest that deposition rates average 7.7-8.5 mm/yr in the middle reach of the river (Highway 258 to Williamston) and increases to 18.3-20 mm/yr at study sites below Williamston (Hupp et al. 2009a). This study has been greatly expanded indicating similar trends. These findings have not yet been published by Townsend, Peet, and Hupp.

With the hydrology of the coastal plain reach regulated by dams, the redistribution of these sediments is restricted to a relatively small portion of the floodplain. Since the dams prevent large magnitude scouring flood events downstream, the general trend well into the future suggests deposition rates will remain high in the lower reach. Also, in the absence of overbank flooding, sedimentation rates will tend to be higher in the back swamps than levees. This suggests that floodplain topography is becoming homogenized, which has implications for forest community distribution and diversity.

CONSTRUCTION OF UPSTREAM DAMS

The USACE completed construction of the John H. Kerr flood control project in 1953. Located in Virginia, this project was authorized to prevent catastrophic flooding downstream. In 1963, the construction of two private hydropower dams owned and operated by Dominion Generation was completed below the USACE’s flood control project. These dams have effectively taken away the natural variability in flows the river once had and basically put the river on valium.

The construction of the dams is the most significant anthropogenic change to the Roanoke River’s coastal plain. The carefully managed flow regime has redefined the active floodplain. Once encompassing more than 250,000 acres, the active floodplain has been reduced to just over 145,000 acres. The seasonal timing and duration of flood events that occur within the redefined floodplain have significantly changed. This has implications for the future composition of forest communities and channel morphology which determines what fish and wildlife species can be supported.

Every river system in the southeast has been significantly altered by European settlers to some degree. Everything ranging from the exploitation of forest resources, introduction of exotic species, hydrologic alterations through dam construction and dredging channels, to re-channelization, and the building of artificial levees, has changed the dynamics of floodplain systems. Considering the anthropogenic impacts to the Roanoke River and its floodplain, the lower Roanoke River floodplain remains surprisingly intact and minimally disturbed when compared to other river systems in the southeast.

DESCRIPTION OF VEGETATIVE COMMUNITIES BY TRACT

DESCRIPTION OF BOTTOMLAND FOREST HABITAT ON THE REFUGE

The bottomland hardwood forests associated with the Roanoke River floodplain are present on the low ridge, high ridge, natural levees, and alluvial flat features of the river's floodplain. These features represent abandoned natural river levees and point bars resulting from a migrating river channel. They are usually in a curved parallel pattern associated with sloughs in ridge swale topography typical of an alluvial floodplain. The soils on the ridges tend to be coarser in nature, providing better drainage than the finer soils found in the swale and backswamp features. Low and high ridges differ only in relative height and by different plant communities defined by frequency and duration of flooding. Wildlife habitat of the bottomland hardwood forests is determined by the complexity of the vertical and horizontal structure and species composition. The understory, midstory, canopy (dominants and co-dominants), and species composition all play a role in determining what wildlife species may or may not occur in a bottomland forest community. There are approximately 8,203 acres of this habitat type on the refuge.

The following is a description of bottomland habitats found on the refuge by tract. Some tracts have been lumped and are summarized together, due to their close physical proximity resulting in similar elevations, soil types, and species composition. If significant differences do exist between tracts that are lumped together, they are appropriately identified. Maps showing the distribution of bottomland forest communities on refuge lands can be found in Appendix F, along with a table listing specific forest community types by acreage.

BROADNECK SWAMP TRACT

The Rainbow and Broadneck Units together make up the Broadneck Swamp tract. The tract is located in a section of the river's floodplain that is relatively wide (4 to 5 miles) and is joined on the southeastern boundary of the Broadneck Unit. Along the river channel is a well-developed natural levee of Chewacla loam soils, which averages a hundred yards or more wide. There is considerable variation in the vegetation associations on the levee, depending on height and corresponding differences in hydroperiod and flooding regimes. The levee is highest adjacent to the riverbank and gradually slopes downward away from the river. Adjacent to the levee and most prominent on the Broadneck Unit in the inner portions of the site are lower, less frequently flooded alluvial ridges which parallel deeply flooded sloughs and occasionally inundated low flats. Since the construction of the dams, the higher ridges are rarely flooded and, if at all, for brief periods.

The forests found today on fine silty, sandy loam soils are a diverse mixture of alluvial hardwoods. Common canopy species include sugarberry (Celtis laevigata), green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), sweetgum (*Liquidambar styraciflua*), cherrybark oak (*Quercus pagodifolia*), swamp chestnut oak (*Quercus michauxii*), bitternut hickory (*Carya cordiformis*), water hickory (*Carya aquatic*), Eastern cottonwood (*Populus deltoides*), swamp cottonwood (*Populus heterophylla*), and American elm (*Ulmus americana*). Boxelder (*Acer negundo*) is a common subcanopy tree and other locally common shrubs or small trees include pawpaw (*Asimina triloba*), buckeye (*Aesculus sylvatica*), ironwood (*Carpinus caroliniana*), deciduous holly (*Ilex decidua*), and spicebush (*Lindera benzoin*). Woody vines are abundant and include poison ivy (*Toxicodendron radicans*), rattan vine (*Berchemia scandens*), wild grape (*Vitis spp*.), cross vine (*Bignonia capreolata*), and trumpet creeper *(Campsis radicans*). On the higher portions of the levee and higher ridges, a diverse ground

cover is present. Characteristic species include violet (*Viola spp.*), bedstraw (*Galium spp.*), and various sedges (*Carex spp.*). Giant river cane (*Arundinaria gigantea*) is present in large patches on the Broadneck Unit and to a lesser extent on the Rainbow Unit mainly due to the narrower river levee and hydrological conditions.

BROADNECK UNIT

The Broadneck Unit includes about 2.5 miles of river frontage and consists of 2,076 acres; approximately 1,790 acres consists of levee and bottomland hardwood forests. Selective cutting occurred in the 1950s and 1960s and the high areas, especially along Indian Creek, were farmed back in the early 20th Century.

RAINBOW UNIT

The Rainbow Unit, also located on the east bank of the Roanoke River, includes about 3.5 miles of frontage along the channel and consists of 3,491 acres; approximately 1,757 acres consists of levee and bottomland hardwood forests and 353 acres were planted in hardwood plantations (ash, sweetgum and sycamore) in the 1980s. The natural areas (1,263 acres) were selectively cut in the 1960s into the 1970s.

TOWN SWAMP TRACT

The Town Swamp tract is 2,255 acres in size and consists of a series of higher alluvial ridges beginning about 0.75 or more miles from the river. These forest communities developed on older fluvial landforms that in pre-dam times would only flood on rare occasions and for brief periods. Many of these ridges may never flood again due to the managed flow regime present on the river and are referred to in this HMP as hydrologically disconnected floodplain forests (HDFF); approximately 655 acres make up the HDFF. The tract is divided into two primary management units with the Town Swamp Road as the boundary between the north and south units. In the 1970s up until 1990, 291 acres were cleared and plantations of sweetgum, sycamore, and green ash were planted. In the early 2000s, 107 acres of natural forest stands were clear-cut and planted with loblolly pine and cottonwood trees. There still exists approximately 1,081 acres of mid- to late-successional growth forests on the Town Swamp tract. The soils range from silts to fine sandy loams, with moderate to good drainage. The highest best-drained ridges are dominated by mixed stands of cherrybark oak, American beech (*Fagus grandifolia*), loblolly pine (*Pinus taeda*), willow oak (*Quercus pagoda*), sweetgum, and swamp chestnut oak. A well-developed understory layer contains ironwood, American holly (*Ilex opaca*), flowering dogwood (*Cornus florida*), and pawpaw. A sparse-to-moderate ground layer includes a wide array of ferns, sedges, grasses, and herbs. Farming occurred on the high ridges in the early mid-20th Century.

In those areas where a hydrological connection to the river remains (bottomland forests), the dominant oak species are laurel and overcup oak, with some swamp chestnut oak. Other tree species found throughout the bottomland hardwood forests are green ash, sweetgum, and red maple, with ironwood and deciduous holly dominating the understory.

Both the Broadneck and Town Swamp tracts are bisected by a network of jeep trails. Some of these trails are presently maintained by refuge staff through mowing. Low-water crossings have been constructed in several of the areas where these trails cut through sloughs. The raised

roads that were on average three feet above swamp elevation were dropped to eight inches above swamp elevation to restore the flow of water in this portion of the floodplain.

COMPANY SWAMP TRACT

The Company Swamp tract was first protected by the North Carolina Department of Transportation as a wetlands mitigation bank. Located along the north bank of the Roanoke River it contains approximately 5.8 miles of river frontage. The Rhoades tract located immediately adjacent and upstream to the Company Swamp tract has been lumped with the Company Swamp tract due to their close proximity and similarity. It is distinguished from the Company Swamp tract for acquisition records only. The Rhodes tract makes up the western 570 acres of the Company Swamp tract. The tract is located in the lower, more frequently flooded portion of the floodplain and is dominated by hydric natural communities. Of the 1,964 acres that comprise the tract, 1,153 acres consists of levee and bottomland hardwood forests.

Mid- to late-successional levee forests occur on the natural levees and flats that parallel the river channel. The levee tends to be highest adjacent to the riverbank and slopes gradually downward to the interior backswamp depressions. The levee and flats are characterized by Chewacla loam soils that are moderately well-to-poorly drained. These areas are flooded less frequently than the cypress-tupelo backswamp and for much shorter duration. The levee forest of the Company Swamp tract is slightly lower, more hydric, and flooded more frequently than the levees further upstream on the Broadneck tract.

A mixture of hardwood trees occurs in the community depending on slight variations in soil texture, hydroperiod, and past logging disturbance. The most common species include sugarberry, green ash, water hickory, sycamore, sweetgum, laurel oak, swamp chestnut oak, overcup oak, and American elm. Common midstory trees include boxelder, red maple (*Acer rubrum*), ironwood, deciduous holly *(Ilex decidua*), and hawthorn (*Crataegus spp.*). On the highest portions of the levee and ridges, other shrubs or small trees, such as pawpaw, are common. Ground cover ranges from sparse to locally dense, and includes various sedges (*Carex spp*.), cutgrass (*Leersia lenticularis*), giant cane (*Arundinaria gigantea*), ferns and various herbs such as false nettle (*Boehmeria cylindrica*), greenbriar (*Smilax spp*.), violets, and bedstraw. Woody and herbaceous vines are abundant and conspicuous elements. Common species include wild grape, crossvine, trumpet creeper, poison ivy, rattan vine, and peppervine (*Ampelopsis arborea*).

The tract was selectively logged in the 1950s and 1960s at which time the hickory, ash, and oak component of the forest community was targeted. Secondary logging roads can still be detected today by two distinct tire tracks and few trees growing in these areas. Soil compaction is most likely the reason these roads are still easily distinguishable in many areas. One primary logging road was constructed to haul out the timber. Coming in from the high ground, the road follows the power-line corridor toward the river and then parallels the river. This road is maintained and used by refuge staff.

Dominion Generation maintains a power-line corridor on this tract approximately 1.3 miles in length and 200 feet wide. Periodic mowing and herbicide applications are used to prevent tree growth. Due to an incident in June 2005, in which the power company began clear-cutting trees outside of their designated right-of-way, a memorandum of understanding (MOU) has been signed by Service management and Dominion Generation personnel. The purpose of the MOU is to notify staff of maintenance activities within the right-of-way and

approval from refuge staff must be sought before any trees can be cut outside the designated right-of-way. Within the right-of-way, pockets of giant river cane are present along with a good seed bank of plants valuable to wildlife (e.g., smartweed (*Polygonum spp*.), milo (*Sorghum vulgare*), panic grasses (*Panicum spp*.), and beggarticks (*Bidens spp*.)) to name a few. When flooded, this area provides high-value habitat for foraging waterfowl. A copy of the MOU can be found in Appendix G.

ASKEW AND CONINE ISLAND TRACTS

The Askew tract is located to the north of the Conine Island tract with Conine Creek forming the boundary between the two tracts. It is comprised of 1,276 acres; 719 acres consists of levee and bottomland hardwood forests. The tract has approximately 1.5 miles of river frontage and its southern boundary runs along 3.0 miles of Conine Creek (an anabranch of the Roanoke River). The Conine Island tract contains 3,756 acres of wetland habitats in the lower Roanoke River floodplain, with approximately 2,066 acres of levee and bottomland hardwood forests. The island is bordered by the Roanoke River on the west, south, and east and by Conine Creek on the north. Stream frontage is significant: 9.75 miles along the Roanoke River and 3.5 miles (entire stream length) along Conine Creek. U.S. Highway 13/17, a divided four-lane highway, bisects both tracts. The levee and flats are located along the Roanoke River and Conine Creek in bands that vary from 50 to 100 yards wide. Because of their slightly higher elevation in the floodplain (1 to 3 feet above the adjoining backswamp), the natural levees flood less frequently than the backswamp and are dominated by vegetation less tolerant of prolonged flooding. However, due to their overall lower elevations within the system, they are flooded for longer periods of time than upstream levee habitats. When compared with levees further upstream on the Broadneck, and Company Swamp tracts, the levees on this section of the Roanoke River floodplain are poorly developed, resulting in plant communities being less diverse.

The levee and bottomland flat communities of the Askew and Conine Island tracts are dominated by more hydric species than representative levee forests previously described. Characteristic species include water hickory, overcup oak, green ash, sweetgum, American elm, and laurel oak. Midstory species include red maple, hawthorn, ironwood, and deciduous holly. Woody vines are very common; characteristic species include peppervine, wild grape, rattan vine, and trumpet creeper. Ground cover consists of common herbaceous species including various sedges, cutgrass, false nettle, lizard's tail (*Saururus cernuus*), and greenbriar.

Depending on logging history, there is substantial variability in the structure, composition, and age of the various stands. Much of these tracts have been selectively logged in the past seventy years. In particular the ash, oak, and hickory trees were targeted. Other areas, specifically on the western portion of the Askew tract, were extensively logged resulting in dense, young stands of red maple, sweetgum, boxelder, and ironwood being present today. In many other places the cutting has been patchy. As a result, scattered high-quality stands of late-successional growth forest can be found on both tracts. Recent hurricanes, Isabel in 2003 and Irene in 2011, have caused large dominant trees to either snap off or uproot, creating significant openings in the canopy.

HAMPTON SWAMP, GREAT AND GOODMAN ISLANDS TRACTS

The bottomland hardwood communities on these tracts are overshadowed by the presence of tupelo/cypress and blackgum, mixed forested peatland communities. Of the three tracts, Hampton Swamp has the largest occurrence, 39 acres of bottomland hardwood forest, followed by Great Island with 14 acres, Goodman Island with 7 acres, and Sunken Islands with 5 acres. The bottomlands on Hampton Swamp are located on the northern boundary where American beech, willow, and cherrybark oak, along with loblolly pine, green ash, and red maple, are common. Loblolly pine, giant rivercane, and a variety of hardwood species are found in patches on the high ridges located in the center of the tract. The bottomland hardwood communities found on Hampton Swamp and the Island tracts are to be acknowledged; however, there is no planned management strategy other than continuing to have them contribute to the diverse forest mosaic found in these areas.

DESCRIPTION OF TUPELO CYPRESS SWAMP HABITAT ON THE REFUGE

This habitat type varies greatly in response to past management practices, moisture gradient, and position on the slope of the valley. In general, it can be described as some mixture of cypress and swamp hardwood species, ideally with a healthy component of water tupelo soft mast species and blackgum, especially on the lower portions of the river where the soils become more organic in nature.

The refuge has 6,424 acres of this habitat type. During the mid- to late-1800s through the mid-1900s, old growth bald cypress was culled from what are now refuge swamps and sloughs. The results are stands dominated by water tupelo (Nyssa aquatic) and small to medium sized bald cypress (Taxodium distichum), with old growth cypress scattered relatively rarely throughout.

Descriptions of these tracts have been from incidental observations conducted during routine refuge operations. Presently, further specifics on these tracts are limited due to lack of information from ground or aerial vegetation surveys. The predominant soil type is Wehadkee loam. Maps showing the distribution of tupelo/cypress swamp communities on refuge lands can be found in Appendix F, along with a table listing specific forest community types by acreage.

BROADNECK AND TOWN SWAMP TRACTS

Many of the tupelo cypress swamp communities on the Broadneck Unit and Town Swamp Tract are found associated with a ridge and swale topography. In general, the sloughs are somewhat narrow (20 to 40 meters wide), deeply flooded, and surrounded by low-to-high hardwood ridges. At low river flows, the hydrology of these sloughs is regulated by the inflow and outflow of Indian Creek and its distributary, Duck Gut. During prolonged flood events (discharges greater than 20,000-cubic-feet-per-second from the Roanoke Rapids Dam), Indian Creek, Black Gut, and Coniott Creek are the main sources of inflow and outflow respectively on these tracts. Of the 2,025 acres comprising the Broadneck Unit, approximately 225 acres are of the tupelo/cypress swamp community type. Approximately 552 acres of tupelo/cypress swamp are found on the Towns Swamp Tract. Water tupelo is dominant, with bald cypress as a co-dominant. Along the edges of the sloughs, overcup oak (*Quercus lyrata*) and red maple (*Acer rubrum*) are common constituents, with swamp cottonwood locally common. Carolina water ash (*Fraxinus caroliniana*) is often present as a dominant understory tree in the tupelo/cypress stands.

The hydrology of the Broadneck Unit is closely tied to that of the Rainbow Unit. The Rainbow and Broadneck Units make up the Broadneck Tract. The main hydrological regulator of the Rainbow Unit is Black Gut from the east and, up until one year ago, three artificial canals from the south. Remnants from past logging days, these canals which breach the river's levee and extend back to the tupelo/cypress swamps were designed to drain water from these areas to facilitate removal of cypress. Steel beamed, permanent plugs were placed on the three artificial canals in an effort to restore the hydrology to over 1,100 acres of swamp habitat. The tupelo/cypress swamp community comprises approximately 1,600 acres of the 3,484-acre Rainbow Unit. It is an expansive swamp community. Many of the sloughs from the Broadneck Unit flow directly into the expansive swamps of the Rainbow Unit. At high flows, 15,000 cfs and greater, the hydrology of the Broadneck Unit is directly connected to the Rainbow Unit via Duck Gut and its associated sloughs. Small dense pockets of young cypress (approximately 25 years old) exist within the swamp. In the interior of the swamp, water tupelo is present in relatively high numbers. On both units, large remnant cypress exists; however, they are rare in occurrence.

COMPANY SWAMP TRACT

An outstanding feature of the 1,964-acre Company Swamp Tract is the 811-acre tupelo/cypress swamp community. It is characterized by low, poorly drained, semi-permanently flooded backswamps. These backswamp depressions are situated behind the natural levee and are drained by Coniott Creek and by a natural gut that was deepened and rerouted several decades ago for silvicultural practices. The clayey or fine silty sediment and poor drainage, resulting in a long hydroperiod, are the primary factors influencing the vegetation. The backswamp is dominated exclusively by water tupelo and bald cypress in varying proportions. In many areas, water tupelo occurs in almost pure stands. The understory is quite open and park-like due to the sparseness of understory trees and herbaceous species. The stands are often flooded by 5-10 feet of water during the winter and spring months. Flooding often extends into the growing season although there is usually an annual dry down during the summer and early fall. Carolina water ash occurs as a common sub-canopy species. The fringes of the swamp are dominated by green ash, overcup oak, and swamp cottonwood.

ASKEW AND CONINE ISLAND TRACTS

The cypress-tupelo swamp community occupies about 397 acres of the 1,276 acres that comprise the Askew Tract and 1,461 acres of the 3,756 acres of the Conine Island Tract. Located in the more frequently flooded interior portions of Conine Island, much of the cypress was logged from the swamp 60 years ago; however, there is still a significant cypress component present. A thick band of young cypress exists on the southern periphery of the Conine Island swamp. The majority of the swamp is permanently inundated with 1 to 2 feet of water. Standing water has been observed, in the interior sections of the swamp, during extreme drought conditions. Lizard's tail and various sedges are the dominant herbaceous plants during periods of dry down or low water.

Three impoundments that encompass approximately 292 acres were constructed on the Askew Tract. The impoundments are predominantly forested with some open water emergent plant areas. When water levels on the floodplain are low, these forested areas are intentionally flooded during the dormant season to provide food resources for migratory and wintering waterfowl. Bottomland forests can tolerate flooding during the dormant season and contain a variety of tree species, specifically oak and hickory that produce mast for waterfowl. There are approximately 152 acres of bottomland forest and 142 acres of tupelo/cypress swamp in the

project area. With a significant dry down during the growing season, the lower areas in the southeast impoundment and west side of the north impoundment can support annual and perennial herbaceous plants, such as smartweed, rice cutgrass, wild millet, fall panicum, and various grasses and sedges, providing forage for wintering waterfowl when these areas are flooded. Recently, the exotic marsh dewflower (*Murdannia keisak*) has invaded the west side of the north impoundment successfully out-competing the desired species. Alligator weed (*Alternanthera philoxeroides*), dewflower, and Parrot feather (*Myriophyllum aquaticum*) have been found in the barrow canals and in the southeast impoundment. The water management plan for the Askew Project can be found in Appendix H.

HAMPTON SWAMP AND GREAT AND GOODMAN ISLAND TRACTS

Located at and near the mouth of the Roanoke River, these tracts are a tupelo/cypress community type growing predominantly on organic soils. The Hampton Swamp covers 1,122 acres; Great, Goodman, and Sunken Islands comprise 4,481 acres. There is no distinguishable river levee feature found on these tracts. Doravan soils are interspersed with small areas of Bibb and Seabrook loamy sand. Over half of the Hampton Swamp Tract, approximately 700 acres, consists of tupelo/cypress forest. Approximately 354 acres have been classified as tupelo/cypress forest on Great Island. The 516-acre Goodman Island has 96 acres of tupelo/cypress habitat. The five acres that make up Sunken Islands, two small islands located to the north of Goodman Island, are classified as tupelo/cypress swamp habitat. The dominant tree in this forest type is water tupelo, with bald cypress present as a co-dominant.

DESCRIPTION OF SWAMP BLACKGUM, MIXED PEATLAND FOREST

This forest type is most prevalent in the first twenty miles from the mouth of the river where the floodplain is devoid of topographic diversity and underlain by moderate to deep deposits of mucky peat. This portion of the floodplain is at sea level now and no longer receives any sediment deposition from the river channel. It will also be one of the first habitat types to be impacted by sea level rise. The organic soils underlying the mixed peatland forests are deepest near the mouth of the river and become progressively shallower in an upstream direction. These forests are flooded year-round during most years and only occasionally dry out during extended drought periods. The mixed peatland forest system gradually grades into the tupelo/cypress forests. No distinct boundary line between the two forest community types can be drawn. Swamp blackgum (*Nyssa biflora*), along with cypress and red maple, dominate the canopy. Present as the understory are water ash, sweet bay (*Magnolia virginiana*), black alder (*Ilex verticillata*), tag alder (*Alnus serrulata*), titi (*Cyrilla racemiflora*), bitter gallberry (Ilex glabra), various blueberries (*Vaccinium sp.*), and sweet pepperbush (*Clethra alnifolia*). The ground cover consists of ferns, mosses, and other hydrophytic plants. The 2008 vegetation layer, developed by Townsend, indicates small scattered patches of this habitat type on the Town Swamp (58 acres), Broadneck Swamp (72 acres), Company Swamp (46 acres), and Conine Island (126 acres). The presence of this forest type on the above-named tracts is to be acknowledged; however, there is no planned management strategy other than continuing to have them contribute to the diverse forest mosaic found in these areas. This habitat type was lumped with the tupelo/cypress habitats when calculating acreages for the unit maps found in Appendix B. Maps showing the distribution of the swamp blackgum, mixed peatland forest communities on refuge lands can be found in Appendix F, along with a table listing specific forest community types by acreage.

HAMPTON SWAMP TRACT

As one proceeds downstream, the first tract having any significant acreage of this forest type is Hampton Swamp, located between river miles 12 and 13, with 430 acres of swamp blackgum/mixed forest peatland.

GREAT, GOODMAN, AND SUNKEN ISLANDS TRACTS

Blackwater streams and distributaries are present throughout the lower reach, often called the delta reach where the Cashie, Roanoke, Middle, and Eastmost Rivers drain into the Albemarle Sound. Approximately 3,668 acres of this forest type make up Great Island. Two prominent black-water creeks (Broad and Grennell) fork into Great Island from the Cashie River. The 510-acre Goodman Island has 367 acres of swamp blackgum/mixed forest peatland habitat. The soil type on both islands is exclusively Dorovan soils. Refer to Appendix C for the distribution of this soil type.

The Hampton Swamp, Great, Goodman, and Sunken Islands Tracts were not visited during the Bioreview in 2001. Refuge staff does not anticipate implementing any forest management tasks on these tracts within the next 15 years.

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST

This habitat type is defined as those areas that are no longer hydrologically connected to the river due to dams upstream controlling the magnitude of the floods. Historically, floods between 50,000 cfs were common, occurring on average eight times within a decade and sometimes several times within a given year. Floods 100,000 cfs and greater would occur on average twice within a decade (Figure 4). However, since 1953, the USACE's flood control dam has been successful in preventing discharges greater than 35,000 cfs, effectively disconnecting 655 acres (the high ridges) on the Town Swamp Tract from the river. Of the 655 acres, approximately 470 acres consist of hardwood and pine plantations. A description of this habitat type can be found on page 23, Description of Bottomland Forest Habitat on the Refuge, Town Swamp Tract. The map of the Town Swamp Tract in Appendix F shows the distribution of the hydrologically disconnected floodplain forest communities along with a table listing specific forest community types by acreage.

III. Resources of Concern

INTRODUCTION

To meet the objectives as stated in the refuge's establishing legislation, the North Carolina State Wildlife Action Plan, and other applicable regional and national plans, the identified resources of concern must be a top priority in the development of this HMP. For the purposes of this HMP, resources of concern are defined as the biotic and abiotic resources that drive management decisions on the refuge. The idea behind this HMP is to manage for all native species and ecological processes within the Roanoke River NWR and surrounding lands, with emphasis toward Service priority species. This would lead one to conclude that, in theory, the conservation needs of all priority species within the lower Roanoke River Basin would be addressed. However, fiscal constraints require the Service to focus its management actions on a smaller subset of species. The smaller subset of species is referred to as focal species. Identifying focal species to represent a given guild is a difficult but critical step in the biological planning element of the strategic habitat conservation (SHC) model. Focal species are selected to represent guilds of species that may similarly benefit from management actions with the focal species being more sensitive to environmental conditions and therefore more responsive to management actions (Lambeck 1997; USFWS 2008). The one assumption being made in selecting and managing for focal species is that enough is known about its life requisites and habitat requirements to be able to serve as a good representative of a given guild. As new information becomes available through research, monitoring, and species habitat requirements, biologists may decide that the current focal species representing a given guild is no longer suitable and may be replaced by a species that better represents a given guild. Therefore, an adaptive management approach, with emphasis on monitoring and research, must be built into the focal species concept to ensure that other species within the guild are not being adversely affected by the management actions put toward managing for the focal species; in theory, all species within a guild should be benefiting. Habitat management efforts will be geared toward identified focal species that represent a given guild found within the lower Roanoke River Basin. Table 2 lists the major species guilds found within the lower Roanoke River Basin, a representative list of those species that fall within a guild are presented along with the landowner constituency that has the potential to provide and sustain habitat for the respective guild.

With the predicted impacts of climate change (Appendix A) on North Carolina's coastal conservation lands, it will also be necessary to consider resources of concern at a larger level by linking the coastal landscapes of Alligator and Pocosin Lakes National Wildlife Refuges to inland conservation lands, such as Roanoke River NWR, NCWRC State Gamelands, and lands protected by The Nature Conservancy in the lower Roanoke River Basin. Some of the species expected to migrate westward from the coast (e.g., red wolf, nesting American black duck, and marshbirds) may not currently be a priority for Roanoke River NWR, but may become one in the future as the habitat at the mouth of the river transitions into something more estuarine in nature. For the scope of this HMP, the resources of concern will be those presently located within the boundary of the lower Roanoke River Basin. However, the resources of concern listed below may significantly change for the target area in the next several decades, if the models of climate change play out as predicted.

IDENTIFIED SPECIES GUILDS AND ASSOCIATED FOCAL SPECIES

MIGRATORY AND NESTING WATERFOWL

The primary purpose of Roanoke River NWR is to provide an inviolate sanctuary and habitat for wintering waterfowl and other migratory birds. The refuge is part of a conservation initiative within the lower Roanoke River Basin in which several thousands of acres of public and private conservation lands are available to provide habitat to the wintering and migratory waterfowl that utilize this part of the landscape within the Atlantic Flyway. This HMP will focus on conserving the biological integrity and diversity of the floodplain ecosystem, as directed in the Improvement Act, as well as assisting in meeting the needs of waterfowl in support of ecosystem, regional, national, and international goals and objectives established under conservation partnership plans. The species guilds identified on Roanoke River NWR for migratory and nesting waterfowl are: flooded forest (winter and spring), swamp forest, and cavity nesters.

Priority species for the lower Roanoke River Basin include: wood duck, wintering black duck, mallard, and ring-necked duck. Refer to Table 2 for a list of the priority species found in the lower Roanoke River Basin and the referenced plan that identifies them as a priority. Focal species in this category include the wood duck and wintering black duck. The Service will put management effort toward all three of the species guilds identified for migratory and nesting waterfowl.

MIGRATORY AND NESTING LANDBIRDS

Several species of migratory landbirds found on the refuge have been undergoing long-term declines in continental populations due in part to the loss of bottomland hardwood forest habitat throughout the southeast. Maintaining a diverse landscape that provides sufficient suitable habitat to sustain populations of priority landbird species is the goal the Service strives to achieve in the lower Roanoke River Basin. The species guilds identified on Roanoke River NWR for migratory and nesting landbirds are: ground and near ground nesters, ground foragers, forest interior, cavity nesters, edge species, open woodland, early successional, and shrub-scrub, swamp, and riverine. Refer to Table 2 for a list of the priority species found in the lower Roanoke River Basin and the referenced plan that identifies them as a priority.

The species guilds in this category that the Service will put management effort toward are: forest interior, cavity nesters, swamp forest, ground and near ground nesters, and ground foragers. Focal species in this category include: Swainson's warbler, Cerulean warbler, and wood thrush. Edge species, open woodland, early successional, scrub-shrub, and riverine species guilds will not be managed for on Roanoke River NWR, since the habitat that supports these guilds is abundant throughout the lower Roanoke River.

WATERBIRDS

Wading birds find suitable habitats on the refuge for feeding, nesting, and resting. The largest inland rookery in North Carolina is located on the Conine Island Tract. The rookery is estimated to be approximately 40 acres in size; Anhinga, great blue heron, and great egret can be found nesting there. There are an unknown number of smaller rookeries that occur throughout the swamp forests. No nesting shorebirds are found on the refuge; however, during migration, the refuge and surrounding lands are used as resting and refueling areas for species such as spotted sandpipers and greater yellow legs.

There is one dominant species guild identified for waterbirds: swamp forest, in which the yellow-crowned night heron has been identified as a focal species. Refer to Table 2 for a list of the priority species found in the lower Roanoke River Basin and the referenced plan that identifies them as a priority. The Service will place management effort toward the swamp forest guild.

AQUATIC RESOURCES

The Roanoke River supports a significantly large migratory fish population in eastern North America, as well as a wide variety of resident fishes and other aquatic life. During the spring, the river serves as a "super highway," providing migratory anadromous fish species access to their spawning grounds. Or, in the case of the American eel, a catadromous species, a place the eel calls home for 10-12 years, to live until sexually mature then migrates from the river to its spawning grounds in the Sargasso Sea. Some of these species stay within the river's mainstem to carry out their spawning activities; e.g., American shad, Atlantic sturgeon, and striped bass, while others, such as alewife and blueback herring, collectively known as river herring and hickory shad, are known to utilize floodplain habitat for spawning and/or nursery areas during spring floods (Peters et al. 1998).

The creeks, guts, sloughs, and swamps within the floodplain system support a great diversity of resident fish, including largemouth bass, white crappie, redear sunfish, bluegill, channel catfish, yellow bullhead, and white catfish. Nongame fish such as carp, longnose gar, bowfin, red fin pickerel, and creek chub sucker are just some of the species also found utilizing floodplain habitat.

There is one dominant species guild identified for migratory and resident fishes: floodplain utilizers. When flooding occurs in the spring, flooded swamp and bottomland habitat provide spawning habitat for adult fish and excellent nurseries for juvenile fish. Refer to Table 2 for a list of the priority species found in the lower Roanoke River Basin and the referenced plan that identifies them as a priority. The identified focal species for this guild is the river herring. The Service will make management decisions that will protect access and habitat integrity of the floodplain utilizers species guild.

RESIDENT WILDLIFE

The refuge's bottomland hardwood forests and associated habitats support high populations of indigenous wildlife. Many of the indigenous species are important game animals, such as gray squirrels, eastern cottontail and marsh rabbits, white-tailed deer, wild turkey, raccoons, and bobcat. Other species receive less interest from the general public, such as resident songbirds, small and medium-sized mammals, reptiles, and amphibians, yet are critical to the environmental health and biodiversity of the refuge and the lower Roanoke River ecosystem. In compliance with establishing purposes and partnership conservation plans, sound biological principles are used in the assessment of, and when feasible, management for resident wildlife species. Management efforts for focal wildlife species and habitat conditions which were historically found in the floodplain ecosystem should benefit many of these species and species' groups.

The species guilds identified on Roanoke River NWR for resident non-avian wildlife are: cavity nesters, downed woody debris, standing water, flooded and non-flooded woodlands, and cavity dwellers. Refer to Table 2 for a list of the priority species found in the lower Roanoke River Basin and the referenced plan that identifies them as a priority. The focal species identified are the marbled salamander and Rafinesque's big-eared bat. To protect the biological diversity and integrity of Roanoke River NWR, the Service will design habitat management prescriptions in a

way that will enhance or protect the following species guilds: downed woody debris, standing water, non-flooded woodlands, and cavity dwellers.

WATER QUANTITY AND QUALITY

All refuge lands fall within the active floodplain of the Roanoke River and are subjected to the altered hydrology. The Roanoke River's surface hydrology dominates the management of the refuge and affects all of its resources. The flows are managed by dam operators upstream of the refuge, primarily for flood control and hydroelectric power generation. This managed-flow regime has resulted in a highly altered system with which the floodplain ecosystem did not evolve. Presently, the dam operators release flows in a way that reduces the magnitude of short-duration floods by creating long-duration moderate floods in the spring and summer months (Figures 5a and b). The results are areas that once flooded may never flood, and areas that do flood are flooded for a much longer period of time, causing shifts in forest community composition and structure. The flows affect aquatic resources by minimizing the amount of floodplain spawning habitat available in the spring, eliminating the exposure of spawning and resting habitat around bars in the summer, and saturating the banks and promoting bank erosion. Prolonged flooding of the floodplain during the summer has also caused the river's water quality to deteriorate; water with low dissolved oxygen levels drain into the river. This is of special concern when fish eggs and fry are present in the river during the late spring and summer. At this life stage, low levels of dissolved oxygen will kill the eggs and fry.

The managed flows also affect terrestrial resources by inhibiting plant regeneration and natural plant succession, and the actual killing of viable hardwoods. Bird nests and the foraging habitat of birds that nest on or near the ground are inundated, while other wildlife populations are artificially dispersed. Studies over the last decade under Dominion Generation's 2004 [1]FERC license and in conjunction with the [2]USACE's Section 216 study indicate that the way in which flows are currently managed on the Roanoke River appear to be negatively impacting the river's geomorphic processes (Hupp et al. 2009a,b) and forest community dynamics (Hochman 2004; Wilder et al. 2011). Other documented science supports the conclusion that managed-flow regimes disrupt the normal evolving ecological balances associated with free-flowing, bottomland hardwood floodplain systems over time (Boon et al. 1992, Collier et al. 1996, Hunt 1988, Ligon et al. 1995, McCully 1996, Poff and Zimmerman 2010, Richter et al. 1996, Ruane et al. 1986, Stallins et al. 2009, and Trush et al. 2000).

In an effort to restore some semblance of natural flows back to the lower Roanoke River, FWS Division of Refuges, Ecological Services and Fisheries continue to coordinate efforts with partners to address the flow issues. FWS staff will continue to:

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[1] The Federal Energy Regulatory Commission (FERC) is the United States Federal agency with jurisdiction over electricity sales, wholesale electric rates, hydroelectric licensing of non-federal hydropower projects, natural gas pricing, and oil pipeline rates.

[2] The U.S. Army Corps of Engineers Wilmington District, in partnership with the State of North Carolina and the Commonwealth of Virginia, are sponsoring a Section 216 study under the authority of Section 216 of the River and Harbor and Flood Control Act of 1970 (Public Law 91-611) for the John H. Kerr Dam and Reservoir. Section 216 authorizes the USACE to review the operations of water projects that have already been built to improve their environmental performance.

- Actively participate on the Cooperative Management Team, an obligation under Dominion Generation's FERC relicensing agreement, to address the effects of hydropower peaking on the downstream ecosystem.

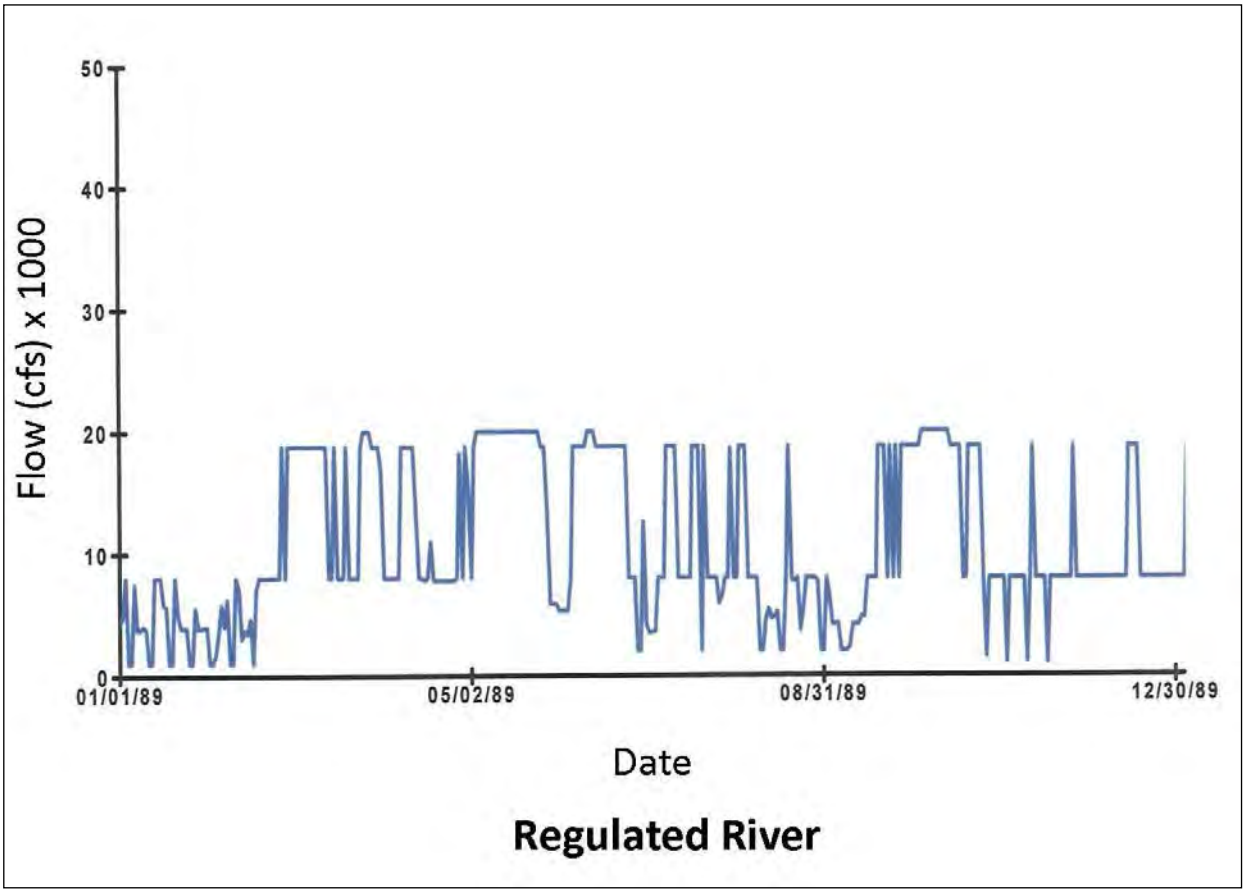
- Actively participate in the USACE's Section 216 study to address the effects of its flood control project on the downstream ecosystem.

- Participate in weekly conference calls hosted by the USACE's Division of Water Management to stay abreast of weather and water conditions within the basin and voice concerns when suggested flow releases may adversely affect the ecology and recreational opportunities on the refuge.

- Collaborate with partners to fund research projects that focus on the impacts of the altered flow regime on the flora and fauna of the downstream ecosystem.

Figures 6a and b. Hydrograph discharges from Roanoke Rapids Dam in 1989 with the USACE's flood control project (a) and without the USACE's project (b)

a.



b.

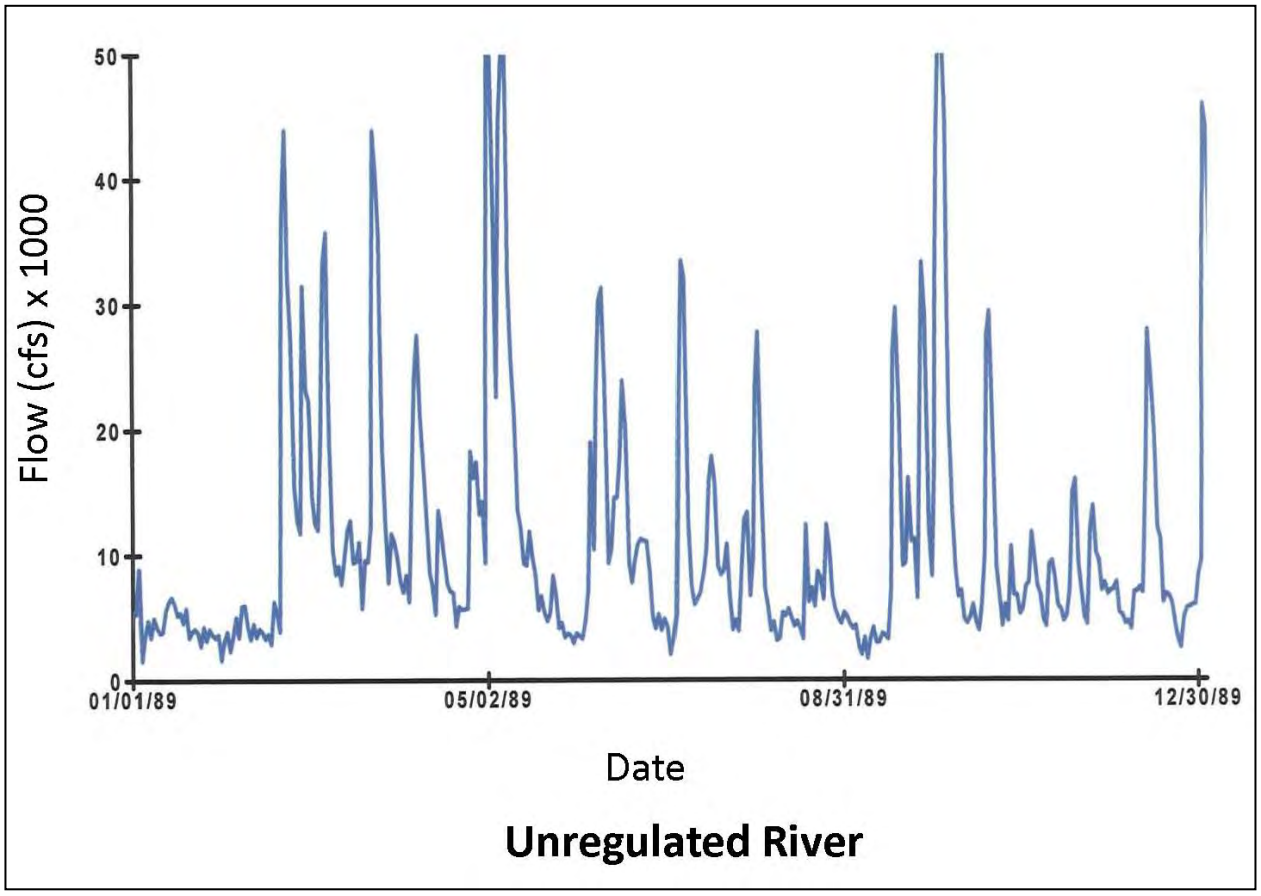


Table 2. Major species guilds found along the coastal plain reach of the Roanoke River with an abbreviated list of wildlife species associated with each. Column 4 lists the priority species that are referenced in the respective conservation plan(s) footnoted at the end of the table. Focal species are identified along with the landowner constituency that can provide a significant amount of habitat for a given guild.

Taxa	Species Guild	Species (Examples)	Priority Species Within Guild	Focal Species	Stakeholder Contribution to Resources of Concern
Avian	Ground, Near ground Nesters, and Ground Foragers	Northern bobwhite, wild turkey, Kentucky warbler, Swainson's warbler, ovenbird	[1,6,7]Kentucky warbler, [1,2,6,7]Swainson's warbler, [6] ovenbird, [1,2,6] American Woodcock	Swainson's Warbler	USFWS, NCWRC, TNC, private

Taxa	Species Guild	Species (Examples)	Priority Species Within Guild	Focal Species	Stakeholder Contribution to Resources of Concern
	Forest Interior	Worm-eating warbler, Wood thrush, Cerulean warbler, Scarlet tanager, Acadian flycatcher, Hooded warbler, Yellow-throated vireo, American redstart, Eastern wood peewee, Northern parula warbler, Yellow-throated warbler	[1,2] Worm-eating warbler, [1,2,6,7] Wood thrush, [1,2,6,7] Cerulean warbler, [6] Scarlet tanager, [6] Acadian flycatcher, [1,2,6] Hooded warbler, [6] Yellow-throated vireo, [2,6,7] Northern parula warbler, [2] Yellow-throated warbler, [1] Eastern wood-pewee	Wood thrush, Cerulean warbler	USFWS, NCWRC, TNC, private (less likely to sustain)
	Cavity Nesters	Woodpeckers: red bellied, pileated, red-headed, downy, hairy; northern flicker; Wood duck; Hooded merganser; Great crested flycatcher; Prothonotary warbler; Carolina chickadee; Barred owl	[1] Red-headed woodpecker, [1] Hairy woodpecker, [3] Wood duck, [3,6] Hooded merganser, [2,6,7] Prothonotary warbler, [1] Northern flicker	Wood duck	USFWS, NCWRC, TNC, private (less likely to sustain)
	Edge Species	Indigo bunting, Blue grosbeak, White-eyed vireo, Summer tanager, Common yellowthroat warbler, Eastern towhee, Brown thrasher	[2] Eastern towhee	N/A - River corridor and agricultural edges provide abundant edge habitat along 138 miles of river	USFWS, NCWRC, TNC, private

Taxa	Species Guild	Species (Examples)	Priority Species Within Guild	Focal Species	Stakeholder Contribution to Resources of Concern
	Open woodland	Mississippi kite, Yellow-billed cuckoo, Orchard oriole	[2(local)] Mississippi kite, [1]Yellow-billed cuckoo, [1,7] Orchard oriole	N/A - Sufficient habitat is available in surrounding area.	USFWS, NCWRC, TNC, private
	Early succession, scrub-shrub	Yellow-breasted chat, Prairie warbler, Indigo bunting, White-eyed vireo, American woodcock	[1,2] Prairie warbler, [2] White-eyed vireo	N/A- Surrounding lands will support in the long term. Spot analysis of regional early successional habitat for next 15 years indicates that of the 850K acres of habitat in LRR Basin, 250K is early successional.	USFWS (less likely to sustain), NCWRC (less likely to sustain), TNC (less likely to sustain), private
	Swamp	Rusty blackbird (winter), Prothonotary warbler, Yellow-crowned night heron, Great egret, Green heron, Louisiana waterthrush, Wood duck, Hooded merganser	[2,6,7] Rusty blackbird (winter), [1(local)] Yellow-crowned night heron, [6]Louisiana waterthrush, [2,6,7] Prothonotary warbler, [3] Wood duck	Yellow-crowned night heron (spring/sum-mer) Rusty black bird (winter)	USFWS, NCWRC, TNC, private (less likely to sustain)
	Flooded Forest (winter and spring)	Wintering American black duck, Mallard, American wigeon, Ring-necked duck, Gadwall, Green-winged teal, Wood duck (year-round)	[2,3] American black duck (winter), [2,3] Wood duck (year-round), [2,3] Mallard (winter), [2,] Ring-necked duck (winter),	Wood duck (spring) and American black duck (winter)	USFWS, NCWRC, TNC, private (less likely to sustain)

Taxa	Species Guild	Species (Examples)	Priority Species Within Guild	Focal Species	Stakeholder Contribution to Resources of Concern
	Riverine	Bald eagle, Osprey, Spotted sandpiper (nonbreeding), Louisiana waterthrush	[1,7] Bald eagle, [6] Louisiana waterthrush	N/A - habitat in great abundance	USFWS, NCWRC, TNC, private
Aquatic	Migratory fish (floodplain utilizers)	American eel, Blueback herring, Alewife, Hickory shad, Striped bass	[5]American eel, [5] River herring (Blueback/ Alewife), [5] Hickory shad, [5] Striped bass	River herring	USFWS, NCWRC, TNC, private (less likely to sustain)
	Resident fish (floodplain utilizers)	Black crappie, Bluegill, Warmouth, Largemouth bass, Yellow bullhead, Bowfin, Long-nose gar, Creek chubsucker, Flier, Mosquito fish,		N/A - species guild covered by migratory fish and swamp guild	USFWS, NCWRC, TNC, private
Resident Wildlife Non-Avian	Downed woody debris with seasonally flooded water body nearby	Salamanders: Marbled, Slimy, Mud, Eastern newt; Spadefoot toad, Green tree frog, Squirrel tree frog, Gray tree frog	[1] Marbled salamander, [1] Slimy salamander, [1] Spadefoot toad,	Marbled salamander	USFWS, NCWRC, TNC, private (less likely to sustain)
	Standing water	Spotted turtle, Green frog, Eastern cottonmouth, Crayfish sp.	[1]Spotted turtle,	N/A - species covered by swamp guild	USFWS, NCWRC, TNC, private
	Flooded and non-flooded woodlands	Golden mouse, Short-tailed shrew, Marsh rabbit, White-footed mouse	[1] Golden mouse, [1] Marsh rabbit,	N/A-species covered by several avian guilds	USFWS, NCWRC, TNC, private
	Cavity dwellers	Black bear, Southeastern myotis bat, Rafinesque's big-eared bat,	1(NC species of concern) Southeastern myotis, 1 (NC threatened) Rafinesque's big-eared bat,	Rafinesque's big-eared bat	USFWS, NCWRC, TNC, private (less likely to sustain)

[1]***North Carolina Wildlife Action Plan (NCWRC 2005) -*** *identified if species was listed as a priority or higher.*
[2]***South Atlantic Coastal Plain Partners In Flight Bird Conservation Plan (Hunter et. al. 2001) -*** *identified if species is of high or extremely high priority.*
[3] ***Atlantic Coast Joint Venture (ACJV 2004) -*** *identified if species is of moderately high to high priority.*
[4]***Southeast United States Regional Waterbird Conservation Plan (Hunter et al. 2006) -*** *identified if species of immediate or high management concern.*
[5]***Atlantic States Marine Fisheries, Fisheries Management Reports (ASMFC 1999, 2000, and 2003) -*** *identified if management plan has been developed.*
[6]***North Carolina Bird Species Assessment, Coastal Plain of NC (Johns 2006) -*** *identified if species of moderate to extremely high conservation concern within the South Atlantic Coastal Plain physiographic region.*
N/A - habitat within this guild is in great abundance or there is adequate protection of the habitat for species within the guild by focal species designated in other guilds.

NOTE: In the CCP for Roanoke River NWR, marsh grass was included as a separate habitat type. This habitat is not of any sufficient quantity to address in this HMP. It is present in strips 3-6' wide in various locations on Great and Goodman Islands. It is expected that with sea level rise that the marsh grass will encroach into the forested wetland areas. For now, however, it will not be recognized as a separate habitat type.

HABITAT REQUIREMENTS FOR RESOURCES OF CONCERN

Many fish and wildlife species have specific habitat requirements and needs that are no longer being adequately met on private lands. The clearing of millions of acres of bottomland hardwood forests, the advent of agriculture, and alterations to the natural hydrological cycles and landscape features have severely altered the landscape on which these species rely. Thus, the responsibility to provide these dwindling resources lies largely with the public and private conservation land sectors to ensure that the habitat requirements for the resources of concern mentioned above are furnished on the network of conservation lands found within the lower Roanoke River.

For purposes of this HMP, habitats are designated as areas where the majority of the individuals of a species spend most of their time meeting a particular need. Breeding habitats are defined as areas that support mate selection, nesting, and brood rearing. Foraging habitats are those locales where most individuals secure nutrients to meet the basic metabolic requirements for survival. Resting or loafing habitats are those that provide security from disturbance, whether human or predatory. Migratory birds exploit forage resources to build up nutrient reserves in preparation for flight to the next stopover location or to the final destination on the breeding or wintering grounds. The species guilds identified that the Service will place management effort toward are listed in Table 2. Within each guild, focal species have been identified with the idea that if the habitat requirements can be met for the focal species, the habitat should also be suitable for the suite of species that relies on a given habitat type. Normally, the designated focal species may be a bit more specialized in their habitat requirements or maybe of importance due to declining numbers throughout their range. The identified resources of concern are headlined below along with the species guild the refuge plans on putting management effort toward followed by the habitat requirements for the focal species that represent each guild.

MIGRATORY AND NESTING WATERFOWL

Focal Species –
Wintering black duck, nesting wood duck

Species Guilds Identified –
Flooded forest (winter and spring), swamp forest, cavity nesters

Migratory waterfowl have many specific requirements during migration. Surface water is critical to the survival of this group of birds in the form of rivers, lakes, flooded forests, beaver impounded areas, and managed impoundments. Adequate food resources to restore energy and fat reserves lost during migration are crucial for survival. Bottomland hardwood forests provide both hard and soft mast food resources along with a diverse invertebrate community for waterfowl. Nested within the forested areas are the occasional early successional moist-soil wetlands that were created by logging activities, beaver ponds or maintenance of power line rights-of-way. Such areas provide ideal conditions for emergent plant growth of native plants such as smartweed, millets, wild rice and various grasses and sedges; also valuable food resources for wintering waterfowl, especially dabblers like the black duck. Aside from food resources, forested wetlands also provide thermal, loafing, and escape cover for waterfowl. The seasonal flooding that occurs on the Roanoke River allows waterfowl access to these food resources. During dry years, the Askew Impoundment project, specifically the northwest impoundment, can be flooded using a well pump in an effort to allow waterfowl access to the food resources described above. The NCWRC also has a series of impoundments on their Conoho Farms Tract that can be flooded also providing waterfowl access to food resources.

The only waterfowl species that nest on the refuge are the wood duck and hooded merganser. Both species are cavity nesters, so mid-to-late successional hardwood forests near a reliable water source are the first prerequisite in providing habitat. Preferred habitat includes forested wetlands, wooded and shrub swamps, tree-lined rivers, streams, sloughs, and beaver ponds with cavity trees. Sufficient cover should be present to increase the survival rate of ducklings to flight age. Overhead cover within 1 to 2 feet of the water surface is vital for wood duck broods. Optimum habitat should have 75 percent cover and 25 percent open water, with a minimum of 1/3 cover to 2/3's open water (McGlivrey 1968). In addition, shallowly flooded areas that contain good invertebrate mass important to laying hens and ducklings up to six weeks of age are essential for successful brood rearing. At about seven weeks of age, the young ducklings will switch to plant foods until their diet consists of approximately 90 percent vegetative material, primarily aquatic plants such as algae, watermeal, watershield, sago pondweed, and duckweed (USDA, NRCS). Adult wood ducks feed on a variety of nuts and fruits, aquatic plants and seeds, and aquatic insects and other invertebrates.

Like the wood duck, aquatic invertebrates are especially important to young hooded mergansers while the adults broaden their diet and prey on small fish, and crustaceans, especially crayfish. The permanently flooded (except in very dry conditions) tupelo/cypress swamps and sloughs are the habitat types present on the refuge. Also, during the winter and spring flood events, waterfowl have access to the food resources (hard and soft mast) found in bottomland hardwood forests.

Due to the loss of forested wetlands and competition for nest sites from a host of other species, natural cavities are usually the primary limiting factor to reproduction in many areas. Nest boxes are commonly used to supplement natural cavities and increase local production of wood

ducks. The mid-to-late successional forests on the Roanoke River NWR provide adequate nest cavities. Nest cavities are not thought to be a limiting factor for breeding wood ducks. Currently, the refuge staff maintains 68 wood duck boxes since this is the only method available to monitor production and nest success of this species.

MIGRATORY AND NESTING LANDBIRDS

Focal Species –
Swainson's warbler, cerulean warbler, wood thrush, and wintering rusty blackbird

Species Guilds –
Forest interior, swamp forest, ground and near ground nesters and foragers

There are an estimated 88 species of breeding birds found on the refuge, of which 35 are neotropical migratory species. Many migratory landbird species require large tracts of contiguous forest to survive. Each species requires a different set of habitat components to meet life history needs. Thus, a landscape matrix of habitats comprised of forest, giant river cane, early successional habitats, and grassland is critical to the survival of this group of birds. Across the bottomland hardwood forest landscape, a variety of tree species is adapted to specific zones based on factors such as soil composition, elevation, and hydroperiod. Slight differences in these factors can change the overlaying plant communities. As a result, bottomland hardwood forests contain a great variety of trees, shrubs, and vines often growing close together. The plants are different in many ways such as height, branch pattern, fruit, foliage thickness, and shade tolerance. Food resources, such as soft and hard mast, are produced at different times of the year and flooding stimulates invertebrate abundance and diversity. This rich complexity provides a diverse habitat which meets the needs of forest dwelling migratory landbirds.

The management of bottomland hardwoods at Roanoke River NWR will focus on ensuring a minimum of 35 to 50 percent of all bottomland hardwood forests are in desired forest conditions as detailed in Table 3 of this document. Many migratory landbird species utilize the refuge for migrating, wintering, breeding, and nesting. Although specific habitat requirements vary among bird species, they share broad overlapping habitat requirements. Management efforts will be centered on providing critical habitat needs for priority landbirds, specifically the focal species listed above, and should provide benefits for many of the other migratory species.

The Swainson's warbler has been selected as the focal species to represent the ground and near ground nesters and foragers of the bottomland forest community. This warbler is primarily a ground forager, consuming insects found under leaves as it moves on the ground flipping leaves. Its preferred habitat consists of a contiguous forest comprised of damp bottomland hardwoods with good growth of dense, shrubby understory vegetation, containing minimal herbaceous ground cover and an extensive carpet of dense leaf litter overlying moist soils. On the refuge, the species is most often associated with giant rivercane, brier tangles with pawpaw, buckeye and mid-to-late successional hardwoods nearby usually on hummocks or on the river levee. Warblers have also been found some distance from the river associated with clumps of rivercane and mid-to-late successional hardwoods nearby. Graves (2002) found that the warbler attained its greatest abundance in the core of its range (Lower Mississippi River Alluvial Valley) of (10-20 territorial males/km^2) in floodplain forests characterized by small (<25 cm dbh) trees (approximately 620-820 stems/ha) and understory thickets of saplings, vines, and shrubs (approx. 35,000-48,000 small woody stems/ha). Graves also reported that canopy height, basal

area, and floristics appear to be relatively unimportant factors in habitat selection, provided that understory requirements are met and that territories in mid-to-late successional forests typically were associated with disturbance gaps.

To create the dense understory desired by the warbler, small group selection cuts from 0.6- to 1.2-acre are recommended (Graves 2002, Bednarz et al. 2005). Bednarz et al. (2005) recommended that tree harvest operations in warbler habitat that is becoming less desirable should be limited to individual tree or small group-selection cuts, because this method more closely resembles natural disturbances. The Partners in Flight South Atlantic Coastal Plain Plan recommends forested tracts of 10,000 acres or greater to support 500 breeding pairs of Swainson's warbler as a habitat objective (Hunter et al. 2001). The floodplain of the lower Roanoke River definitely meets this habitat criterion, providing approximately 6 – 10,000 acre blocks of unfragmented forested habitat on conservation lands and neighboring private lands. However, it is unknown how much of this is considered suitable habitat for the warbler. The refuge contributes approximately 9,000 acres to the unfragmented forested habitat with about 500 acres as suitable habitat and another 700 acres that could be brought into suitable condition with appropriate forest management.

The cerulean warbler and wood thrush have been selected as the focal species to represent forest interior birds. Each species requires contiguous tracts of unfragmented, deciduous forest. The two species were chosen because they occupy different niches within the forest and because of their current population status. Each species has shown significant declines in population numbers over the last few decades. It is estimated that the wood thrush population has declined by 43 percent since 1967 (www.allaboutbirds.org/guide/wood_thrush/lifehistory) and the cerulean warbler has been experiencing a decline in its population of -4.6 percent/year since 1966 (Hamel 2000, Rosenburg et al. 2000).

The breeding habitat for the cerulean warbler has been described as deciduous forests with tall, large-diameter trees with diverse vertical structure in the forest canopy, and irregular or broken canopy structure (Lynch 1981, Rosenburg et al. 2000). Habitat characteristics vary throughout the species range. Researchers have struggled to find a common denominator for the habitat characteristic(s) the warbler is keying in on and have not yet been successful. The species prefers large wooded tracts of at least 50-75 acres and typically avoids isolated woodlots less than 20-25 acres in size in Ohio (Peterjohn and Rice 1991). In other areas, stands greater than 1,300 acres are considered optimal for cerulean warbler (Evans and Fischer 1997). In the southeast, nearly all the birds found were in forests > 1,000 acres suggesting strong area sensitivity. The Partners in Flight South Atlantic Coastal Plain Plan recommends forested tracts of 20,000 acres or greater to support 500 breeding pairs of cerulean warblers as a habitat objective (Hunter et al. 2001). The floodplain of the lower Roanoke River meets the habitat criteria providing approximately 3 – 20,000-acre blocks of unfragmented forested habitat found on conservation lands and neighboring private lands. However, it is unknown how much of this is considered suitable habitat for the warbler. The refuge contributes approximately 9,000 acres to this unfragmented forested habitat, with approximately 2,000 acres being in suitable habitat condition and another 4,000 acres that could be brought into suitable condition with appropriate forest management.

The wood thrush prefers deciduous and/or mixed forests for breeding. It prefers late-successional, upland mesic forests with a moderately dense shrub layer. Hoover and Brittingham (1998) found that nests in forested areas of Pennsylvania were associated with greater densities of trees, greater canopy closure, higher density of shrubs, and taller shrub

height. Bertin (1977) found that wood thrush favor areas with running water, moist ground, and high understory cover. The breeding habitat generally includes trees taller than 52 feet, a fairly open forest floor, moist soil, and leaf litter, with substrate moisture more important than either canopy cover or access to running water. The wood thrush has been known to breed in a wide range of tract sizes with the smallest being < 1.2 acres. However, Hoover et al. (1995) found that nesting success was less than 50 percent in tracts < 198 acres and that patches of suitable forest types of 370 acres or larger were regarded as optimal for wood thrush nest success (Rosenberg et al. 2000). The Partners in Flight South Atlantic Coastal Plain Plan recommends forested tracts of 10,000 acres or greater to support 500 breeding pairs of wood thrush as a habitat objective (Hunter et al. 2001). The floodplain of the lower Roanoke River definitely meets the habitat criteria providing approximately 6- to 10,000-acre blocks of unfragmented forested habitat found on conservation lands and neighboring private lands. However, it is unknown how much of this is considered suitable habitat for the wood thrush. The refuge contributes approximately 9,000 acres to this unfragmented forested habitat with approximately 3,000 acres of this being in suitable habitat condition. Another 4,000 acres could be brought into suitable condition with appropriate forest management.

The rusty blackbird is a species that has shown chronic long-term declines in its population numbers. The population has plunged an estimated 85 to 99 percent over the past 40 years and scientists are completely puzzled as to what is the cause (http://www.allaboutbirds.org/guide/Rusty_Blackbird/id**)**. It nests in boreal forests and winters in the eastern United States where it frequents wooded swamps and bottomland hardwood forests. The reason for its exponential decline is most likely a combination of multiple factors from habitat loss and fragmentation in its breeding and wintering grounds, environmental contaminants, acid rain, global climate change, etc. This is a species that not much is known about however, it is known that when on its wintering grounds it is not commonly associated with the large flocks of red-winged blackbirds and common grackles. Instead, it forms small single species' flocks where it can be found foraging in agricultural fields, but most commonly associated with bottomland hardwood swamp forests foraging on insects and hard mast from trees. Habitat requirements for wintering rusty blackbirds would be large, intact forested swamps that are relatively undisturbed.

WATERBIRDS

Focal Species –
Yellow-crowned night heron

Species Guilds –
Swamp forest

Yellow-crowned night herons often nest alone or are scattered in loose aggregations. They nest in a variety of different habitat types including hardwood timber and pines, swamps, and coastal scrub/shrub habitats. On the Roanoke River NWR, this species can be found nesting in loose, single species colonies in the tupleo/cypress swamp habitat type. Murray and Reid (1991) found that the height of the nest was correlated to the overall height of the tree with the vertical position of the nest about 29 to 36 feet below the maximum tree height. The nests are typically placed toward the outer edge of the canopy and low in the tree canopy (Watts 1989), which is hypothesized to minimize exposure to avian predators (Burger 1978), inclement weather conditions (Beaver et al. 1980), and excessive thermal stress during the brood period (Beaver et al. 1980, Burger 1978). Murray and Reid (1991) characterized the nest sites of this species in

the lowlands of Missouri. The five nest tree variables they measured are outlined here along with the ranges of their observations: tree height (20.0 to 35.5 m), dbh (27.0 to 87.0 cm), nest height (10.5 to 25.0 m), nest branch angle (60.0 to 90.0°), and horizontal nest position which was measured as an index of nest position relative to canopy breadth (distance of nest from tree center/nest branch length) x 100 and ranged from 50.0 to 87.0 percent. For the overall forest habitat, the BA ranged from 44.5-140 feet^2/acre.

The yellow-crowned night-heron is unique among other herons in that its feeding specializes on crustaceans. In the swamp forests this would mean that crayfish comprise a good part of its diet with the opportunistic frog and small fish. Adequate foraging habitat should be located in close proximity to nesting sites to minimize time away from the nest when parents are collecting food for nestlings. Of all the herons, the yellow-crowned is shier, quieter, and less gregarious than other herons. The species has been described as intolerant of human disturbance and is easily driven from its nest (Mengel 1965, Sprunt and Chamberlain 1970, and Holt 1933).

To sum up, the habitat requirements for this species in swamp forest habitats are large, mid-to-late successional stands of tupelo/cypress trees with semi-permanently to permanently flooded habitat nearby. The trees should have well-developed lateral branches that extend between 60 to 90° from the trunk. The stands will have a basal area with a range of 44.5-140 feet^2/acre. On the refuge, basal area in the tupelo/cypress swamps may be high (120 feet^2/acre plus) with a low stem count. Recommendations on the tract size necessary to support a rookery could not be found. On Roanoke River NWR the yellow-crowned rookeries are associated with large swamp interiors (>1,000 acres) or large sloughs in the interior floodplain.

AQUATIC RESOURCES

Focal Species –
River herring

Species Guild –
Floodplain utilizers

Blueback herring and alewife are collectively referred to as “river herring” due to similarities in appearance and relatively similar life requisites. They are both considered anadromous species in that they spend most of their life in a saltwater environment, ascend freshwater rivers in the spring to spawn, and return to saltwater after spawning. There are subtle anatomical differences between the two species which are difficult to distinguish by the untrained eye. The subtle differences in their ecology include ideal spawning temperatures, hatching times of fertilized eggs, and spawning habitat. The two species have similar geographic distributions along the Atlantic coast, ranging north from Nova Scotia to South Carolina. The range of the blueback extends beyond South Carolina to the St. John’s River in Florida. The stock status assessment of the river herring in North Carolina is considered depleted (NCDMF 2007), and has been listed as a species of concern throughout its range by NOAA’s National Marine Fisheries Service since 2006. Since the arrival of the first colonists, river herring have been a major fishery in North Carolina. During the 90-year period of 1880-1970, average landings of river herring in the Albemarle Sound were 11.9 million pounds/year (Hightower et al. 1996). Landings from 1997-2006, in contrast averaged only 286,171 pounds/year, 5 percent of the historical average (NCDMF 2010). In 2007, a moratorium was placed on the commercial and recreational herring fishery in North Carolina.

Both the alewife and blueback herring spawn in large rivers, small streams and associated tributaries, as well as low-lying areas (swamp forests) adjacent to main rivers (Walsh et al. 2005, Peters et al. 1998, Pardue 1983). The eggs of river herring are initially demersal and adhesive. Sufficient submerged woody debris and detritus must be present in spawning areas to accommodate the eggs. Water temperatures for optimal spawning range between 53.6-60.8°F. Access to spawning sites is important. On the refuge, any impediments such as dikes traversing sloughs and culverts present obstacles to river herring tying to access spawning habitat and should be removed if possible. Biologists are developing models and habitat criteria to assist land managers in setting population objectives for the river herring.

RESIDENT WILDLIFE

Focal Species –
Marbled salamander, Rafinesque's big-eared bat

Species Guild –
Downed woody debris with seasonally flooded water body nearby, cavity dwellers

The marbled salamander has been chosen as a focal species to represent the guild of wildlife that relies on coarse woody debris to meet a critical part of its habitat requirements. Coarse woody debris functions to recycle nutrients in the forest, provides necessary cover for herpetafauna, and is a key microhabitat component to a number of species of reptiles and amphibians that are temperature and moisture sensitive. In addition, coarse woody debris provides food for the lower organisms (e.g., invertebrates) in the food chain which in turn provide forage for subsequent links in the food chain (e.g., skinks, salamanders, newts, snakes, woodpeckers, and bears) (LMVJV 2007). The woody debris should be in close proximity to vernal pools or flooded swamps that are necessary to carry out the reproductive phase of the species life cycle. The marbled salamander relies on flooded swamps or vernal pools during the fall when it breeds, while most other amphibians need inundated areas during the spring. The LMVJV (2007) desired forest conditions guidelines recommend maintaining a volume of coarse woody debris of > 200 feet^3/acre with a dbh of 10 inches or greater. Meeting this recommendation should not only provide the benefits to the marbled salamander but also the benefits of coarse woody debris to the forest ecosystem as described above.

The Massachusetts Natural Heritage and Endangered Species Program provides more specific guidance on habitat requirements that should be considered for mole salamanders, including the marbled salamander. The guidelines are as follows: retain a management zone within 450 feet of a vernal pool with 70 percent having > 75 percent canopy cover, limit commercial harvesting, leave two snags/acre or uncut older dying trees to provide a future source of woody debris; during forest management activities, avoid disturbing fallen logs and limit activities between vernal pools; leave limb tops in the forest; maintain pieces of downed wood with 5 inches dbh or greater and ≥15 inches long, and retain a 50-foot no cut filter strip from the vernal pool(s). All these factors need to be taken into consideration when developing habitat management prescriptions on the refuge.

The Rafinesque's big-eared bat is known to form colonies in large hollow trees in forested areas usually in the vicinity of streams or other bodies of water. With a historical range throughout the southeastern United States in close proximity to great cypress/tupelo swamps, one can infer that they have a reliance on these areas for foraging and roosting habitat. Inventory biologists from the North Carolina Natural Heritage Program documented the presence of this bat on the

Company Swamp and Broadneck Swamp Tracts in 1998. Both tracts have large swamp interiors with large, intact mid-to-late successional stands of bottomland hardwood forests directly adjacent. Stevenson (2008) found that the Rafinesque's big-eared bat most frequently used large hollow trees with a dbh of >80 cm and chamber height > 300 cm. A variety of tree species have been known to be utilized by this bat with no particular species preference apparent. Trees in which this bat have been found include water tupelo (Gooding and Langford 2004), bald cypress (Clark 1990, Stevenson 2008), black tupelo (*Nyssa sylvatica*), American beech (Mirowsky and Horner 1997), and sycamore (Clark 1990, Stevenson 2008).

Forest management strategies should be directed toward retention of 1 to 2 large diameter trees/10 acres that have cavities >10 inches in diameter and retain large diameter trees that have a susceptibility to cavity formation.

LANDSCAPE MANAGEMENT APPROACH

The challenge of conserving fish and wildlife populations vastly exceeds the resources the Service can reasonably expect to have in the future. The future of conservation hinges on a landscape approach, and the success of the Service in meeting its conservation goals hinges on how well efforts with other federal, state, and non-governmental partners are integrated.

Most importantly, the Service has to understand how each of its partners and private landowners fit into the larger landscape of the lower Roanoke River ecosystem. The Service does not intend to manage for all the species guilds listed in Table 2. Roanoke River NWR will focus its efforts on those habitat types that are in decline at local and regional scales. The decision to place management efforts toward a few of the guilds will enable the Service to concentrate on a few high-priority species guilds (e.g., forest interior, swamp forest, cavity nesters, ground and near ground nesters and not toward edge, open woodland, and scrub-shrub) in an effort to be more effective in its conservation delivery. As a large conservation land holder without the pressures of needing to generate revenue from the land, the Service is in a position to be able to hold on to the type of habitat that makes bottomland forests most appealing to private landowners - large timber. The large tracts of late-successional forests are oftentimes cashed in on in the form of large-scale clear-cuts. These same large tracts of forested bottomlands provide habitat for several forest interior bird species, many of which are declining in numbers due to the diminishing quality and acreage of contiguous forested bottomland areas.

Through conservation partnerships and easements, the lower river landscape, with the appropriate forest manipulation, is very well-suited to provide habitat for forest interior birds as well as cavity nesters and dwellers; species requiring downed woody debris; and species that are ground foragers and nesters. Although the large-scale clear-cuts that have occurred on private lands up and down the lower river and throughout the basin fragment the forest landscape, these clear-cuts do provide early succession habitat for those priority bird species (e.g., prairie warbler, yellow breasted chat) that require this habitat type, relieving the Service from that management responsibility.

RECONCILING CONFLICTING HABITAT NEEDS

Habitat management activities inherently create short-term conflicts between species and species groups that arise as vegetative, soil, or hydrological manipulations are completed. For example, timber harvest or timber stand improvement activities will tend to diversify the forest canopy from a uniform closed condition to a varied vertical and horizontal structure throughout the forested landscape. Although this will change the forest structure, the resulting more diversified forest should provide benefits for forest interior bird species especially in those areas where the surrounding lands are largely forested. In more fragmented landscapes, there could be some short-term impacts, but given that closed canopies in mid-successional forests are not serviceable for most interior species, the net negative impact should be minor. Additionally, vegetation management in open lands can adversely affect existing plant communities in the short term. Disking, mowing, flooding, and prescribed fire essentially decimate the existing plant community and vertical structure upon which some species depend for food, cover, and breeding habitat. However, these impacts are typically short term in duration and have long term positive benefits for priority species. Conversely, these same actions benefit other species as desirable vegetation replaces the undesirable plant species or is rejuvenated from the initial treatment, thereby creating desirable habitat conditions.

In a normal annual hydrologic cycle, Roanoke River NWR has the capacity to meet the habitat needs for the priority wildlife identified as resources of concern. Each year, a complex of different wetland types is provided, either by natural means or through management decisions at the dams and manipulations by refuge staff. The manipulation of impounded wetlands influences plant diversity, seed production, and aquatic invertebrate communities. Forested tracts are managed through sound silvicultural practices to ensure that the forest provides

desirable tree species and structural composition which meet the needs of priority species. Consequently, initial conflicts among species groups are remedied through time and kept to a minimum through unit evaluation, prioritization, and planning.

Refuge actions are dictated and prioritized by established purposes, guidance in the Improvement Act, and, when appropriate, support for objectives established under conservation partnership plans. Management actions will be based on good science and the best technology available to ensure quality management for target natural resources and provide a model for land management on the river's floodplain. Management efforts will focus on meeting habitat objectives to fulfill the needs of target species guilds, and any conflicts will be resolved by priority decisions based on what is best for the resource and protecting the biological integrity and diversity of the lower Roanoke River floodplain ecosystem.

IV. Habitat Goals and Objectives

BACKGROUND

The habitat goals and objectives presented in the refuge's CCP are very broad in scope and require refinement to provide the specificity needed for an HMP. The goals and objectives outlined below build upon those outlined in the CCP, keeping the scope and intent of those original guidelines. Specific areas of the refuge and focal species from species guilds are used to focus the goals and objectives in a way that will help guide management actions. A list of species guilds, the priority species associated with each, and the focal species identified for each priority guild, can be found in Chapter III (Resources of Concern) of this HMP. An adaptive management approach will be employed to evaluate whether habitat objectives for focal species are being met.

In order to determine the effectiveness of prescribed management actions, a monitoring program will be implemented. The monitoring component is presented in this HMP in an effort to marry the HMP with the refuge's Inventory and Monitoring Plan, to ensure that appropriate and adequate monitoring of habitat and wildlife response variables is being carried out. After each stated objective, a brief outline of the primary habitat and wildlife response variables to be monitored can be found along with those species guilds likely to benefit. The monitoring component associated with each objective will also be essential to determine the effect the altered flow regime has on forest dynamics. For example, a forest prescription will be discontinued or adapted if monitoring indicates the altered hydrology is causing an undesirable effect.

There are approximately 8,592 acres of bottomland forests on the refuge. Species specific logging and floodplain sediment dynamics have changed the composition and distribution of the forest communities. A well-developed understory and midstory component desired for perpetuation of good wildlife habitat is absent in many areas. Lack of sunlight and a managed hydrological regime are the suspected reasons for the deficiency in this structural component. While restoring a more natural hydrological regime on the Roanoke River is being worked on through regulatory channels, resource managers can play a significant role in addressing the lack of sunlight problem using various forest management techniques.

The objectives outlined below that focus on bottomland forest habitats are very specific and quantitative in nature. They are centered on achieving a set of desired stand characteristics that have been shown to enhance habitat for wildlife. It has been demonstrated that habitat disturbance to forest stands is vital to create suitable habitat for a variety of forest dwelling wildlife (Wigley and Roberts 1997, LMVJV 2007, Norris et al. 2008, Twedt and Somershoe 2009). The vertical and horizontal structural diversity in terms of tree species, size, age classes, and growth forms (e.g., trees, shrubs, and vines) within a heterogeneous forest canopy that is comprised of gaps and complex layering and age structure over the landscape is important (LMVJV 2007, Franklin 2007, Lindenmayer and Franklin 2002).

For the last, decade researchers and resource managers in the Lower Mississippi Valley have quantitatively assessed the habitat characteristics mentioned above and have determined the best conditions to sustain a variety of wildlife species in bottomland hardwood communities. The desired stand conditions resource managers should strive for in the bottomland forests they manage are outlined in Table 3. Even though these variables were derived in the floodplain

forests of the Mississippi Alluvial Valley, they should also be applicable to the bottomlands found on the Roanoke River's Coastal Plain since wildlife is primarily keying in on forest structure and less so on species. The objectives for bottomland hardwood habitat incorporate the desired stand conditions for key forest variables. Resource managers with Roanoke River NWR will strive to achieve the desired forest characteristics across 35 to 50 percent of refuge landscape, with the ultimate goal of getting the forest to the point where it will be self-sustaining, meaning no silvicultural manipulation is required to retain the most beneficial forest structure.

Table 3. Desired stand conditions for bottomland hardwood forests within the Mississippi Alluvial Valley

This table was taken directly from the Recommendations for Enhancing Wildlife Habitat developed by the Lower Mississippi Alluvial Valley Joint Venture Forest Resource Conservation Working Group (LMVJV 2007).

Forest Variables[1]	Desired Stand Structure	Conditions That May Warrant Management
Primary Management Factors		
Overstory Canopy Cover	60-70%	>80%
Midstory Cover	25-40%	<20% or >50%
Basal Area	60-70 ft^2/acre with ≥ 25% in older age classes[2]	90ft2/acre or ≥ 60% in older age classes
Tree Stocking	60-70%	< 50% or > 90%
Secondary Management Factors		
Dominant Trees[3]	>2/acre	<1/acre
Understory Cover	25-40%	<20%
Regeneration[4]	30-40% of area	<20% of area
Coarse Woody Debris (>10 inch diameter)	≥ 200 ft^3/acre	<100 ft^3/acre
Small Cavities (<10 inch diameter)	>4 visible holes/acre or >4 "snag" stems ≥4 inch dbh or ≥ 2 stems >20 inch dbh	<2 visible holes/acre or <2 snags ≥4 inch dbh or <1 stem ≥ 20 inch dbh

Forest Variables[1]	Desired Stand Structure	Conditions That May Warrant Management
Den Trees/Large Cavities[5] (>10 inch diameter)	1 visible hole/10 acres or ≥ 2 stems ≥ 26 inch dbh (≥ 8ft^2 BA ≥ 26 inch dbh)	0 visible holes/10 acres or < 1 stem ≥ 26 inch dbh (< 4 ft2 BA ≥ 26 inch dbh)
Standing Den and/or Stressed Trees[5]	>6 stems/acre ≥ 10 inch dbh or ≥ 2 stems ≥ 20 inch dbh (> 4ft2 BA ≥ 10 inch dbh)	< 4 stems ≥ 10 inch dbh/acre or < 1 stem ≥ 20 inch dbh (< 2 ft^2 BA ≥ 10 inch dbh)

[1] *Promotion of species and structural diversity within stands is the underlying principle of management. Management should promote vines, cane, and Spanish moss within site limitations.*

[2] *"Older age class" stems are those approaching biological maturity, (i.e., senescence). We do not advocate aging individual trees but use of species-site-size relationships as a practical surrogate to discern age.*

[3] *Dominants (a.k.a. emergents) should have stronger consideration on more diverse sites, such as ridges and first bottoms.*

[4] *Advanced regeneration of shade-intolerant trees in sufficient numbers (circa 400/acre) to ensure their succession to forest canopy. Areas lacking canopy (i.e., group cuts) should be restricted to <20% of stand area.*

[5] *Utilizing BA parameters allows the forest manager to maintain this variable in size classes that re most suitable for the stand instead of using specific size classes noted.*

HABITAT GOALS AND OBJECTIVES

Goal: Habitat: Restore, maintain, and enhance the health and biodiversity of bottomland forested wetland habitats to ensure optimum ecological productivity.

Sub-goal 1: Bottomland Hardwood

Provide a sustainable and diverse bottomland hardwood forest community having the structural characteristics necessary to support a rich diversity of migratory birds and resident wildlife on 8,752 acres in an effort to maintain the ecological integrity of North Carolina's Coastal Plain region.

BOTTOMLAND HARDWOOD OBJECTIVE 1.1

In Management Units RB-ash-1-5 (93 acres); RB-syc-1-4 (129 acres); RB-swg-1 (11 acres); TS-north-ash 1-3 (30 acres); reduce overall basal area of plantation stands to 50-70 ft^2/ac with basal area of dominant species not to exceed 50 ft^2/ac within the next 5 years on 263 acres.

Rationale: This objective is expected to promote a canopy cover of 60-70%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover to promote the growth of hard and soft mast producing species (e.g., oaks, hickory, American elm, and persimmon).

Species guilds addressed: avian - forest interior, cavity nesters; resident wildlife non-avian-flooded and non-flooded woodlands, cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Density and occurrence of invasive species	➢ Forest cruise/inventory sampling ➢ Visual survey for invasives every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird Surveys (e.g., breeding bird point counts or indices; migration banding and counts ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

BOTTOMLAND HARDWOOD OBJECTIVE 1.2

In Management Units RB-Ash-2,5 (39 acres), RB-swg-1 (10 acres), RB-syc-1 (32 acres), BN-nat-1(1,790 acres), RB-nat-1 (1,244 acres), and CS-nat-1 (1,118 acres): in those areas where already established, within 5 years, promote the growth and expansion of river cane by 5-10% increase in patch sizes by reducing the BA to 40-60 ft2/acre in and around the river cane.

Rationale: The expected outcome of this objective is to create canopy gaps large enough (BA < 60 ft^2) to sustain vigorous growth of river cane in and around established stands (Cirtain et al. 2009).

Species guilds addressed: avian - forest interior, ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian-flooded and non-flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Expansion of river cane ➢ Density and occurrence of invasive species	➢ Forest cruise/inventory sampling ➢ Monitor cane patch sizes ➢ Visual survey for invasives every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts or indices; migration banding and counts) ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (1/x years, drift fence or cover board methods)

BOTTOMLAND HARDWOOD OBJECTIVE 1.3

Over the next 15 years, for the clearcut natural area, management unit RB-nat-2 (113 acres), and RB-MixHW-1 (121 acres): strive to achieve a future mature forest on 234 acres with 25-40% of the forest having the following characteristics: BA 60-70 ft2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, and American elm) present on 30-50% of inventory plots.

Rationale: This objective is expected to promote a regeneration of hard and soft mast producing tree species (e.g., oaks, hickory, American elm, and persimmon).

Species guilds addressed: avian - forest interior, ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian-flooded and non-flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Occurrence of invasive species and density	➢ Forest cruise/inventory sampling ➢ Visual survey for invasives every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts or indices; migration banding and counts) ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (1/x years, drift fence or cover board methods)

BOTTOMLAND HARDWOOD OBJECTIVE 1.4

Within 5 years of this HMP's approval, conduct a baseline forest inventory to determine the existing composition and relative abundance of forest species in units RB-nat-1 (1,244 acres), BN-nat-1 (1,790 acres), TS-nat-South (845 acres), TS-nat-North (220 acres), CS-nat-1 (1,118 acres), AS-nat-East (324 acres), AS-nat-West (180 acres), and CI-nat (2,067 acres), as mid-to-late successional bottomland hardwood forests allowing natural succession to dictate forest structure and composition on 6,788 acres . However, if a forest inventory of the natural areas is completed, strive to maintain 35-50% of the forest with the following characteristics: BA 60-70 ft^2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, and American elm) present on 30-50% of inventory plots.

Rationale: Create a forest community with varied vertical and horizontal structure to promote diverse species composition and maintain ecological integrity of bottomland hardwood forest.

Species guilds addressed: avian - forest interior, ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian-flooded and non-flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within target areas ➢ Occurrence of invasive species and density	➢ Forest cruise/inventory sampling ➢ Visual survey for invasives every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance) ➢ Cavity dwellers	➢ Bird surveys (e.g., breeding bird point counts or indices; migration banding and counts) ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (1/x years, drift fence or cover board methods) ➢ Cavity surveys, bat acoustic surveys, den trees, bird cavities

BOTTOMLAND HARDWOOD OBJECTIVE 1.5

Within 5 years, in all bottomland hardwood management units: strive to maintain 2 to 4 logs/acre with a diameter > 10 inches and length 5 feet or greater to provide coarse woody debris, 4-6 cavity trees >10" dbh/acre, and 1 to 4 large den trees >10" dbh or "unsound cull" trees per 10 acres to increase habitat for resident wildlife species such as amphibians, reptiles, bats, and bears (LMVJV 2007) in 40-60% of 8,752 acres of forest.

Rationale: To provide sufficient foraging habitat and cover for amphibians, herpetofauna, mammals, and forest dwelling avian species.

Species guilds addressed: avian - cavity nesters; resident wildlife non-avian-downed woody debris with seasonally flooded water body nearby, cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Volume of woody debris	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts or indices; migration banding and counts) ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (1/x years, drift fence or cover board methods)

BOTTOMLAND HARDWOOD OBJECTIVE 1.6

Within 10 years following the approval of this HMP, in Management Units AS-East-IMPOUND-SE (46 ac) and NE (102 ac), AS-West-IMPOUND-NW (35 ac) and SW (38 ac): create 2- to 5-acre gaps to promote the growth of hard mast species by 15% - 25% and maintain the biological integrity and diversity of approximately 221 acres of bottomland hardwood habitat within the Askew Impoundments by appropriate water management as defined in the Water Management Plan for the Askew Project found in Appendix H of this HMP. Implement Integrated Waterbird Monitoring and Management (IWMM) Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Rationale: The intent is to promote a diverse plant community consisting of emergent plants and mast producing tree species, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as low cypress regeneration, emergent vegetation) and implement adaptive management to perpetuate the ecological integrity of a functional tupelo/cypress swamp as a natural community. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Species guilds addressed: avian - flooded forest (winter and spring), forest interior, cavity nesters; aquatic - resident and migratory fish; resident wildlife non-avian-flooded and non-flooded woodlands, standing water.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Species composition and percent cover of emergents ➢ Occurrence of invasive species and density	➢ Forest cruise/inventory sampling ➢ Sample target areas annually ➢ Visual survey for invasives every 3 years or every opportunity
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Abundance and diversity of wintering waterfowl.	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state and flyway monitoring recommendations and IWMM or hardwood areas when flooded.

Rationale: The intent is to promote a diverse plant community consisting of emergent plants and mast producing tree species, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as low cypress regeneration, emergent vegetation) and implement adaptive management to perpetuate the ecological integrity of a functional tupelo/cypress swamp as a natural community. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Species guilds addressed: avian - flooded forest (winter and spring), forest interior, cavity nesters; aquatic - resident and migratory fish; resident wildlife non-avian-flooded and non-flooded woodlands, standing water.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Species composition and percent cover of emergents ➢ Occurrence of invasive species and density	➢ Sample target areas annually (see I WMM) ➢ Visual survey for invasives every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Abundance and diversity of wintering waterfowl ➢ Cavity dwellers	➢ Waterfowl survey (link to state and flyway monitoring recommendations and IWMM of hardwood areas when flooded. ➢ Bat acoustic surveys

BOTTOMLAND HARDWOOD OBJECTIVE 1.7

Over the 15 years following the approval of this plan, in Management Unit CS-ROW (35 ac) and HS-ROW (0.66 ac): maintain native herbaceous cover and promote the expansion of river cane by 15 - 30% and avoid trees from attaining a height greater than 12 feet.

Rationale: Adhere to guidelines set forth by the Federal Energy Regulatory Commission to prevent the growth of trees that can interfere with the maintenance and function of power lines within designated Legal Right of Ways. Implement Integrated Waterbird Monitoring and Management (IWMM) Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Species guilds addressed: avian - flooded forest (winter and spring); aquatic - resident and migratory fish; resident wildlife non-avian-flooded and non-flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Species composition and percent cover of emergents ➢ Occurrence of invasive species and density	➢ Sample target areas annually (see I WMM) ➢ Visual survey for invasives every 3 yrs.
1º Wildlife Response Variables	**Probable Methods**
➢ Abundance and diversity of wintering waterfowl. ➢ Cavity dwellers	➢ Waterfowl survey (link to state and flyway monitoring recommendations and IWMM of hardwood areas when flooded. ➢ Bat acoustic surveys

BOTTOMLAND HARDWOOD OBJECTIVE 1.8

Over the next 15 years following approval of this HMP, maintain 60 acres of bottomland hardwood forest as pristine, allowing natural succession to dictate forest composition and structure in management units HS-Nat-1 (39 acres), and Great (14 acres), and Goodman (7 acres), Islands.

Rationale: The intent is to leave the unit to natural processes and monitor to detect changes (i.e., invasive species or shifts in vegetation composition).

Species guilds addressed: avian - flooded forest (winter and spring), swamp forest, forest interior, cavity nesters; aquatic-resident and migratory fish; resident wildlife non-avian-cavity dwellers. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Occurrence of aquatic invasives	➢ Forest cruise/inventory sampling ➢ Opportunistic visual surveys for aquatic invasives
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Herp inventory ➢ Cavity dwellers	➢ Bird surveys (e.g., breeding bird point counts or indices; migration banding and counts) ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (1/x years, drift fence or cover board methods) ➢ Bat acoustic surveys

Sub-goal 2: Tupelo/Cypress

Enhance and protect 6,619 acres of healthy, functional tupelo/cypress swamp habitat to maintain it as a natural community that fosters the ecological integrity of North Carolina's Coastal Plain region.

TUPELO/CYPRESS FOREST OBJECTIVE 2.1

Over the next 15 years following the approval of this HMP, as existing stand conditions permit, in Management Units RB-Nat-1 (1,660 acres), BN-Nat-1 (235 acres) and CS-Nat 1 (811 acres), select up to 5-10 patches with approximately 1-5 acres in each unit where the swamp forest is dominated by more than 90% tupelo in an effort to increase the cypress component to an approximate 50:50 cypress/tupelo forest.

Rationale: The intent is to restore the cypress component back to the tupelo/cypress swamp, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as low cypress regeneration), and implement adaptive management to perpetuate the ecological integrity of a functional tupelo/cypress swamp as a natural community.

Species guilds addressed: avian-swamp forest, flooded forest (winter and spring), cavity nesters; resident wildlife non-avian-cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure and species composition ➢ Area (acres) in condition ➢ Occurrence of aquatic invasives	➢ Forest cruise/inventory sampling ➢ Visual survey in cypress release treatment areas ➢ Visual estimate of invasive species every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Cavity dwellers	➢ Bird surveys (e.g., breeding bird point counts or indices; migration banding and counts) ➢ Bat acoustic surveys

TUPELO/CYPRESS FOREST OBJECTIVE 2.2

Over the 15 years following the approval of this HMP, in Management Units, AS-East-IMPOUND-SE (32 acres) and SW (22 acres), AS-West-IMPOUND-SW (21 acres) and NW (27 acres): maintain the integrity of the tupelo/cypress swamp habitat within the impoundments found on the Askew Tract by appropriate water management as defined in the Water Management Plan found in Appendix H.

Rationale: The intent is to promote the growth of mast producing tree species and emergent plants, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as low cypress regeneration), and implement adaptive management to perpetuate the ecological integrity of a functional tupelo/cypress swamp as a natural community. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Species guilds addressed: avian-flooded forest (winter and spring), swamp forest, forest interior; resident wildlife non-avian-cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Regeneration within targeted areas ➢ Species composition and percent cover of emergents ➢ Occurrence of aquatic invasives	➢ Forest cruise/inventory sampling ➢ Sample target areas annually ➢ Implemenet IWMM habitat protocol ➢ Visual estimate of invasive species every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Abundance and diversity of wintering waterfowl ➢ Abundance and diversity of herps ➢ Cavity dwellers	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state and flyway monitoring recommendations and IWMM) ➢ Anuran call survey (e.g., 3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board ➢ Acoustic bat surveys

TUPELO/CYPRESS FOREST OBJECTIVE 2.3

Over the 15 years following the approval of this HMP, in Management Unit AS-West-IMPOUND-NW (27 acres): maximize occurrence of emergent plants considered good for waterfowl in the area inundated using the well pump by maintaining 30-50% of the area relatively open with BA not to exceed 60 feet2/acre within designated open areas.

Rationale: The intent is to promote a diverse plant community consisting of emergent plants and mast producing tree species, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as low cypress regeneration, emergent vegetation) and implement adaptive management to perpetuate the ecological integrity of a functional tupelo/cypress swamp as a natural community. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Species guilds addressed: avian-flooded forest (winter and spring), swamp forest, cavity nesters; resident wildlife non-avian-cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Species composition and percent cover of emergents ➢ Occurrence of aquatic invasives	➢ Forest cruise/inventory sampling ➢ Sample target areas annually ➢ Implement IWMM habitat protocol ➢ Visual estimate of invasive species every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Abundance and diversity of wintering waterfowl	➢ Waterfowl survey (link to state and flyway monitoring recommendations and IWMM)

TUPELO/CYPRESS FOREST OBJECTIVE 2.4

Over the 15 years following the approval of this HMP, in Management Unit RB-Nat-3 (47 acres): increase by 20-30% the occurrence of emergent plants considered good for waterfowl in the area inundated by maintaining 30-50% of the area relatively open with BA not to exceed 60 feet^2/acre within designated open areas.

Rationale: Promote the emergent plant growth and foraging habitat for waterbirds, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as emergent vegetation) and implement adaptive management to perpetuate the ecological integrity of emergent waterbird habitat. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (2012).

Species guilds addressed: avian-flooded forest (winter and spring), swamp forest, cavity nesters; resident wildlife non-avian-cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Species composition and percent cover of emergents ➢ Occurrence of aquatic invasives	➢ Forest cruise/inventory sampling ➢ Sample target areas annually ➢ Implement IWMM Habitat Protocol ➢ Visual estimate of invasive species every 3 years
1º Wildlife Response Variables	**Probable Methods**
➢ Abundance and diversity of wintering waterfowl ➢ Cavity dwellers ➢ Abundance and diversity of wintering waterfowl	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state flyway monitoring recommendations and IWMM) ➢ Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods) ➢ Bat acoustic surveys

TUPELO/CYPRESS FOREST OBJECTIVE 2.5

Over the next 15 years following the approval of this HMP, maintain 6,388 acres of tupelo/cypress swamp as pristine, allowing natural succession to dictate forest composition and structure in Management Units RB-Nat-1 (1,660 acres), BN-Nat-1 (235 acres), TS-Nat-South (365 acres), TS-Nat-North (127 acres), CS-Nat-1 (811) acres), AS-East-Nat-1 (426 acres), AS-West-Nat-1 (16 acres), CI-Nat-1 (1,587 ac), HS-Nat-1 (706 ac), and Great (354 ac), Goodman (96 ac), and Sunken Islands (5 acres).

Rationale: The intent is to promote a diverse plant community consisting of emergent plants and mast producing tree species, monitor to detect changes (i.e., invasive species or shifts in vegetation composition such as low cypress regeneration, emergent vegetation) and implement adaptive management to perpetuate the ecological integrity of a functional tupelo/cypress swamp as a natural community. Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Species guilds addressed: avian-flooded forest (winter and spring), swamp forest, forest interior, cavity nesters; aquatic-resident and migratory fish; resident wildlife non-avian-cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Tree regeneration within targeted areas ➢ Occurrence of aquatic invasives	➢ Forest cruise/inventory sampling ➢ Visual surveys for aquatic invasives, annually
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Abundance and diversity of wintering waterfowl ➢ Herp inventory ➢ Cavity dwellers	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state flyway monitoring recommendations and IWMM) ➢ Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods, Herpblitz) ➢ Bat acoustic surveys, den trees, bird cavities surveys

Sub-goal 3: Swamp Blackgum, Mixed Forested Peatland

Protect 4,465 acres of healthy, functional swamp blackgum and mixed peatland forest as a natural community that fosters the ecological integrity of North Carolina's Coastal Plain region.

SWAMP BLACKGUM, MIXED FORESTED PEATLAND OBJECTIVE 3.1

Over the 15 years following the approval of this HMP, maintain 4,465 acres of swamp blackgum, mixed peatland forest as pristine allowing natural succession to dictate forest composition and structure in management units Great Island, Goodman, and Sunken Islands, and Hampton Swamp.

Rationale: The intent is to leave the unit to natural processes and monitor to detect changes (i.e., invasive species or shifts in vegetation composition).

Species guilds addressed: avian-flooded forest (winter and spring), swamp forest, forest interior, cavity nesters; aquatic-resident and migratory fish; resident wildlife non-avian-cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest structure and diversity ➢ Area (acres) in condition	➢ Forest cruise/inventory sampling (e.g., forest plot data) ➢ Water leveling and salinity probes to be installed in 5-10 years, work with NOAA, EPA, and other partners to monitor sea level rise and impacts to habitat, FWS SET station
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts)

Sub-goal 4: Hydrologically Disconnected Floodplain Forest

Restore and enhance 655 acres of forest including 490 acres of plantation forests to create a mosaic that reflects the habitat requirements for a mixed, uneven-aged deciduous hardwood forest having the structural characteristics necessary to support a rich diversity of migratory birds and resident wildlife in an effort to maintain the ecological integrity of North Carolina's Coastal Plain region.

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.1

Over the 10 years following the approval of this HMP, in Management Units TS-south-syc-1-4 (22 acres) and TS-north-syc-1-10 (115 acres): reduce the BA from 92 feet^2/acre to 40-70 feet^2/acre in 50-70% of the approximately 137 acres of sycamore plantation with basal area of dominant species not to exceed 50 feet^2/acre.

Rationale: This objective is expected to provide a target canopy cover between 60-80%, 25-40% mid-story cover, 25-40% understory cover and 20-50% ground cover.

Species guilds addressed: avian-ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian non-flooded/flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.2

Over the 10 years following the approval of this HMP, in Management Units TS-south-swg1-4 (50 acres) and TS-north-swg1-6 (75 acres): reduce the BA from 115 feet^2/acre to 60-70 feet^2/acre in 50-70% of the approximately 125 acres of sycamore plantation with basal area of dominant species not to exceed 50 feet^2/acre.

Rationale: This objective is expected to provide a target canopy cover between 60-80%, 25-40% mid-story cover, 25-40% understory cover, and 20-50% ground cover.

Species guilds addressed: avian-ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian non-flooded/flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.3

Over the 15 years following the approval of this HMP, in Management Unit TS-south-cot-1-3 (80 acres): strive to achieve a future mature forest with the following characteristics: BA 60-70 feet^2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, and American elm) present on 30-50% of inventory plots.

Rationale: The intent is to promote natural species succession, monitor to detect changes (i.e., invasive species or shifts in vegetation composition) and implement adaptive management to perpetuate the ecological integrity of a functional mixed, uneven-aged deciduous hardwood forest natural community.

Species guilds addressed: avian-ground/near ground nesters and ground foragers; non-avian non-flooded/flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling after 10 years
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.4

Over the 10 years following the approval of this HMP, in Management Unit TS-south-pin-1: promote the growth of mixed hardwoods by reducing the basal area from 171 feet^2/acre to 50-70 feet^2/acre, throughout the 25 acre plantation.

Rationale: This objective is expected to provide a target canopy cover between 40-60%, 30-50% mid-story cover, 25-40% understory cover, and 20-50% ground cover.

Species guilds addressed: ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian non-flooded/flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state flyway monitoring recommendations and IWMM) ➢ Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.5

In Management Units TS-north-pin-1-2 (58 acres) and TS-south-pin-2 (21 acres): promote the growth of mixed drier bottomland hardwood species in 79 acres of pine plantation within the next 5-8 years by attaining a basal area of 60-80 feet^2/acre.

Rationale: This objective is expected to provide a target canopy cover between 40-60%, 30-50% mid-story cover, 25-40% understory cover, and 20-50% ground cover.

Species guilds addressed: ground/near ground nesters and ground foragers; resident wildlife non-avian non-flooded/flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state flyway monitoring recommendations and IWMM Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.6

Over the 15 years following the approval of this HMP, for the 250 acres of clear-cut natural area within Management Unit TS-Nat-South (320 acres) and TS-Nat-North (227 acres), strive to achieve a future mature forest with the following characteristics: canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, American elm) present on 30-50% of inventory plots.

Rationale: Create a forest community with diverse vertical and horizontal structure and maintain ecological integrity of non-flooded woodlands.

Species guilds addressed: avian-forest interior, ground/near ground nesters and ground foragers; resident wildlife resident wildlife non-avian- non-flooded woodlands.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts)

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.7

Within 5 years of this HMP's approval, conduct a baseline forest inventory to determine the existing composition and relative abundance of forest species, maintain 554 acres of mid-to-late successional forests in Management Units TS-nat-south (320 acres), TS-nat-north (227 acres) and TS-south-pin-3 (7 acres), as mid-to-late successional hardwood forests allowing natural succession to dictate forest structure and composition. However, if a forest inventory of the natural areas is completed strive to maintain 35-50% of the forest with the following characteristics: BA 60-70 feet^2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, American elm) present on 30-50% of inventory plots.

Rational: Maintain and promote mast producing tree species and ecological integrity of disconnected floodplain forest.

Species guilds addressed: avian-forest interior, ground/near ground nesters and ground foragers, cavity nesters; resident wildlife non-avian-flooded and non-flooded woodlands, cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Cavity dwellers	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Bat acoustic surveys, den tree, and bird cavities indices

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST OBJECTIVE 4.8

Over the 15 years following the approval of this HMP, in all 655 acres of HDFF forest management units, strive to maintain 2 to 4 logs/acre, >10 inches, and approximately 5 feet in length, to provide coarse woody debris, 4-6 cavity trees >10" dbh/acre, and 1 to 4 large den trees >10" dbh or "unsound cull" trees per 10 acres to increase habitat for resident wildlife species such as amphibians, reptiles, bats, and bears (LMVJV 2007).

Rationale: To provide sufficient foraging habitat and cover for amphibians, herpetofauna, mammals, and forest dwelling avian species.

Species guilds addressed: avian-cavity nesters; resident wildlife non-avian-downed woody debris with seasonally flooded water body nearby, cavity dwellers.

Strategic Habitat Conservation Outcome-based Monitoring Elements:

1º Habitat Response Variables	Probable Methods
➢ Forest overstory structure ➢ Area (acres) in condition ➢ Hardwood regeneration within targeted areas ➢ Volume of woody debris	➢ Forest cruise/inventory sampling
1º Wildlife Response Variables	**Probable Methods**
➢ Forest breeding birds (species composition and abundance) ➢ Presence of herps (species composition and abundance)	➢ Bird surveys (e.g., breeding bird point counts; migration banding and counts) ➢ Waterfowl survey (link to state flyway monitoring recommendations and IWMM Anuran call survey (3 times/year/every 3 years) ➢ Herpetofauna survey (e.g., 1/x years, drift fence or cover board methods)

V. Management Strategies and Prescriptions

POTENTIAL MANAGEMENT STRATEGIES

Ecological forestry is a management approach that uses natural disturbance and ecological processes as a guide to silvicultural prescriptions and restoration practices. The purpose is to build and maintain a complex forest structure usually with multiple age classes, meeting a diversity of wildlife management objectives while maintaining the functionality of the forest being managed.

By use of a variety of methods and finely tuned prescriptions, forest management can establish and maintain desired forest conditions, such as those identified in the Resources of Concern described in this HMP. In the attainment of desired conditions specific to focal species or a suite of species, some other species with different needs will experience poorer habitat quality. For this reason, the Resources of Concern have been carefully identified to represent the needs of many important species.

Past land use activities have influenced the quality and composition of the bottomland forests found on the refuge today. The suite of possible strategies for application of forest management to meet the established habitat objectives put forth in this HMP includes various applications of silvicultural treatments, reforestation, water control, and prescribed fire.

Because the effect of silvicultural methods is specific to the location on which they are applied, there are rarely negative impacts from these methods on neighboring landowners. Depending on the method employed, impacts from heavy equipment can cause incidental damage to soils, hydrologic flow, or non-target trees. Forest management prescriptions on national wildlife refuges are carefully designed to minimize or repair any negative impacts and to assure that these are outweighed by the benefits of the management. No large scale commercial timber sales are planned in those compartments designated as natural areas (e.g., Nat-BLHW, Nat-CT, and Nat-HDFF) in this HMP. However, small scale commercial cuts may occur to achieve desired forest characteristics as described in Table 3 of this HMP (see also Appendix B). Because application of forest management usually requires commercial application, many details of the commercial aspect of application must be addressed in addition to biological application issues. Such details are included in Appendix I.

SILVICULTURAL MANAGEMENT

Silvicultural management is a program of treatments to a forest stand in an effort to obtain desired forest objectives and future conditions. It is a well-established and understood strategy in which the structure and the composition of bottomland hardwood forests can be strategically modified on both a gross and fine scale (Franklin 2007, Hicks et al. 2004). The most common silvicultural management methods used are:

- Thinning - intermediate cuttings that are aimed primarily at controlling the growth of stands by manipulating stand density.

- Single-Tree Selection - removal of a single mature individual tree or small clumps of several such trees.

- Group-Selection - removal of trees from a stand in groups to create openings in the forest canopy.

- Patch-cuts - small clear-cuts that normally range in size from 1 to 3 acres.

- Seed-tree Cutting Method - removal in one cut of all timber from an area, saving a small number of desired species to provide a seed source for establishment of a new stand.

- Shelterwood Cutting Method - even-aged silvicultural system similar to seed-tree cutting, but with lighter, multiple cuts.

- Hack and squirt - a simple non-invasive method of killing trees with herbicides. It can be used for single or group tree selection treatments. The tree is left standing to die in place. It is carried out by making a series of downward cuts in the bark around the entire circumference of the tree trunk. For most species, one cut for every 2 inches of trunk diameter is made with the appropriate herbicide immediately applied into the cuts. The tree will be left standing providing habitat for cavity nesters, insects, and insectivores.

- Precommercial Thinning - any thinning of non-merchantable trees.

- Passive Management - is defined by the condition where a forest is managed by a hands-off approach. It does not imply a hands-off approach for all types of management, but only silviculture. Other management such as water and beaver control and public use may occur.

- Grazing - involves using livestock to remove undesirable vegetation in an effort to reduce competition.

- Weed Control - involves the use of herbicides to control competing vegetation.

- Fertilization - involves fertilizing the target trees to give them a competitive advantage over potential competitors.

REFORESTATION

Reforestation is conducted in areas that have been previously deforested and is used to establish a future forest condition. Typical variations in planting methods include seeding mechanism, planting of seed or seedlings, species composition, pre-planting site preparation, and planting density. Each variable may affect the seedling survival and future condition of the developing area and subsequent habitat value.

Reforestation was used on the Town Swamp Tract in 2001 after several hundred acres of hardwoods were clear-cut and reforested with loblolly pine. In 2007, refuge staff planted trees in 1/4- to 1-acre plots that were used as loading decks during the 2001-2002 logging operation at Town Swamp.

WATER CONTROL

Water control is used in some locations to manipulate water levels for the benefit of target wildlife species. Variations in method generally include the timing, duration, and depth of water applied within the controlled area. Application of water control can provide significant benefits for target species, including the appropriate seasonal water depth for feeding waterfowl and access to breeding and spawning habitat for amphibians and fish. It is also a tool used to set back succession by either killing young hardwoods or preventing hardwood regeneration through prolonged inundation. However, water control must be carefully applied, as significant negative impacts to forest health and plant species composition can occur when water is held on forested habitat at inappropriate seasons, length of time, or depths. This includes controlling beaver if they are building dams in those areas that are in conflict with the objectives identified for the affected management unit.

PRESCRIBED FIRE

Prescribed fire is not commonly used in bottomland hardwood systems. However, specific site uses may be appropriate to create specific conditions. Prescribed fire is a reasonable option for site preparation for tree plantings. In such situations, it would be used to remove weeds or debris and to reduce competition for newly planted seedlings or germinants from seed. It is also useful in managing canebrakes.

CONTROL OF EXOTIC INVASIVE PLANT SPECIES

Control of exotic invasive plant species is necessary if the objectives and overall goals are to be achieved. If an exotic plant infestation is spotted or already occurs, then proper and aggressive eradication measures must be undertaken or spread is inevitable. Continued treatment and re-treatments will be necessary to be successful.

MANAGEMENT STRATEGY SELECTION

The management objectives outlined in this HMP and the strategies used to implement them will set the trajectory of what the structure and species composition of the forest will look like many years from now. Therefore, careful and thoughtful consideration must be given to what strategies will be implemented to achieve the outlined habitat objectives. Prescribed fire management is a strategy with merit for specific conditions that exist on the refuge, but will not be proposed in this HMP to meet the habitat objectives established for the forested habitat of the Roanoke River NWR. Silviculture management methods and water control will be used. There are currently no areas where reforestation is warranted as a potential strategy on the refuge. Water control will be used to set back forest succession when conditions merit its use. Silvicultural management will be most extensively used to reach and maintain the habitat objectives put forth in this HMP. The purpose of silviculture is to establish and maintain the desired forest conditions specified in the objectives. This overall strategy uses a variety of methods of application to achieve desired habitat results. The following are the silvicultural methods to be utilized with a description of the effect they are expected to have on the habitat:

- Thinning - The objective of thinning is to open the forest canopy, release trees from competition, improve regeneration, and improve species composition within a stand. Varying the size of forest openings within a treatment area will enhance species diversity by creating a variety of forest conditions that are needed to meet the habitat

requirement of various plant species. Maintaining plant species diversity within the forest facilitates a constant supply of hard and soft mast for wildlife.

- Single-Tree Selection - Openings created with this method will generally be about 1/4-acre in size. This is an uneven-aged silviculture method that will allow for the development of a new age class of trees within the forest structure. This method favors the regeneration and development of plant species with higher shade tolerances.

- Group-Selection - Removal of trees from a stand, in groups, to create openings in the forest canopy. These openings are generally about 1/2-acre in size. The increased size of the openings will encourage the regeneration of more shade intolerant plant species such as oaks, green ash, sugarberry, etc.

- Passive Management - The objective in using this method is to avoid the use of silvicultural management methods and instead let the progressive sequence of changes in vegetation types result in the formation of a “climax community” that will eventually be in equilibrium with the environment with natural disturbances (e.g., wind falls, hurricanes, lightning strikes, disease, and the rare ice storm), creating canopy gaps large enough to create or, in some cases, maintain an uneven-aged forest.

- Preplanting site appropriate desired tree species 2-3 years before a management action to allow root stock to become established. This is particularly useful for shade intolerant species such as oaks. Preplanting will enable oaks to establish a good root stock and out-compete other species once the canopy has been opened.

- Control of exotic and nuisance species is essential to ensure the implemented forest management strategy has a chance to be successful and in maintaining the integrity of the forest ecosystem. Beaver and nutria numbers will be controlled and feral pigs will be removed from the system and disposed through a trapping and hunting program. Exotic plant species found on the refuge to be particularly invasive (e.g., Chinese privet, mimosa tree, dewflower, and alligator weed) will be controlled with herbicides, with the goal of eventual total eradication from refuge lands. In those units where forest manipulation has been prescribed, an effort will be made to eradicate invasive exotic species.

Maintaining stand diversity in the bottomland forests is a beneficial strategy; a more diverse forest should provide better opportunities for long-term health, stability and functionality. It is certain that forest pests and diseases will continue to pose a threat to the bottomland hardwoods in the Roanoke River system. The potential loss of green ash to emerald ash borer outbreaks may eliminate or significantly reduce this dominant species from the bottomland forests along the Roanoke River. Resource managers should strive to develop stands that include a diverse array of tree species and maintain species vigor. This may entail efforts to increase some of the less common tree associates in this forest type, such as oaks, hickories, and sugarberry, where appropriate. Managers should be aware of the long-term impacts physical barriers placed on the landscape in order to manipulate water levels in forested wetlands may have on tree vigor and health. Keeland et al. 2010 reported that the

vigor and growth of hard mast tree species found in a 21,000-acre managed forested impoundment in Arkansas was reduced over a period of 20 years. Even though resource managers may realize benefits from a given habitat management strategy in the short-term, there may be unintended long-term consequences that are not in keeping with the overall goal. In addition, attempts should be made to reduce invasive, non-native plants. Early detection of new infestations is important, since small populations can often be eliminated or, at a minimum, be contained. Further, management activities should not create conditions conducive to the spread or population build-up of weedy invasive plants. Examples of this would be artificially impounded water during the growing season, allowing alligator weed and parrot feather to become established, or the spread of invasives, such as microstegium, moving from tract to tract via equipment.

Initially, a conservative approach should be taken toward any forest management strategy that involves opening up more than 1/4- to 1/2-acre of canopy or heavy thinning. The concern is invasive plant species, such as privet and mimosa, already present in low numbers on the refuge from becoming established in disturbed areas. Refuge staff will need to be vigilant in monitoring these areas for invasives and take action to eradicate them as soon as they are detected. Caution should also be taken in those areas where it is believed the altered hydrology may be affecting forest species composition. It is suggested to initially apply treatments in those areas impacted on a small scale and monitor the response of species establishment and growth, to develop a management strategy in similar areas on a larger scale. Control of feral pigs should be of highest priority throughout the entire refuge. Feral pigs recently arrived in the lower Roanoke River. Pigs have been observed on the Town Swamp tract during the three years, 2009 to 2012, and evidence of rutting has been found on Broadneck, Town Swamp, and Company Swamp tracts in 2012.

MANAGEMENT STRATEGIES AND PRESCRIPTIONS BY OBJECTIVE

To meet all objectives on all units, management units will be cruised to assess conditions and a site and time specific forestry prescription will be written.

BOTTOMLAND HARDWOOD

Bottomland Hardwood Objective 1.1

In Management Units RB-ash-1-5 (93 acres); RB-syc-1-4 (129 acres); RB-swg-1 (11 acres); TS-north-ash 1-3 (30 acres): within 5 years of the date of this HMP, reduce overall basal area of plantation stands to 50-70 feet^2/acre, with basal area of dominant species not to exceed 50 feet^2/acre on 263 acres.

Strategies:

- Commercial thinning and group tree selection based on desirable species. Use a third, fourth, or fifth row removal and extract smaller, poorly formed trees between rows, treat target stumps with herbicide to reduce the occurrence of coppicing.
- Avoid removal of persimmon, established cottonwood (>10”dbh), and hard mast species in the Carya and Quercus genera. Work to be completed preferably during the dormant season.

- Before manipulating stand, identify and remove any exotic invasive shrubs found in the units such as Chinese privet, mimosa, and China berry, by hacking the shrub and injecting it with an appropriate herbicide.
- Avoid the removal of well-formed emergent trees or good wildlife trees (i.e., cavity trees or potential den trees).

Bottomland Hardwood Objective 1.2

In Management Units RB-Ash-2,5 (39 acres), RB-swg-1 (10 acres), RB-syc-1 (32 acres), BN-nat-1(1,790 acres), RB-nat-1 (1,244 acres), and CS-nat-1 (1,118 acres): in those areas where already established, within 5 years of the date of this HMP, promote the growth and expansion of river cane by 5-10%, and increase patch sizes by reducing the BA to 40-60 feet^2/acre in and around the river cane.

Strategies:

- Thin using hack and squirt. Reduce the BA in and around established stands of river cane to 40-60 feet^2/acre, by injecting trees with the herbicide Habitat during the dormant season.
- Avoid removal of any well-formed emergent trees or good wildlife trees (i.e., cavity trees, potential den trees).
- Before injecting hardwood trees, remove any exotic invasive shrubs found in the units such as Chinese privet, mimosa, and China berry, by hacking the shrub and injecting it with an appropriate herbicide.

Bottomland Hardwood Objective 1.3

Over the 15 years following the date of this HMP, for the clear-cut natural area, Management Unit RB-nat-2 (113 acres), and RB-MixHW-1 (121 acres): strive to achieve a future mature forest on 234 acres with 25-40% of the forest having the following characteristics: BA 60-70 feet2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, and American elm) present on 30-50% of inventory plots.

Strategies:

- Use a passive management approach for approximately 10-15 years then inventory stand to determine if any management action is warranted to improve stand diversity or structure.
- Remove any exotic invasive shrubs found in the units such as Chinese privet, mimosa, and China berry, by hacking the shrub and injecting it with an appropriate herbicide.

Bottomland Hardwood Objective 1.4

Within 5 years of the date of this HMP, conduct a baseline forest inventory to determine the existing composition and relative abundance of forest species in Management Units RB-nat-1 (1,244 acres), BN-nat-1 (1,790 acres), TS-nat-South (845 acres), TS-nat-North (220 acres), CS-nat-1 (1,118 acres), AS-nat-East (324 acres), AS-nat-West (180 acres), and CI-nat (2,067

acres), as mid-to-late successional bottomland hardwood forests allowing natural succession to dictate forest structure and composition on 6,788 acres . However, if a forest inventory of the natural areas is completed, strive to maintain 35-50% of the forest with the following characteristics: BA 60-70 feet^2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, and American elm) present on 30-50% of inventory plots.

Strategies:

- Passive management on all mid-to-late successional, natural bottomland hardwood stands will be the strategy until data on current forest conditions are collected via a comprehensive forest inventory. Management prescriptions based on results of the forest inventory will then be developed, using the future desired forest characteristics outlined in the LMVJV 2007 document as guidance.

Bottomland Hardwood Objective 1.5

Within 5 years of the date of this HMP, in all bottomland hardwood management units, strive to maintain 2 to 4 logs/acre with a diameter > 10 inches and length 5 feet or greater to provide coarse woody debris, 4-6 cavity trees >10" dbh/acre, and 1 to 4 large den trees >10" dbh or "unsound cull" trees per 10 acres to increase habitat for resident wildlife species such as amphibians, reptiles, bats and bears (LMVJV 2007) in 40-60% of 8,752 acres of forest.

Strategies:

- Use data collected in the forest inventory to ensure adequate coarse woody debris and den trees are present. If coarse woody debris is lacking, fell enough trees to meet criteria, taking care not to take good wildlife trees.

Bottomland Hardwood Objective 1.6

Within 10 years of the date of this HMP, in Management Units AS-East-IMPOUND-SE (46 acres) and NE (102 acres), AS-West-IMPOUND-NW (35 acres) and SW (38 acres), create 2 to 5, 2- to 5-acre gaps to promote the growth of hard mast species by 15-25%, and maintain the biological integrity and diversity of approximately 221 acres of bottomland hardwood habitat within the Askew Impoundments by appropriate water management as defined in the Water Management Plan for the Askew Project (see Appendix H). Implement IWMM Protocol to link habitat conditions to populations of waterfowl and other waterbirds (USFWS 2012).

Strategies:

- Hack and squirt treatments will be used to create prescribed gaps. Hard mast trees will be released by injecting competing trees (i.e., maple, ash, sweetgum, and ironwood) with the appropriate herbicide during the dormant season.
- Avoid the removal of well-formed emergent trees and good wildlife trees (i.e., cavity trees and potential den trees).
- Use the Water Management Plan developed for the Askew Project as a guide to manage water levels in the impoundments.

- Control beaver numbers to avoid the ponding of water on hardwoods during the growing season.

Bottomland Hardwood Objective 1.7

Over the 15 years following the date of this HMP, in Management Unit CS-ROW (35 acres) and HS-ROW (0.66-acre), maintain native herbaceous cover and promote the expansion of river cane by 15-30% and avoid trees from attaining a height greater than 12 feet.

Strategies:

- Follow guidelines set forth in the 2006 MOU between Dominion Power and the Service (Roanoke River NWR) found in Appendix G. Avoid any vegetation manipulation from March 15 to September 15.
- Continue to work with the North Carolina Department of Transportation and Dominion Power in reviewing annual pesticide use permits for use of herbicides on refuge lands, and encourage an integrated approach to plant pest management.

Bottomland Hardwood Objective 1.8

Over the 15 years following the date of this HMP, maintain 60 acres of bottomland hardwood forest as pristine, allowing natural succession to dictate forest composition and structure in Management Units HS-Nat-1 (39 acres), and Great (14 acres) and Goodman (7 acres) Islands.

Strategies:

- Passive management strategy to be applied to 100% of the referenced management units. These bottomland forests are going through secondary succession and are expected to become self-sustaining forest communities if left alone.
- If invasives are present, treat as necessary.

TUPELO/CYPRESS

Tupelo/Cypress Forest Objective 2.1

Over the 15 years following the date of this HMP, as existing stand conditions permit, in Management Units RB-Nat-1 (1,660 acres), BN-Nat-1 (235 acres), and CS-Nat 1 (811 acres), select up to 5-10 patches approximately 1-5 acres in each unit where the swamp forest is dominated by more than 90% tupelo in an effort to increase the cypress component to an approximate 50:50 cypress/tupelo forest.

Strategies:

- Single tree selection using hack and squirt. Successfully used in releasing suppressed cypress from the mid-story in treatment plots on the Rainbow Unit (deGravelles 2010).

- Locate pockets of at least 5-10 young cypress trees at breast height or higher competing with canopy tupelo trees for light and inject competing tupelo trees with the appropriate herbicide treatment. Treatment of tupelo trees that have hollowed out bases or other wildlife value should be avoided.
- If aquatic invasives are present, treat invasives before injecting trees.

Tupelo/Cypress Forest Objective 2.2

Over the 15 years following the date of this HMP, in Management Units AS-East-IMPOUND-SE (32 acres) and SW (22 acres), AS-West-IMPOUND-SW (21acres) and NW (27 acres), maintain the integrity of the tupelo/cypress swamp habitat within the impoundments found on the Askew tract by appropriate water management as defined in the Water Management Plan found in Appendix H.

Strategies:

- Use the Water Management Plan developed for the Askew Project as a guide to manage water levels in the impoundments.
- To avoid ponding of water during the growing season, control beaver numbers.
- Select 2-4 areas adjacent to existing openings with established emergent growth. Single tree selection using hack and squirt. Inject target trees with the herbicide Habitat during the dormant season. Avoid injecting good wildlife trees.
- If aquatic invasives are present, treat invasives before opening up canopy.

Tupelo/Cypress Forest Objective 2.3

Over the 15 years following the date of this HMP, in Management Unit AS-West-IMPOUND-NW (27 acres), maximize occurrence of emergent plants considered good for waterfowl in the area inundated using the well pump by maintaining 30-50% of the area relatively open with BA not to exceed 60feet^2/acre within designated open areas.

Strategies:

- Use the Water Management Plan developed for the Askew Project as a guide to manage water levels in the impoundments.
- Control beaver numbers to avoid ponding of water during the growing season.
- Select 2-4 areas adjacent to existing openings with established emergent growth. Single tree selection using hack and squirt. Inject target trees with the herbicide Habitat during the dormant season.
- Avoid injecting good wildlife trees (i.e., cavity trees, potential den trees).
- If aquatic invasives are present, treat invasives before opening up canopy.
- Use water as a tool to set back succession to control the growth of woody vegetation in those areas designated for emergent plant growth.

Tupelo/Cypress Forest Objective 2.4

Over the 15 years following the date of this HMP, in Management Unit RB-Nat-3 (47 acres), increase by 20-30% the occurrence of emergent plants considered good for waterfowl in the area inundated by maintaining 30-50% of the area relatively open with BA, not to exceed 60feet^2/acre within designated open areas.

Strategies:

- Control beaver numbers to avoid ponding of water during the growing season.
- To keep BA ≤ 60feet^2/acre using hack and squirt inject trees that are encroaching into the unit. Inject target trees with the herbicide Habitat during the dormant season.
- Avoid injecting good wildlife trees (i.e., cavity trees, potential den trees).
- If aquatic invasives are present, treat invasives before opening up canopy.

Tupelo/Cypress Forest Objective 2.5

Over the 15 years following the date of this HMP, maintain 6,388 acres of tupelo/cypress swamp as pristine, allowing natural succession to dictate forest composition and structure in Management Units RB-Nat-1 (1,660 acres), BN-Nat-1 (235 acres), TS-Nat-South (365 acres), TS-Nat-North (127 acres), CS-Nat-1 (811) acres), AS-East-Nat-1 (426 acres), AS-West-Nat-1 (16 acres), CI-Nat-1 (1,587 acres), HS-Nat-1 (706 acres), and Great (354 acres), Goodman (96 acres), and Sunken Islands (5 acres).

Strategies:

- Passive management strategy to be applied to 100% of the referenced management units. These swamp forests are going through secondary succession and are expected to become self-sustaining forest communities if left alone.
- If aquatic invasives are present, treat as necessary.

SWAMP BLACKGUM, MIXED FORESTED PEATLAND OBJECTIVE

Swamp Blackgum, Mixed Forested Peatland Objective 3.1

Over the 15 years following the date of this HMP, maintain 4,465 acres of swamp blackgum, mixed peatland forest as pristine, allowing natural succession to dictate forest composition and structure in Management Units Great Island, Goodman, and Sunken Islands, and Hampton Swamp.

Strategies:

- A passive management strategy will be applied to the referenced management units located outside of those areas described in Objective 1 of the tupelo/cypress forest. These swamp forests are going through secondary succession and are expected to become self-sustaining forest communities if left alone.
- If aquatic invasives are present, treat as necessary.

HYDROLOGICALLY DISCONNECTED FLOODPLAIN FOREST (HDFF) OBJECTIVES

Hydrologically Disconnected Floodplain Forest Objective 4.1

Over the 10 years following the date of this HMP, in Management Units TS-South-Syc-1-4 (22 acres) and TS-North-Syc-1-10 (115 acres), reduce the BA from 92 feet^2/acre to 40-70 feet^2/acre in 50-70% of the approximately 137 acres of sycamore plantation, with basal area of dominant species not to exceed 50 feet^2/acre.

Strategies:

- Re-evaluate stand in approximately 5 years. Stand is in decline, sycamore may naturally thin out. If a thinning is warranted, use prescription described in bullets below.
- Promote regeneration of target species through thinning and group tree selection release. Use a third or fifth row removal and extract smaller, poorly formed trees between rows.
- Treat stumps of target trees to reduce the occurrence of coppicing in an effort to promote species diversity within the units.
- Avoid removal of persimmon, established hard mast species in the Carya and Quercus genera.
- Avoid the removal of well-formed canopy trees and good wildlife trees (i.e., cavity trees, potential den trees).

Hydrologically Disconnected Floodplain Forest Objective 4.2

Over the 10 years following the date of this HMP, in Management Units TS-South-swg1-4 (50 acres) and TS-North-swg1-6 (75 acres), reduce the BA from 115 feet^2/acre to 60-70 feet^2/acre in 50-70% of the approximately 125 acres of sycamore plantation, with basal area of dominant species not to exceed 50 feet^2/acre.

Strategies:

- Promote regeneration of target species through thinning and group tree selection release. Use a third or fifth row removal and extract smaller, poorly formed trees between rows.
- Treat target stumps to reduce the occurrence of coppicing in an effort to promote species diversity within the units.
- Avoid removal of persimmon, established hard mast species in the Carya and Quercus genera.
- Avoid the removal of well-formed canopy trees and good wildlife trees (i.e., cavity trees, potential den trees).

Hydrologically Disconnected Floodplain Forest Objective 4.3

Over the 15 years following the date of this HMP, in Management Unit TS-South-cot-1-3 (80 acres), strive to achieve a future mature forest with the following characteristics: BA 60-70 feet^2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover,

and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, and American elm) present on 30-50% of inventory plots.

Strategies:

- Use a passive management approach for approximately 10-15 years then inventory stand to determine if any management action is warranted to improve stand diversity or structure.

Hydrologically Disconnected Floodplain Forest Objective 4.4

Over the 10 years following the date of this HMP, in Management Unit TS-South-pin-1, promote the growth of mixed hardwoods by reducing the basal area from 171feet^2/acre to 50-70 feet^2/acre, throughout the 25-acre plantation.

Strategies:

- Commercially thin stand using a third row removal and extract smaller, poorly formed trees between rows. Avoid unnecessary removal and damage to hard mast tree species and understory species (e.g., hollies, spicebush).
- Avoid removal of cavity tree

Hydrologically Disconnected Floodplain Forest Objective 4.5

In Management Units TS-North-pin-1-2 (58 acres) and TS-South-pin-2 (21 acres), within 5-8 years following the date of this HMP, promote the growth of mixed drier bottomland hardwood species in 79 acres of pine plantation by attaining a basal area of 60-80 feet^2/acre.

Strategies:

- Thin stand at age 15 to reduce basal area to 70 feet^2/acre of pine, avoid removal or damage to native hardwoods. When stand is 25 years of age, consider removing 80% of the remaining pines from the stand. If site appropriate mast species (e.g., oaks, hickories) are less than 4/acre, pre-plant site appropriate species before second thinning in 25 years.

Hydrologically Disconnected Floodplain Forest Objective 4.6

Over the 15 years following the date of this HMP, for the 250 acres of clear-cut natural area within Management Unit TS-Nat-South (320 acres) and TS-Nat-North (227 acres), strive to achieve a future mature forest with the following characteristics: canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, American elm) present on 30-50% of inventory plots.

Strategies:

- Use a passive management approach for approximately 10-15 years, then inventory stand to determine if any management action is warranted to improve stand diversity and structure.
- Passive management strategy to be applied to up to 90% of the CS-Nat Unit; approximately 70% of BN-Nat, CI-Nat, and TS-Nat Units; and 50% of the AS-Nat-East and West Units.
- Remove any exotic invasive shrubs found in the units such as Chinese privet (*Ligustrum sinense*), silk tree (*Albizia julibrissin*) and China berry (*Melia azedarach*) by hacking the shrub and injecting it with an appropriate herbicide.

Hydrologically Disconnected Floodplain Forest Objective 4.7

Within 5 years of the date of this HMP, conduct a baseline forest inventory to determine the existing composition and relative abundance of forest species, maintain 554 acres of mid-to-late successional forests in management units TS-Nat-South (320 acres), TS-Nat-North (227 acres), and TS-South-pin-3 (7 acres), as mid-to-late successional hardwood forests, allowing natural succession to dictate forest structure and composition. However, if a forest inventory of the natural areas is completed, strive to maintain 35-50% of the forest with the following characteristics: BA 60-70 feet^2/acre, canopy cover between 60-80%, 30-60% mid-story cover, 30-40% understory cover, and 20-50% ground cover (LJMV2007), with regeneration of hard and soft mast producing species (e.g., oaks, water hickory, American elm) present on 30-50% of inventory plots.

Strategies:

- Passive management on all mid-to-late successional, natural bottomland hardwood stands will be the strategy until data on current forest conditions are collected via a comprehensive forest inventory. Management prescriptions based on results of the forest inventory will then be developed using the future desired forest characteristics outlined in the LMVJV 2007 document as guidance.
- These management units are going through secondary succession and are expected to become self-sustaining forest communities if left alone.

Hydrologically Disconnected Floodplain Forest Objective 4.8

Over the 15 years following the date of this HMP, in all 655 acres of HDFF forest management units, strive to maintain 2 to 4 logs/acre, >10 inches, and approximately 5 feet in length, to provide coarse woody debris, 4-6 cavity trees >10” dbh/acre, and 1-4 large den trees >10” dbh or “unsound cull” trees per 10 acres to increase habitat for resident wildlife species such as amphibians, reptiles, bats, and bears (LMVJV 2007).

Strategies:

- In all HDFF management units, inventory forest habitat to ensure that adequate coarse woody debris and den trees are present. If coarse woody debris is lacking, fell enough trees to meet criteria, taking care not to take good wildlife trees.

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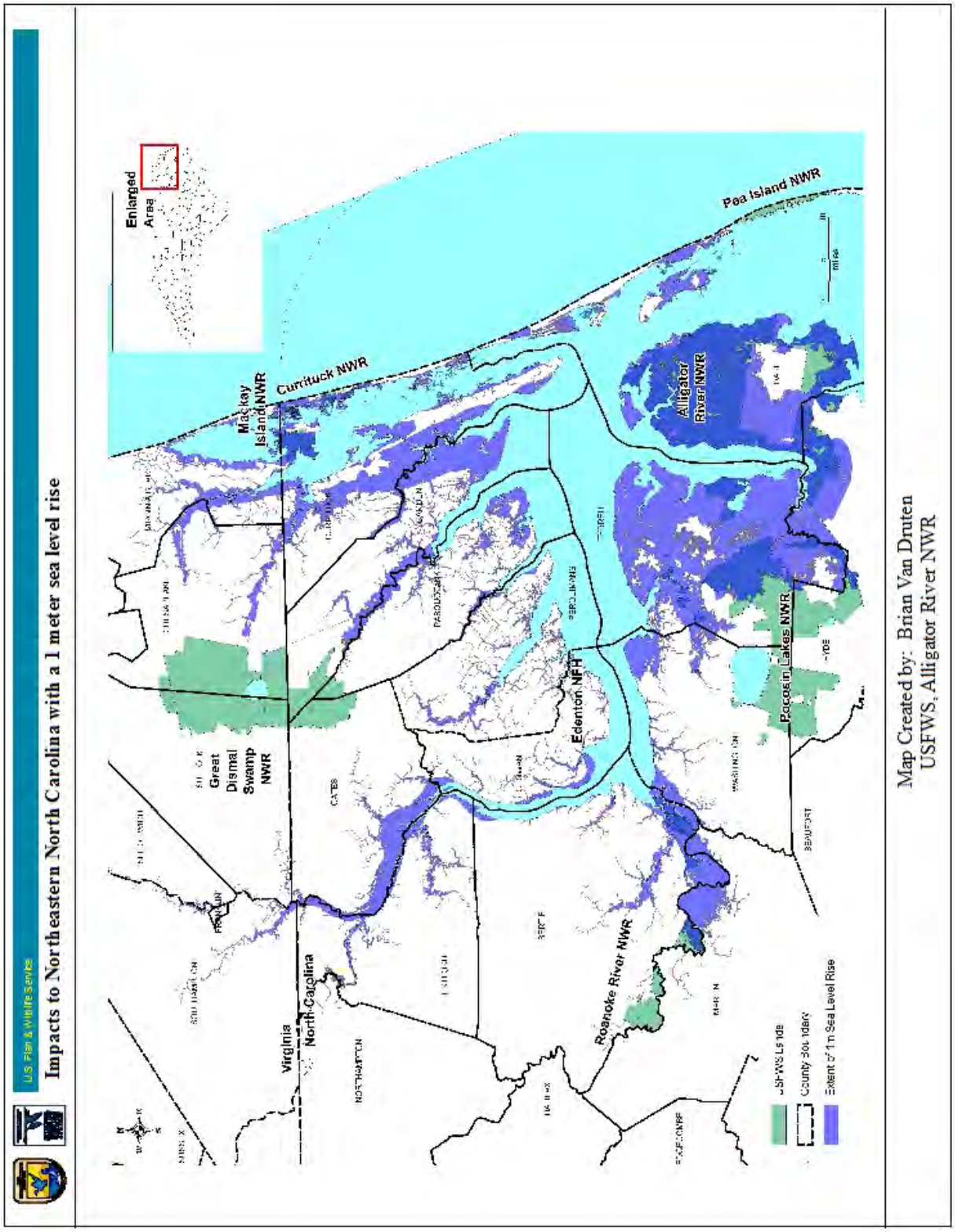
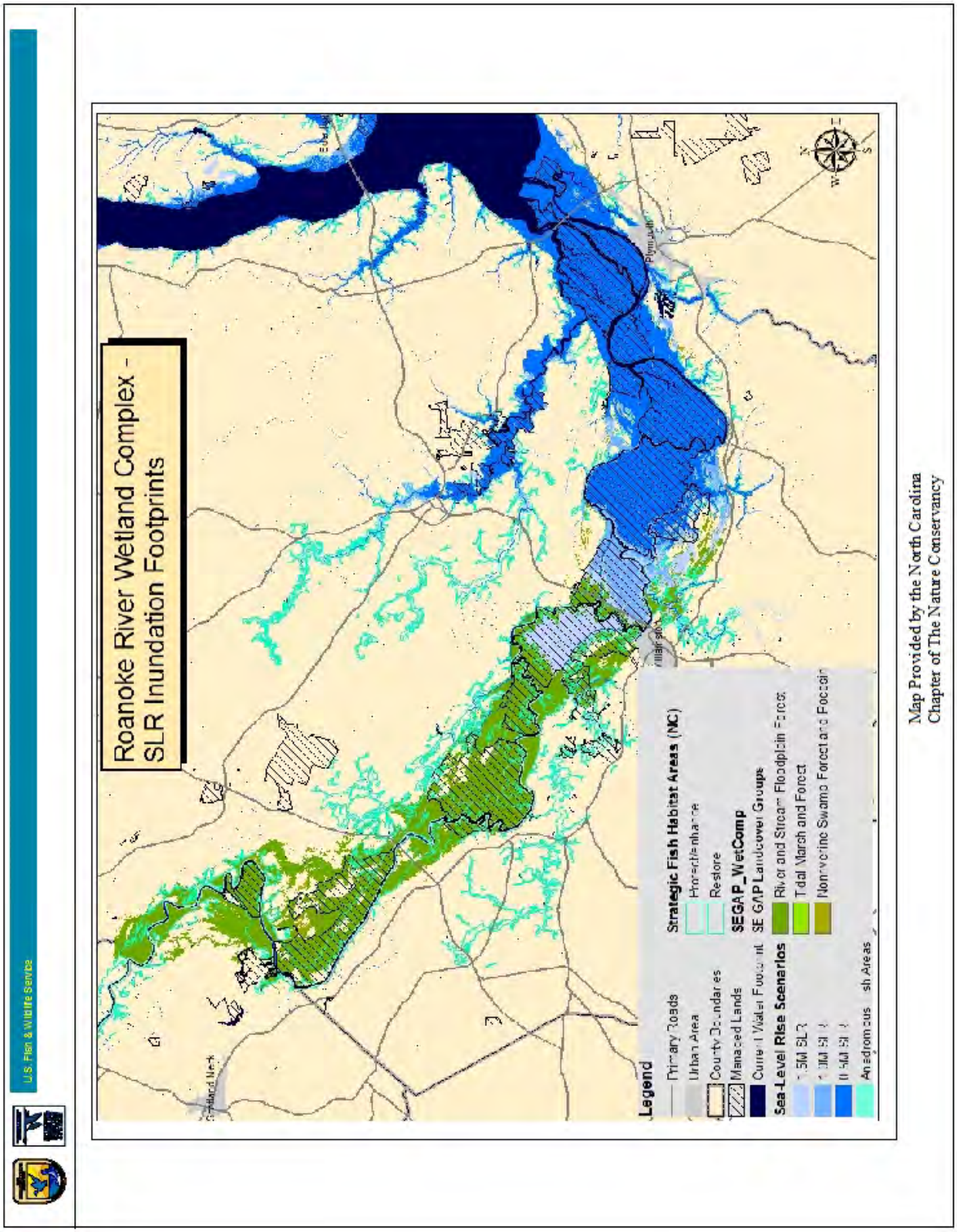
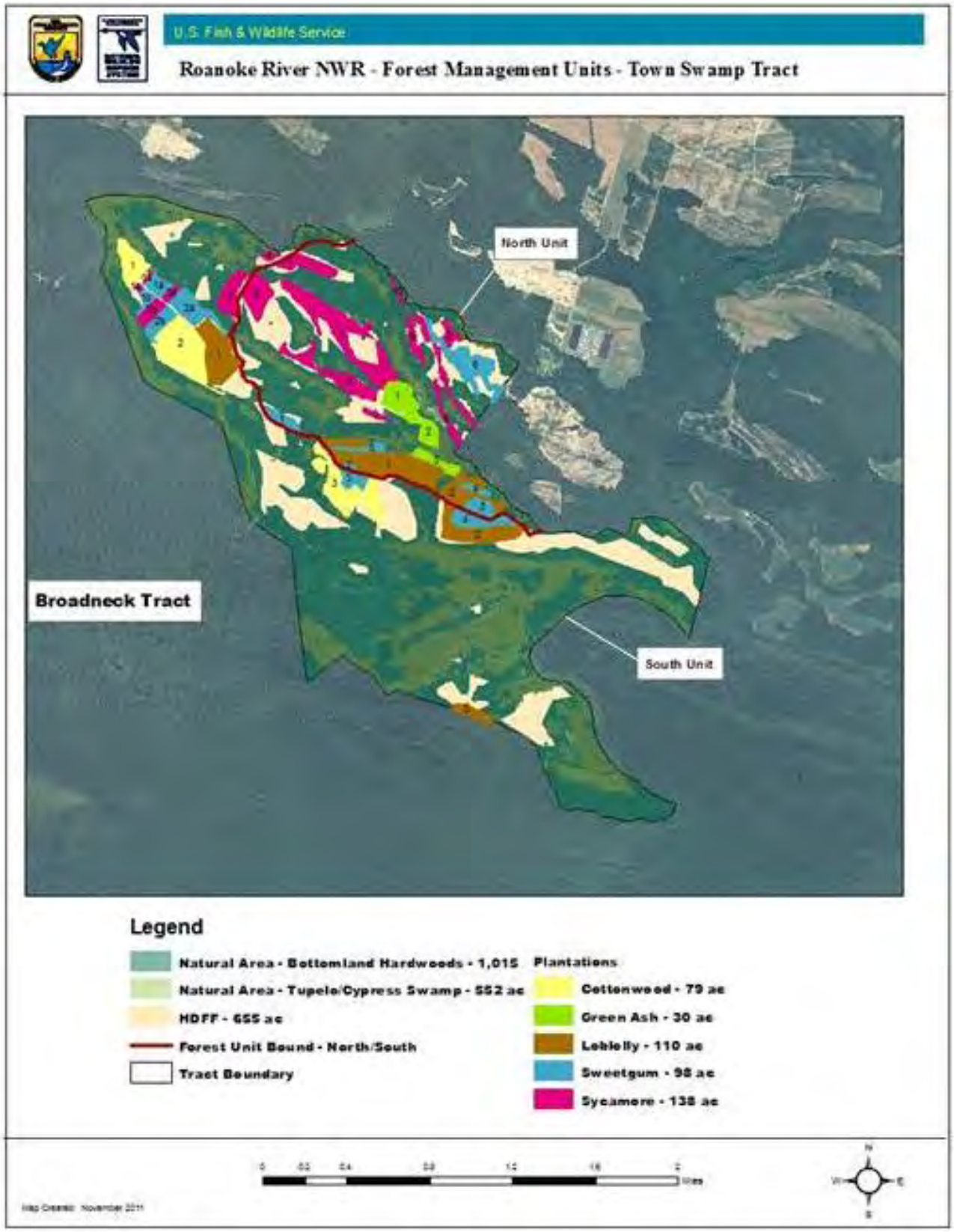
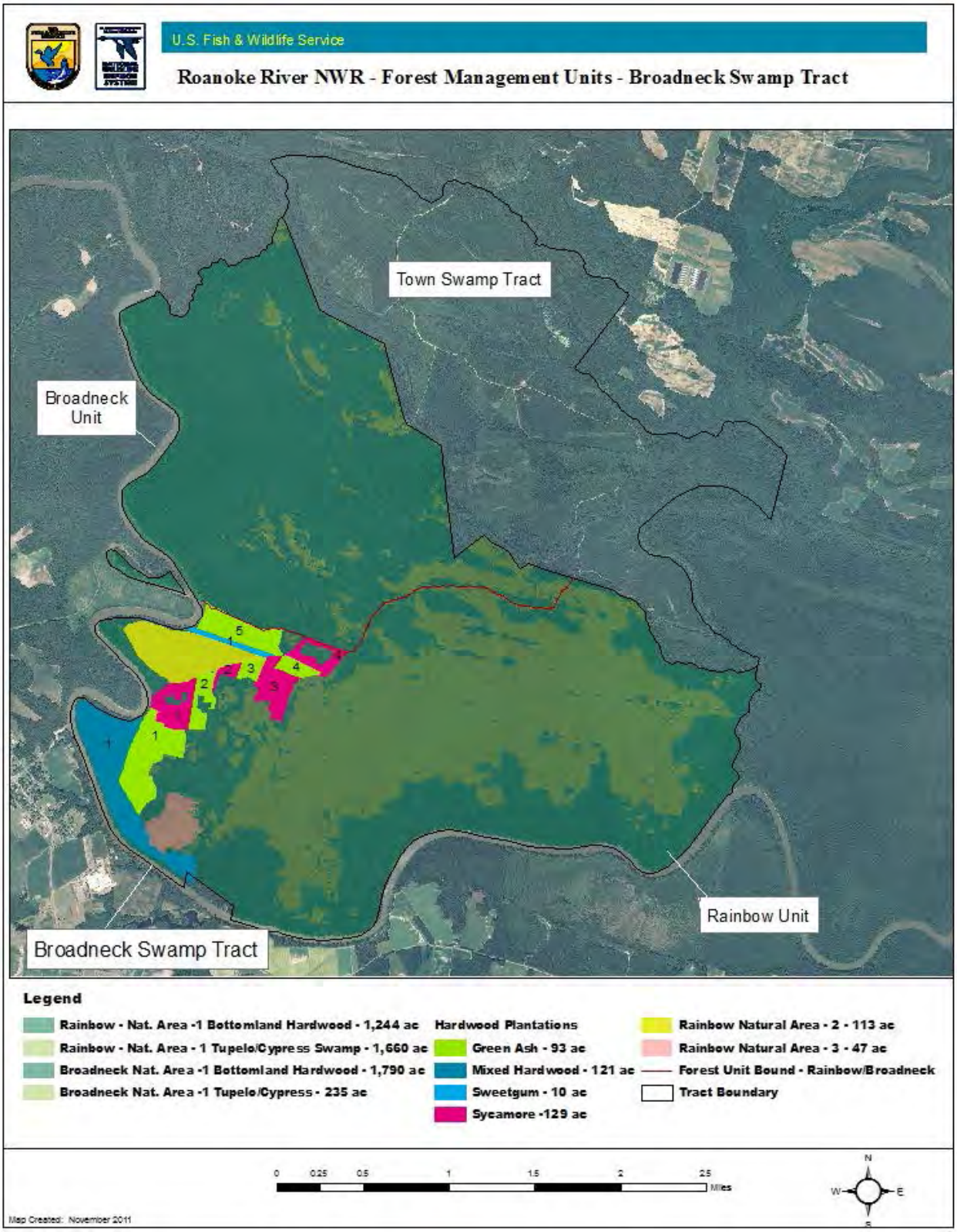
Appendix A. Sea Level Rise Map

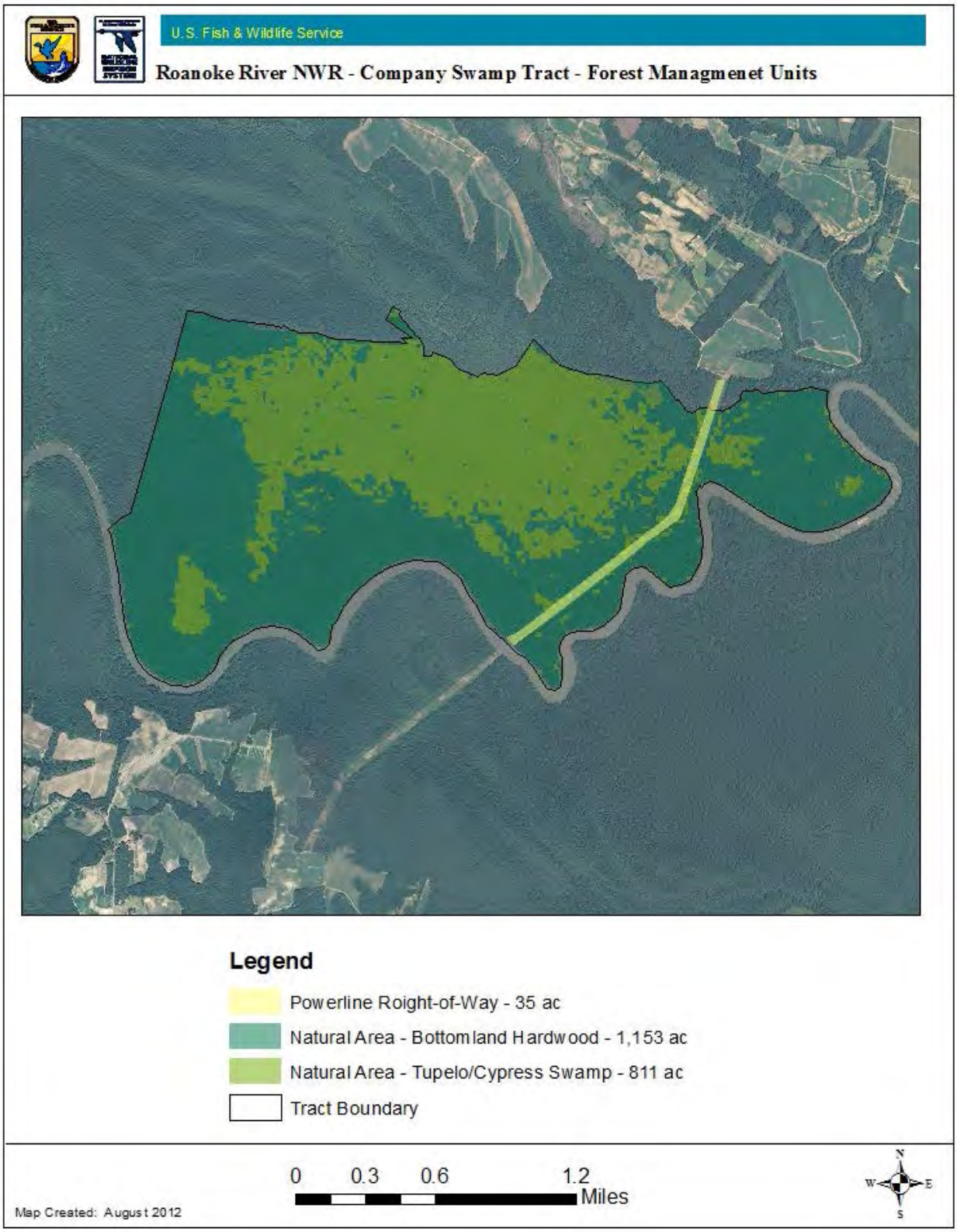


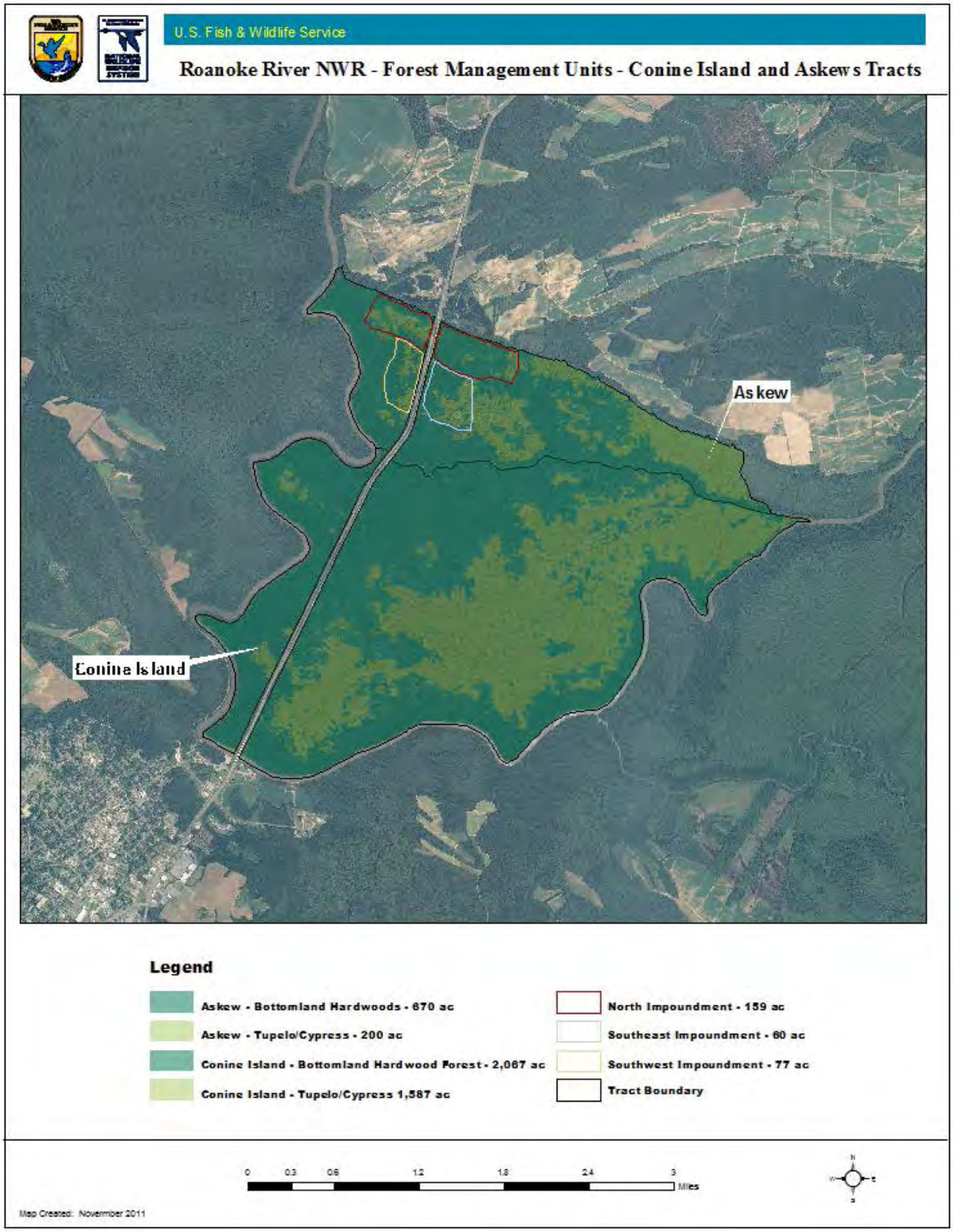

U.S. Fish & Wildlife Service
Roanoke River Wetland Complex -
SLR Inundation Footprints
Legend
Primary Roads
Urban Area
County Boundaries
Managed Lands
Current Water Footprint
Sea-Level Rise Scenarios
Anadromous Fish Areas
Strategic Fish Habitat Areas (NC)
Restore
SEGAP_WetComp
SE GAP Landcover Groups
River and Stream Floodplain Forest
Tidal Marsh and Forest
Nonriverine Swamp Forest and Forest
Plymouth
Map Provided by the North Carolina
Chapter of The Nature Conservancy

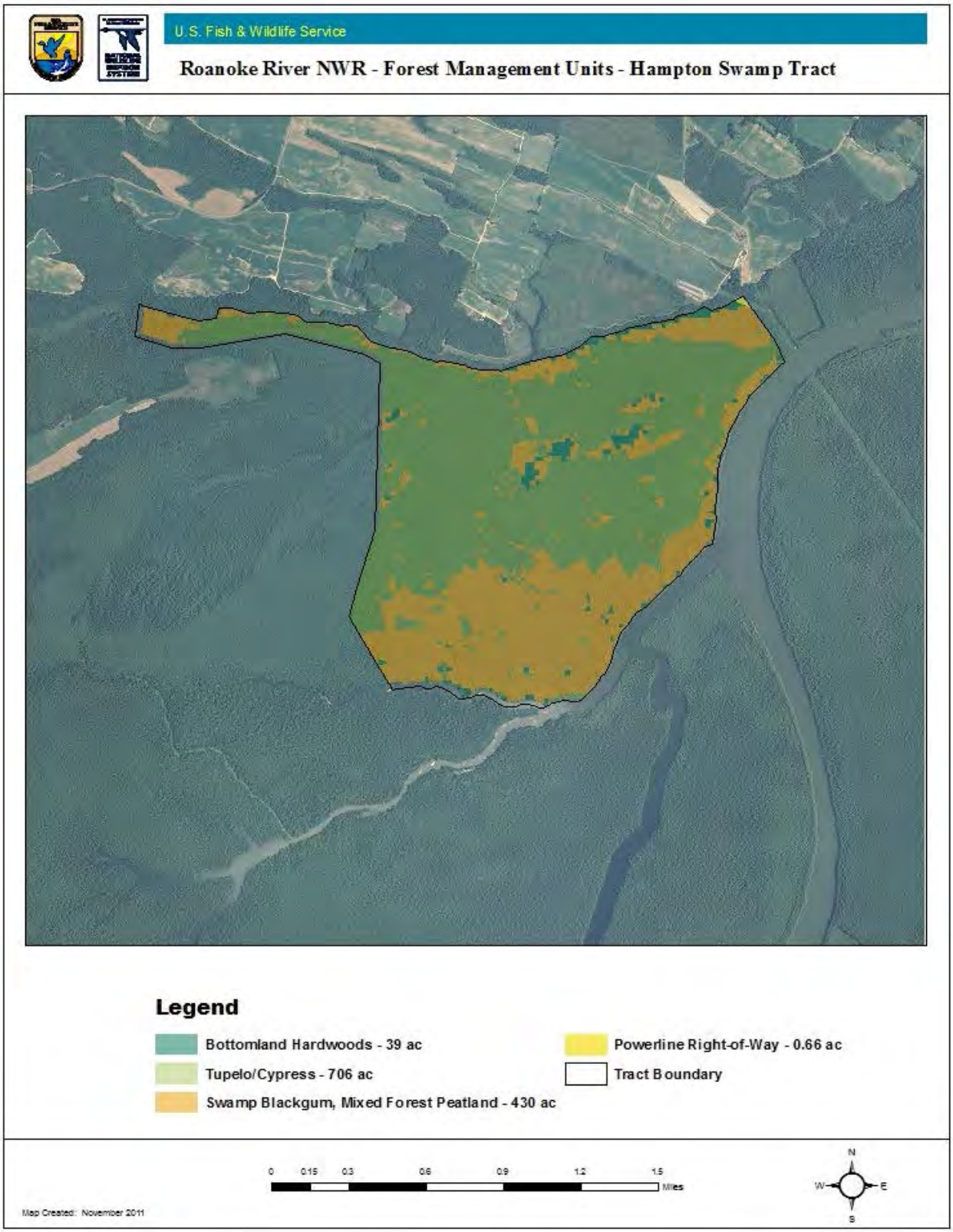
Appendix B. Management Unit Maps and Stats




U.S. Fish & Wildlife Service
Roanoke River NWR - Forest Management Units - Broadneck Swamp Tract
Town Swamp Tract
Broadneck Unit
Rainbow Unit
Broadneck Swamp Tract
Legend
Rainbow - Nat. Area -1 Bottomland Hardwood - 1,244 ac
Rainbow - Nat. Area - 1 Tupelo/Cypress Swamp - 1,660 ac
Broadneck Nat. Area -1 Bottomland Hardwood - 1,790 ac
Broadneck Nat. Area -1 Tupelo/Cypress - 235 ac
Hardwood Plantations
Green Ash - 93 ac
Mixed Hardwood - 121 ac
Sweetgum - 10 ac
Sycamore -129 ac
Rainbow Natural Area - 2 - 113 ac
Rainbow Natural Area - 3 - 47 ac
Forest Unit Bound - Rainbow/Broadneck
Tract Boundary
0 0.25 0.5 1 1.5 2 2.5 Miles
N
W
E
S
Map Created: November 2011


U.S. Fish & Wildlife Service
Roanoke River NWR - Company Swamp Tract - Forest Managmenet Units
Legend
Powerline Roight-of-Way - 35 ac
Natural Area - Bottomland Hardwood - 1,153 ac
Natural Area - Tupelo/Cypress Swamp - 811 ac
Tract Boundary
0 0.3 0.6 1.2
Miles
Map Created: August 2012
N
W
E
S


U.S. Fish & Wildlife Service
Roanoke River NWR - Forest Management Units - Conine Island and Askews Tracts
Askew
Conine Island
Legend
Askew - Bottomland Hardwoods - 670 ac
Askew - Tupelo/Cypress - 200 ac
Conine Island - Bottomland Hardwood Forest - 2,067 ac
Conine Island - Tupelo/Cypress 1,587 ac
North Impoundment - 159 ac
Southeast Impoundment - 60 ac
Southwest Impoundment - 77 ac
Tract Boundary
0 0.3 0.6 1.2 1.8 2.4 3
Miles
Map Created: November 2011


U.S. Fish & Wildlife Service
Roanoke River NWR - Forest Management Units - Hampton Swamp Tract
Legend
Bottomland Hardwoods - 39 ac
Tupelo/Cypress - 706 ac
Swamp Blackgum, Mixed Forest Peatland - 430 ac
Powerline Right-of-Way - 0.66 ac
Tract Boundary
0 0.15 0.3 0.6 0.9 1.2 1.5
Miles
N
W
E
S
Map Created: November 2011

U.S. Fish & Wildlife Service

Roanoke River NWR - Forest Management Units - Great, Goodman, Sunken Islands

Legend

- Goodman Island - Bottomland Hardwoods - 6 ac
- Goodman Island - Swp Blkgum, Mixed Peatland - 412 ac
- Goodman Island - Tupelo/Cypress - 55 ac
- Sunken Islands - Tupelo/cypress - 5 ac
- Great Island - Tupelo/Cypress - 354 ac
- Great Island - Swp Blkgum, Mixed Peatland Forest - 3,668 ac
- Great Island - Bottomland Hardwoods - 14 ac
- Tract Boundary

0 0.375 0.75 1.5 2.25 3 3.75 Miles

N W E S

Map Created: November 2011

Refuge management areas with identified attributes, objective(s) for each stand, and estimated year of entry for implementing the associated objective

Tract	Unit	Compartment	Stand	Acres*	Year Planted	Corresponding Objective	Projected Entry Year (Mgmt. Activity)
Town Swamp	South	Sycamore	1	1	1982	HDFF-1,8	2013
	South	Sycamore	2	8	1982	HDFF-1,8	2013
	South	Sycamore	3	11	1982	HDFF-1,8	2013
	South	Sycamore	4	2	1982	HDFF-1,8	2013
	South	Sweetgum	1	9	1982	HDFF-2,8	2013
	South	Sweetgum	2	23	1982	HDFF-2,8	2013
	South	Sweetgum	3	7	1974	HDFF-2,8	2013
	South	Sweetgum	4	11	1975	HDFF-2,8	2013
	South	Cottonwood	1	14	2000	HDFF-3,8	2020 (evaluate)
	South	Cottonwood	2	35	2000	HDFF-3,8	2020 (evaluate)
	South	Cottonwood	3	31	2000	HDFF-3,8	2020 (evaluate)
	South	Pine	1	25	1991	HDFF-4,8	2013
	South	Pine	2	21	2000	HDFF-5,8	2017
	South	Pine/HW	3	7	1991	HDFF-7,8	2013
	South	Nat-BLHW	1	845	-	BLHW-4,5	2012 (inventory)
	South	Nat-CT	1	365	-	CT-5	n/a
	South	Nat-HDFF	1	320	-	HDFF-6 HDFF-7,8	2020 (evaluate) 2012 (inventory)
	North	Sycamore	1	11	1982	HDFF-1,8	2013

Tract	Unit	Compartment	Stand	Acres*	Year Planted	Corresponding Objective	Projected Entry Year (Mgmt. Activity)
	North	Sycamore	2	13	1982	HDFF-1,8	2013
	North	Sycamore	3	42	1986	HDFF-1,8	2013
	North	Sycamore	4	19	1986	HDFF-1,8	2013
	North	Sycamore	5	3	1986	HDFF-1,8	2013
	North	Sycamore	6	6	1983	HDFF-1,8	2013
	North	Sycamore	7	7	1983	HDFF-1,8	2013
	North	Sycamore	8	9	1983	HDFF-1,8	2013
	North	Sycamore	9	4	1983	HDFF-1,8	2013
	North	Sycamore	10	1	1983	HDFF-1,8	2013
	North	Sweetgum	1	7	1990	HDFF-2,8	2013
	North	Sweetgum	2	1	1974	HDFF-2,8	2013
	North	Sweetgum	3	7	1975	HDFF-2,8	2013
	North	Sweetgum	4	3	1985	HDFF-2,8	2013
	North	Sweetgum	5	31	1983	HDFF-2,8	2013
	North	Sweetgum	6	26	1983	HDFF-2,8	2013
	North	Pine	1	42	2000	HDFF-5,8	2017
	North	Pine	2	16	2000	HDFF-5,8	2017
	North	Green Ash	1	16	1986	BLHW-1,5	2013
	North	Green Ash	2	7	1983	BLHW-1,5	2013
	North	Green Ash	3	7	1983	BLHW-1,5	2013
	North	Nat-BLHW	1	220	-	BLHW-4,5	2012 (Inventory)
	North	Nat-CT	1	127	-	CT-5	n/a

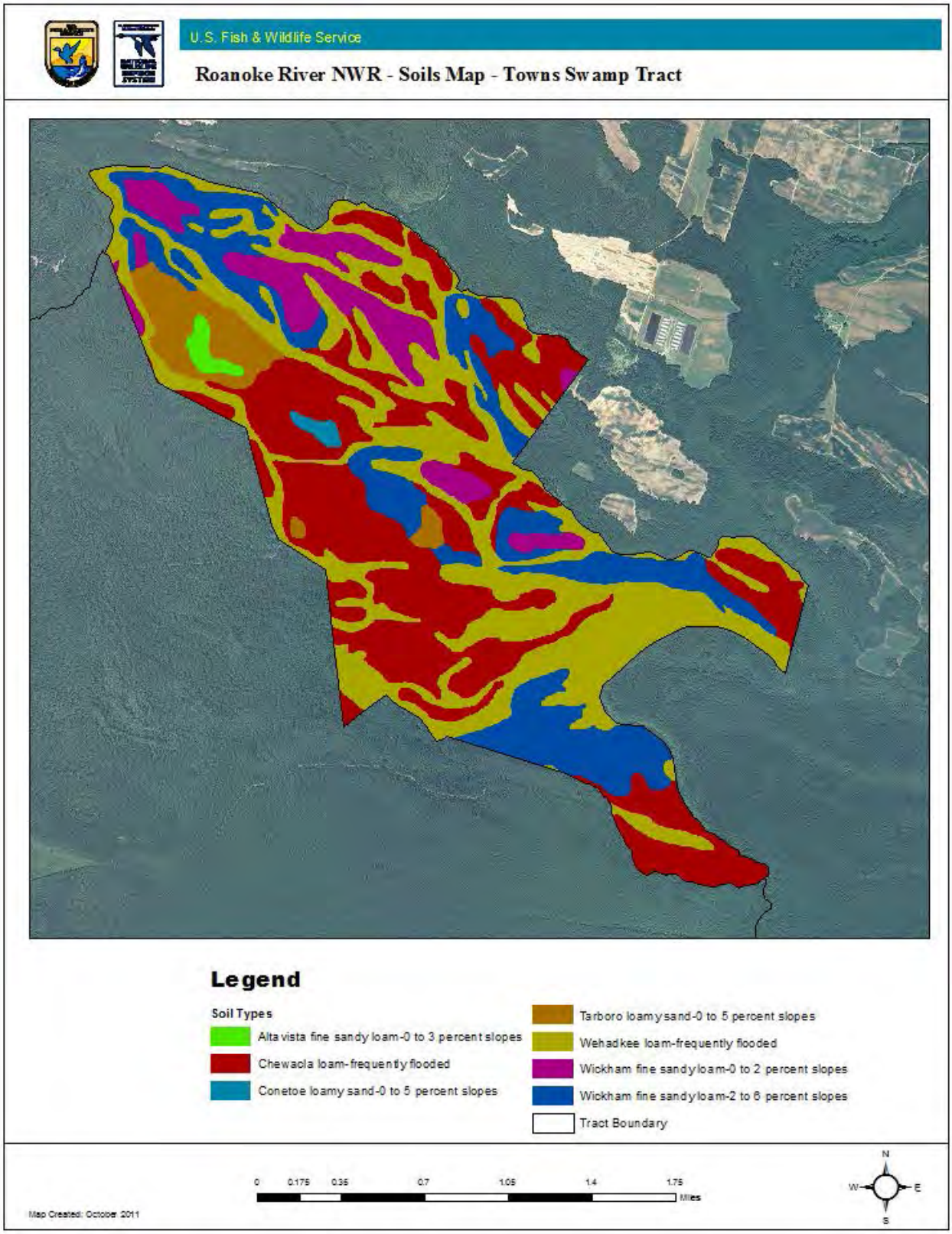
Tract	Unit	Compartment	Stand	Acres*	Year Planted	Corresponding Objective	Projected Entry Year (Mgmt. Activity)
	North	Nat-HDFF	1	227	-	HDFF – 6 HDFF – 7,8	2020 evaluate 2012 (Inventory)
Broad neck	Rainbow	Green Ash	1	70	1984	BLHW-1,5	2015
	Rainbow	Green Ash	2	20	1983	BLHW-1,2,5	2015
	Rainbow	Green Ash	3	9	1983	BLHW-1,5	2015
	Rainbow	Green Ash	4	12	1983	BLHW-1,5	2015
Tract	Unit	Compartment	Stand	Acres*	Year Planted	Corresponding Objective	Entry Year (Management Activity)
	Rainbow	Green Ash	5	19	1984	BLHW-1,2,5	2015
	Rainbow	sycamore	1	32	1983	BLHW-1,2,5	2015
	Rainbow	sycamore	2	6	1983	BLHW-1,5	2015
	Rainbow	sycamore	3	35	1983	BLHW-1,5	2015
	Rainbow	sycamore	4	18	1983	BLHW-1,5	2015
	Rainbow	Sweetgum	1	10	1984	BLHW-1,2,5	2015
	Rainbow	Mix HW	1	121	1985	BLHW-3,4,5	2017 (evaluate)
	Rainbow	Nat-BLHW	1	1,244	-	BLHW-2 BLHW-4,5	2014 2012 (inventory)
	Rainbow	Nat-CT	1	1,660	-	CT-1 CT-5	2014-2017 n/a
	Rainbow	Nat-BLHW	2	113	2002	BLHW-3,5	
	Rainbow	Nat-CT	3	47	2002	CT-4	2013

Tract	Unit	Compartment	Stand	Acres*	Year Planted	Corresponding Objective	Projected Entry Year (Mgmt. Activity)
	Broadneck	Nat-BLHW	1	1,790	-	BLHW-2 BLHW-4,5	2014 2012 (inventory)
	Broadneck	Nat-CT	1	235	-	CT-1 CT-5	2014-2017 n/a
Comp any Swamp	Company Swamp	Nat-BLHW	1	1,118	-	BLHW-4,5 BLHW-2	2012 (inventory) 2014
	Company Swamp	Nat-CT	1	811	-	CT-1 CT-5	2014-2017 n/a
	Company Swamp	ROW	-	35	-	BLHW-7	Annually evaluated
Askew	East	IMPOUND	NE	102	-	BLHW-5,6	
	East	IMPOUND	SE	46	-	BLHW-5,6	
	East	IMPOUND	NE	22	-	CT-2,3	
	East	IMPOUND	SE	32	-	CT-2	
	East	Nat-BLHW	1	324	-	BLHW-4,5	2012 (inventory)
	East	Nat-CT	1	426	-	CT-5	n/a
	West	IMPOUND	NW	35	-	BLHW-5,6	
	West	IMPOUND	NW	27	-	CT-2,3	
	West	IMPOUND	SW	38	-	BLHW-5,6	
	West	IMPOUND	SW	21	-	CT-2	
	West	Nat-BLHW	1	180	-	BLHW-4,5	2012 (inventory)
	West	Nat-CT	1	16	-	CT-5	n/a

Tract	Unit	Compartment	Stand	Acres*	Year Planted	Corresponding Objective	Projected Entry Year (Mgmt. Activity)
Conine Island	Conine Island	Nat-BLHW	1	2,067	-	BLHW-4,5	2012 (inventory)
	Conine Island	Nat-CT	-	1,587	-	CT-5	n/a
Hamp ton Swamp	Hampton Swamp	Nat-CT	-	706	-	CT-5	n/a
	Hampton Swamp	Nat-BLHW	-	39	-	BLHW-8	n/a
	Hampton Swamp	Nat-PTFT/BLGU	-	430	-	PTFT/BLGU-1	n/a
	Hampton Swamp	ROW	-	0.66	-	BLHW-7	Annually evaluated
Islands	Great	Nat-CT	-	354	-	CT-5	n/a
	Great	Nat-PTFT/BLGU	-	3,668	-	PTFT/BLGU-1	n/a
	Great	Nat-BLHW	-	14	-	BLHW-8	n/a
	Goodman	Nat-CT	-	96	-	CT-5	n/a
	Goodman	Nat-PTFT/BLGU	-	367	-	PTFT/BLGU-1	n/a
	Goodman	Nat-BLHW	-	7	-	BLHW-8	n/a
	Sunken	Nat-CT	-	5	-	CT-5	n/a

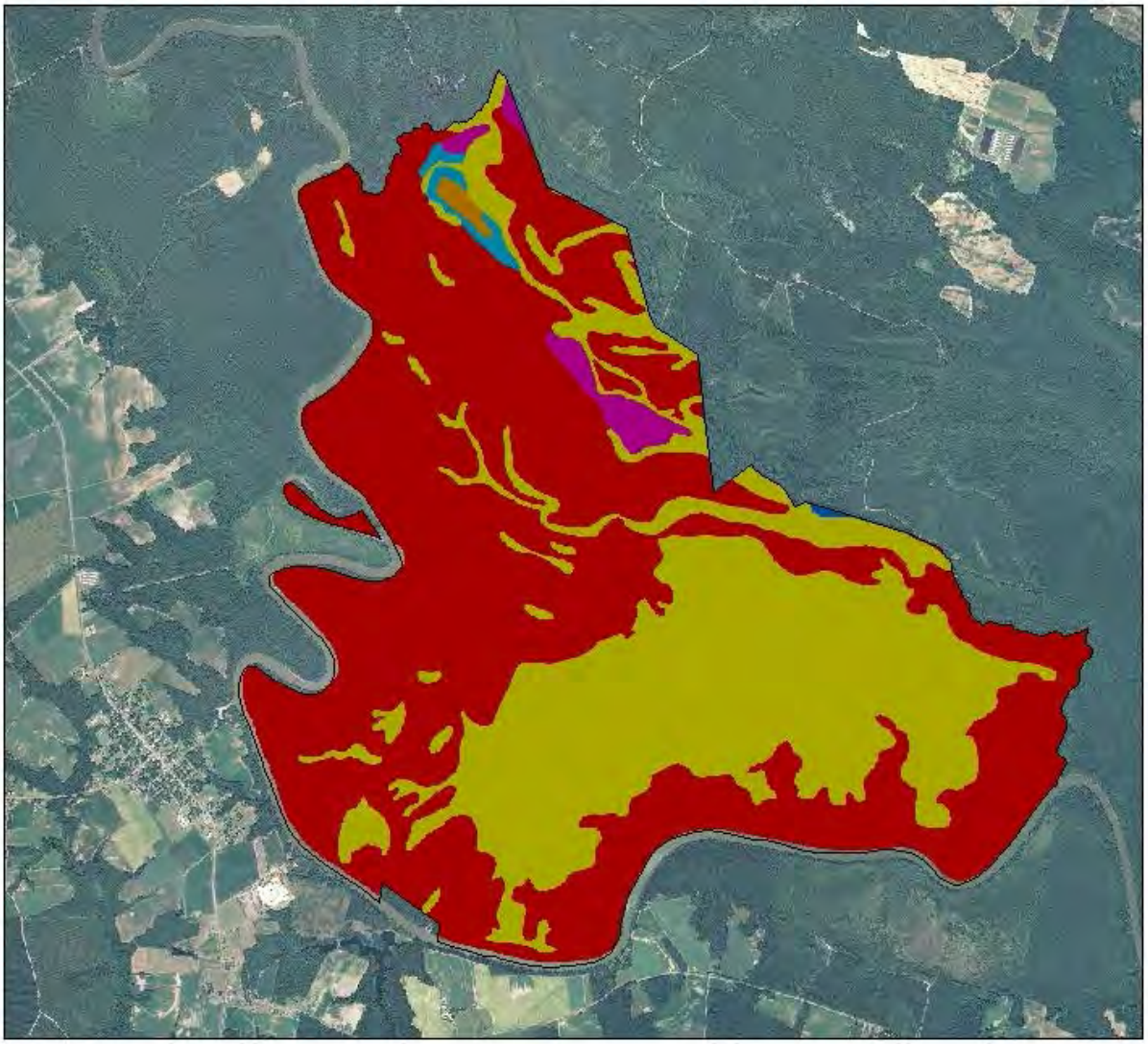
**All acres listed in this table are GIS acreage estimations*
CT - tupelo/cypress swamp
BLHW - bottomland hardwood forest
PTFT/BLGU – mixed peatland forest/blackgum swamp
HDFF - Hydrologically disconnected floodplain forest
n/a – no entry year necessary

Appendix C. Soils Maps



U.S. Fish & Wildlife Service

Roanoke River NWR - Soils Map - Broadneck Swamp Tract



Legend

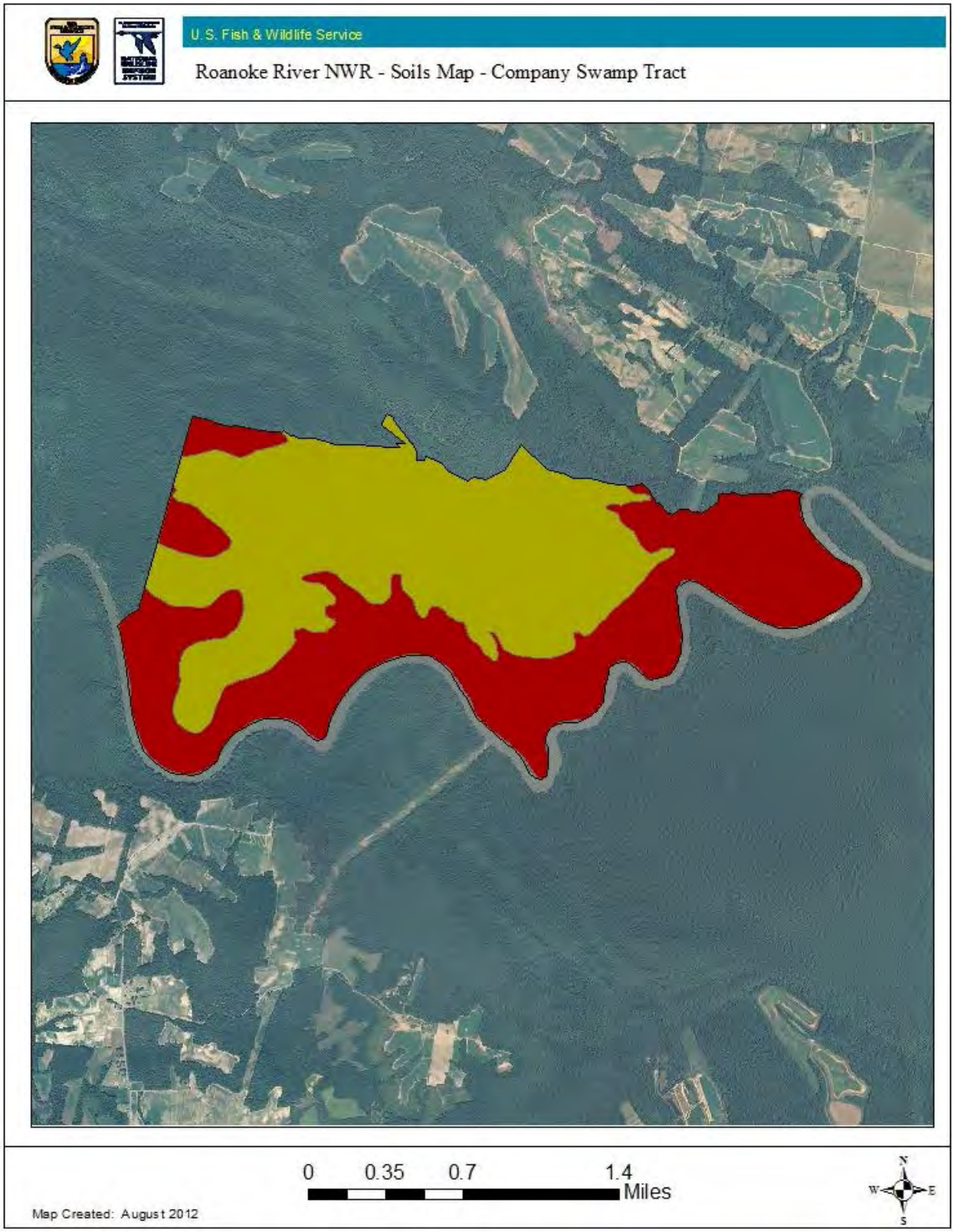
Soil Types

- Chewacla loam-frequently flooded
- Conetoe loamy sand-0 to 5 percent slopes
- Tarboro loamy sand-0 to 5 percent slopes
- Wehadkee loam-frequently flooded
- Wickham fine sandy loam-0 to 2 percent slopes
- Wickham fine sandy loam-2 to 6 percent slopes
- Tract Boundary

0 0.25 0.5 1 1.5 2 2.5 Miles

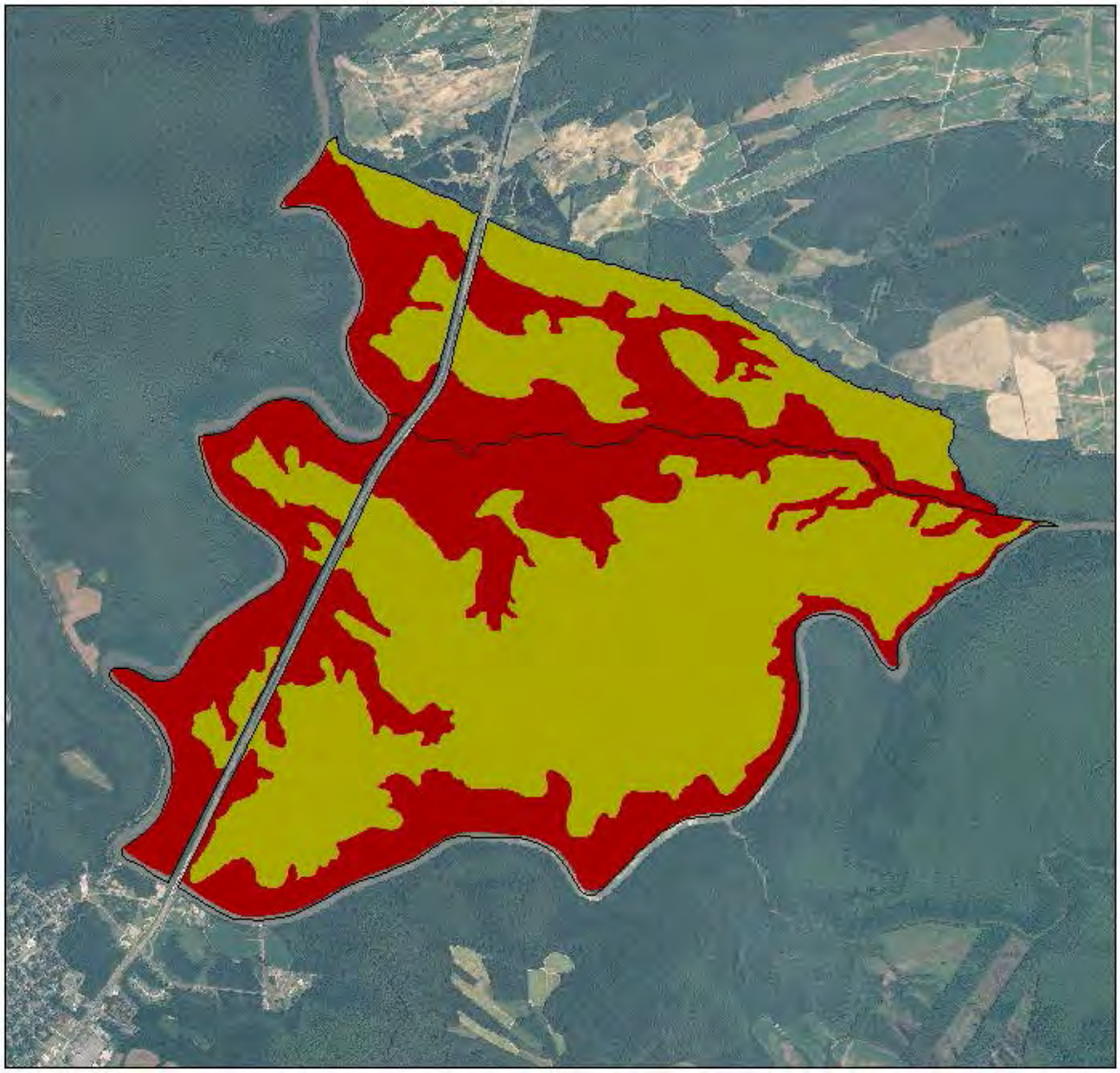
N W E S

Map Created: November 2011


U.S. Fish & Wildlife Service
Roanoke River NWR - Soils Map - Company Swamp Tract
0
0.35
0.7
1.4
Miles
N
W
E
S
Map Created: August 2012

U.S. Fish & Wildlife Service

Roanoke River NWR - Soils Maps - Conine Island and Askew Tracts



Legend

Soil Types

- Chewacla loam-frequently flooded
- Wehadkee loam-frequently flooded
- Tract Boundary

0 0.225 0.45 0.9 1.35 1.8 2.25 Miles

N W E S

Map Created: November 2011

U.S. Fish & Wildlife Service

Roanoke River NWR - Soils Map - Hampton Swamp Tract

Legend

Soil Types

- Bibb and Johnston loams-frequently flooded
- Dorovan mucky peat-frequently flooded
- Seabrook loamy sand
- Tomotley sandy loam
- Wehadkee loam-frequently flooded
- Wickham fine sandy loam-0 to 2 percent slopes
- Tract Boundary

0 0.15 0.3 0.6 0.9 1.2 1.5 Miles

1 = 25,021

N W E S

Map Created: November 2011

U.S. Fish & Wildlife Service

Roanoke River NWR - Soils Maps - Great, Goodman and Sunken Islands

Legend

- Dorovan mucky peat-frequently flooded
- Tract Boundary

0 0.275 0.55 1.1 1.65 2.2 2.75 Miles

N W E S

Map Created: November 2011

Appendix D. Aerial Photos of Refuge Tracts- Past and Present

U.S. Fish & Wildlife Service

Roanoke River NWR - Historic Aerial Photos - Broadneck Swamp Tract

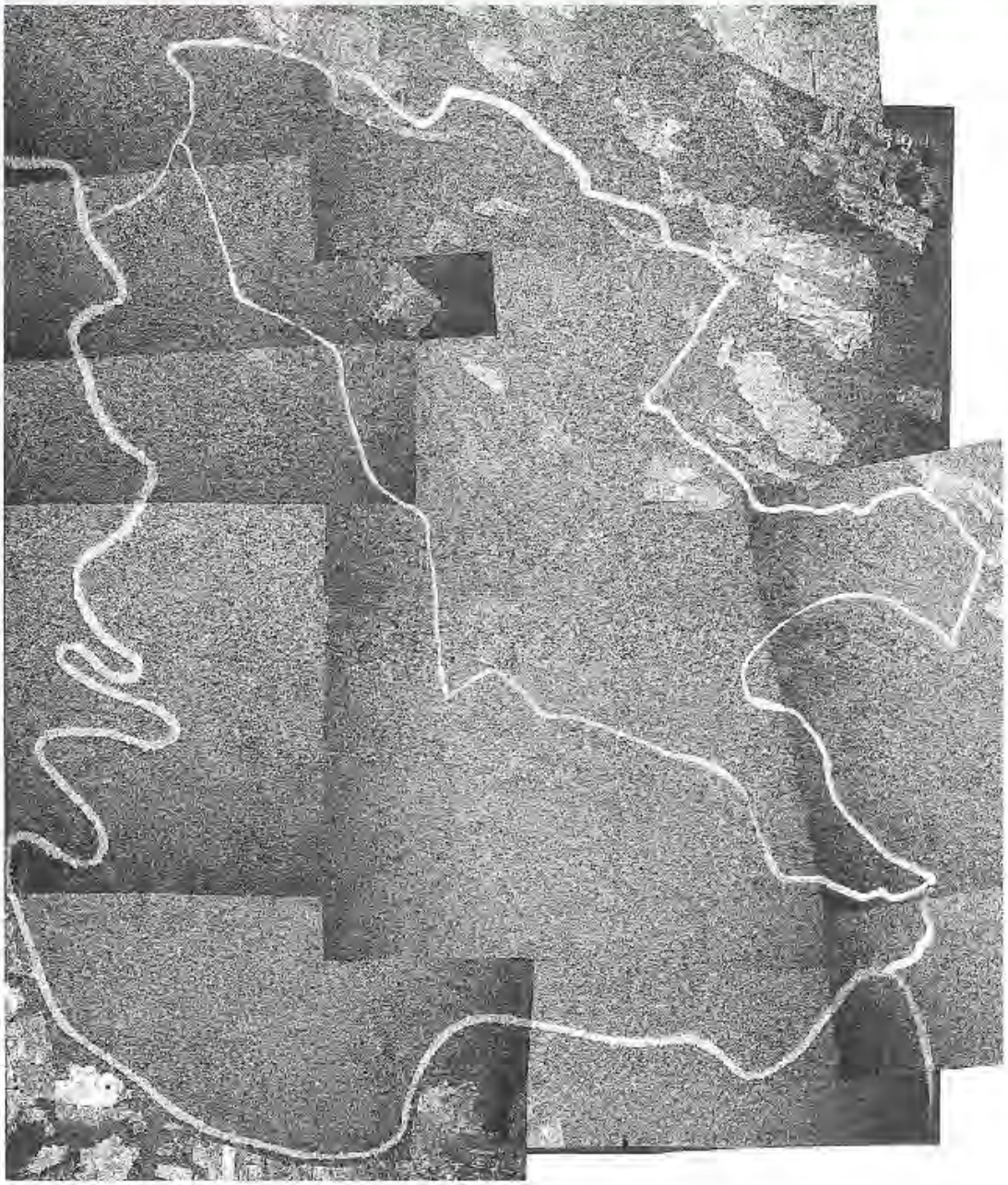


Photo Taken: September 20, 1937

Map Source: National Archives, Washington, DC

U.S. Fish & Wildlife Service
Roanoke River NWR - Company Swamp Tract - 2010 Aerial Photos
Map Source: NCOneMap Geospatial Portal - 2010 NC Digital Orthoimagery
0
0.35
0.7
1.4
Miles
N
W
E
S

U.S. Fish & Wildlife Service

Roanoke River NWR - Historic Aerial Photos - Company Swamp Tract

Photo Taken: September 20, 1937

Map Source: National Archives, Washington, DC

U.S. Fish & Wildlife Service

Roanoke River NWR - 2010 Aerial Photo - Askew and Conine Island Tracts

Map Source: NCOneMap - Geospatial Portal - 2010 NC Digital Orthoimagery

0 0.3 0.6 1.2 1.8 2.4 3 Miles

N W E S

U.S. Fish & Wildlife Service

Roanoke River NWR - Historic Aerial Photos - Askew and Conine Island Tracts

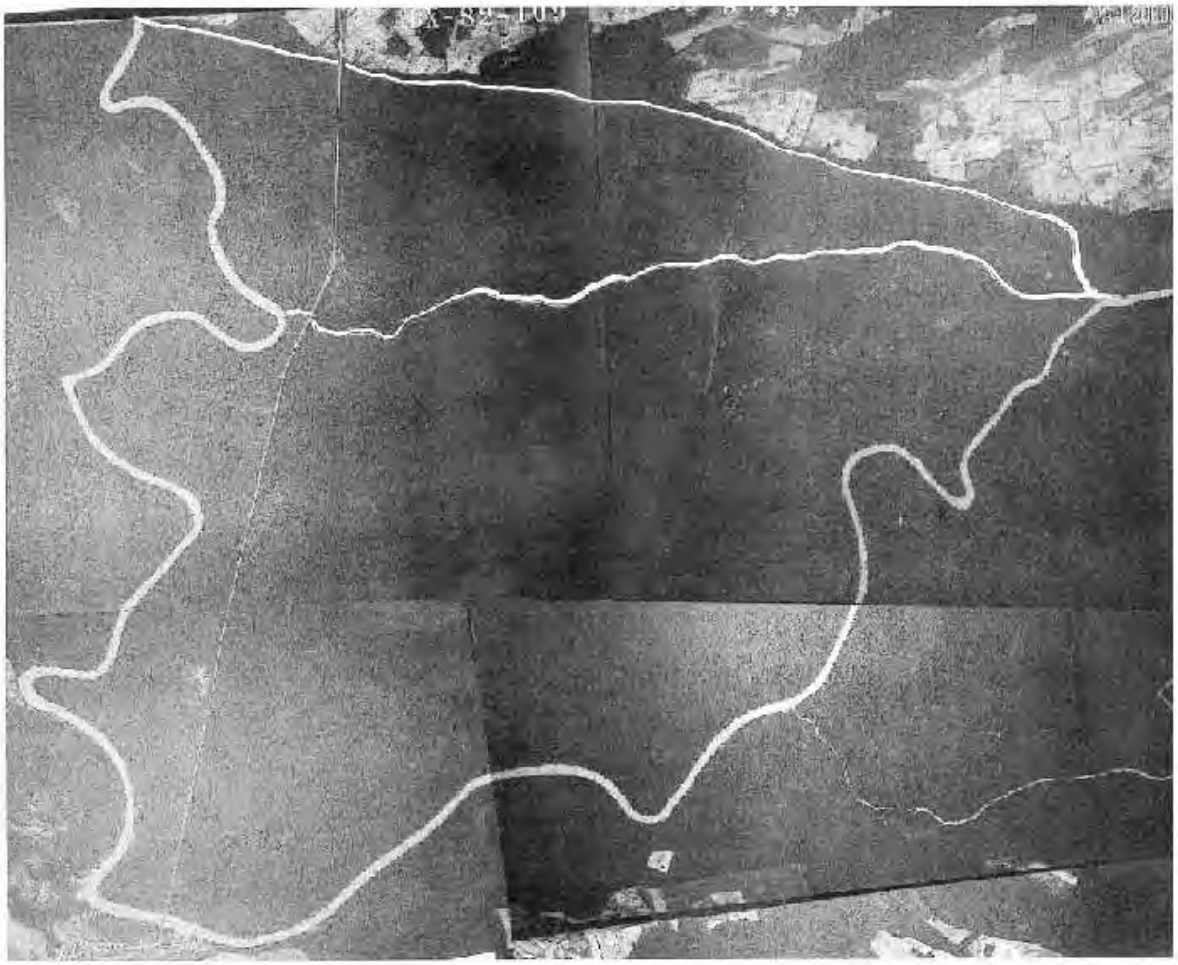


Photo Taken: July 1, 1938

Map Source: National Archives, Washington, DC

U.S. Fish & Wildlife Service

Roanoke River NWR - 2010 Aerial Photos - Hampton Swamp Tract

Map Source: NOOnelMap Geospatial Portal - 2010 NC Digital Orthoimagery

0 0.2 0.4 0.8 1.2 1.6 2 Miles

N W E S

U.S. Fish & Wildlife Service

Roanoke River NWR - Historic Aerial Photos - Hampton Swamp Tract

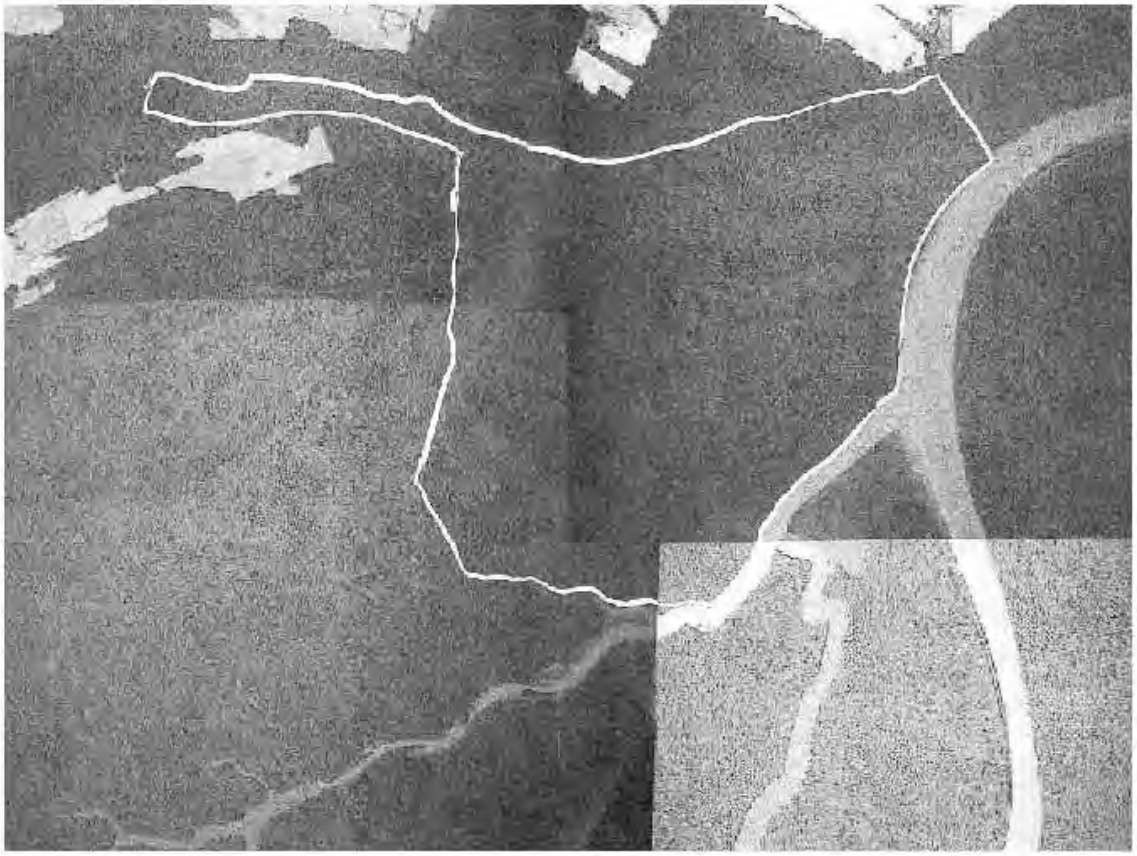


Photo Taken: May 2, 1938

Map Source: National Archives, Washington, DC

U.S. Fish & Wildlife Service

Roanoke River NWR - 2010 Aerial Photos - Great, Goodman and Sunken Islands

Map Source: NCOneMap Geospatial Portal - 2010 NC Digital Orthoimagery

0 0.375 0.75 1.5 2.25 3 3.75 Miles

N W E S

U.S. Fish & Wildlife Service

Roanoke River NWR - Historic Aerial Photos - Great Island Tract

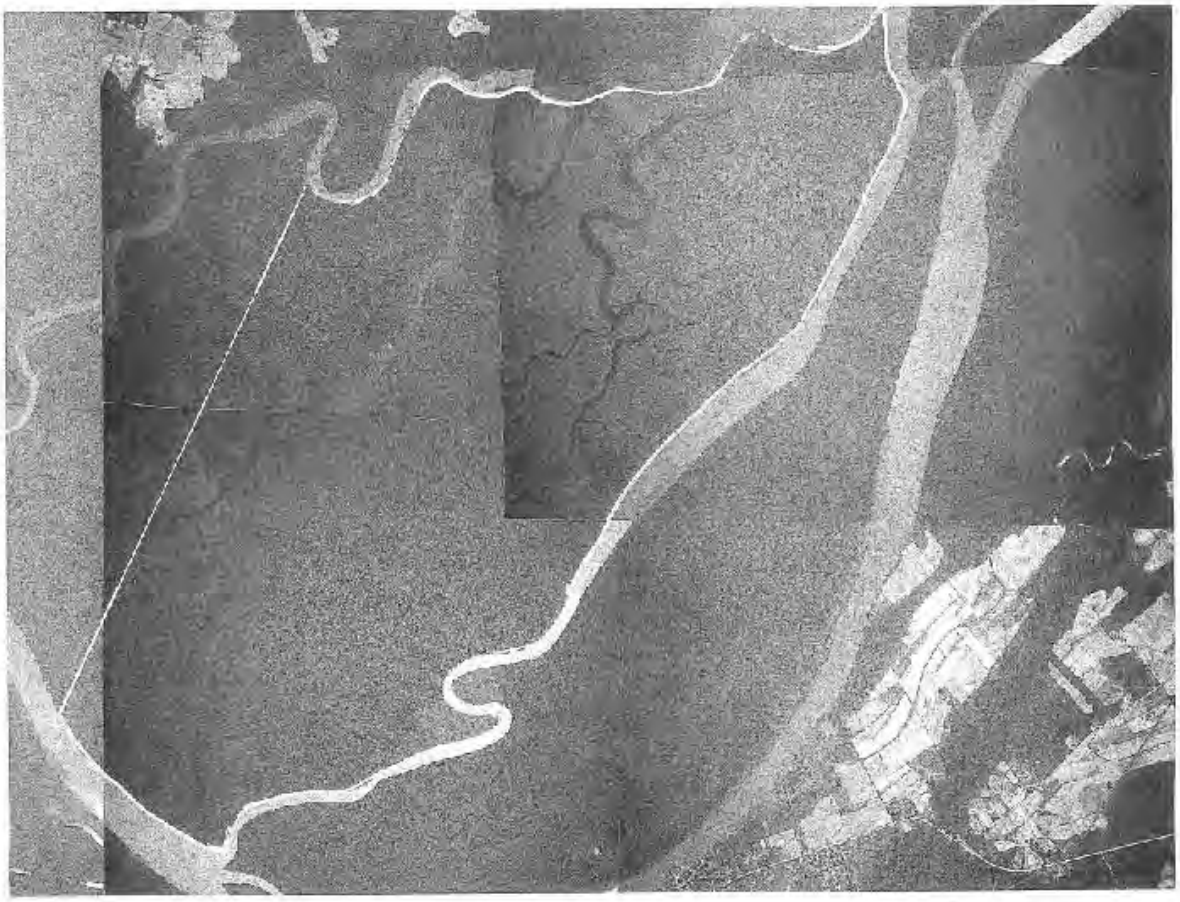


Photo Taken: April 28, 1938

Map Source: National Archives, Washington, DC

U.S. Fish & Wildlife Service

Roanoke River NWR - Historic Aerial Photos - Goodman and Sunken Islands

Photo Taken: April 28, 1938

Map Source: National Archives, Washington, DC

Appendix E. Historic Ownership of Refuge Lands

Historic Owership of Refuge Lands[1]

Company Swamp Tract including Rhodes Tract

Tract (Realty No.)	**Rhodes Tract (16)**	**Company Swamp (12e)**		
Acres	554	1502		
Deed (book/page)	(741/418)	(707/377)		
Ownership History	USFWS RRNWR	USFWS RRNWR		
	8-15-1997 Purchased from ↓ James S. Rhodes Jr. et al.	12-13-1993 Purchased from ↓ NC TNC		
	Inherited from ↓ Helen Rhodes	12-13-1993 Purchased from ↓ State of NC Department of Transportation (wetlands mitigation bank)		
	1-4-1884 purchased from ↓ Henry Slade	9-12-1985 Purchased from ↓ NC TNC		
		purchased from ↓ True Temper Corp., DE		
		Critchlow Swamp	Weathersbee Shingle Swamp	Coffield Swamp
		4-1-1982 Allegheny International Realty Company purchased from	4-1-1982 Allegheny Ludlum Industry Inc., PA purchased from ↓	4-1-1982 Allegheny International Realty Company purchased from ↓ The American Fork

Tract (Realty No.)	Rhodes Tract (16)	Company Swamp (12e)		
		↓ The American Fork and Hoe Co.	The American Fork and Hoe Co.	and Hoe Co.
		12-31-1936?? purchased from ↓ The National Handle Co., OH	12-31-1936?? purchased from ↓ The National Handle Co., OH	12-31-1936?? purchased from ↓ The National Handle Co., OH
		11-27-1920 purchased from ↓ B.F. Godwin, C.H., Mary P. and E.L., Godwin	12-31-1936?? purchased from ↓ J. Davis Reid	11-27-1920 purchased from ↓ B.F. Godwin, C.H., Mary P. and E.L., Godwin
		purchased from ↓ Elli Jones and others	9-20-1898 purchased from ↓ W.K. Gardner	purchased from ↓ Elli Jones and others
		11-26-1889 purchased from ↓ John D. Biggs and wife	4-1-1897 purchased from ↓ R.E. Weathersbee	11-26-1889 purchased from ↓ John D. Biggs and wife
			3-29-1870 purchased from ↓ W.W. Shaw and wife	12-14-1887?? purchased from ↓ Henry Martin

Conine Island and Askew Tracts

Tract (Realty No.)	Askew Tract (12 a,c)	Conine Island (12 g,f) Also referred to as Coerenine Island. Creek referred as Big Sandy Creek	
Acres	1276	3748	
Deed (book/page)	(688/192)	(702/801)	
Ownership History	USFWS RRNWR	USFWS RRNWR	
	6-5-1991 Purchased from ↓ NC TNC	5-27-93 Purchased from ↓ NC TNC	
	7-27-1990 Purchased from ↓ Georgia Pacific Corporation	10-15-86 Purchased from ↓ NCWRC	
	Purchased from ↓ Riverside Manufacturing Company, Inc.	5-17-85 Purchased from ↓ Allegheny international Realty Development Corporation	
	2-27-1951 Purchased from ↓ E. S. Askew	12-12-83 NCDOT purchased HWY 13/17 ROW	4-1-1982 Purchased from ↓ True Temper Corp.
	9-9-1922 Purchased from ↓	Purchased from ↓ The American Fork and Hoe Company	

Tract (Realty No.)	Askew Tract (12 a,c)					Conine Island (12 g,f) Also referred to as Coerenine Island. Creek referred as Big Sandy Creek
	James Bond	Annie Bond	M.B. Gilliam	John W. Bond	J. H. Matthews	12-31-1936 Purchased from ↓ The National Handle Company
	Cannot decifer what is what from deeds due to multiple owners.					11-18-1898 Purchased from ↓ Wheeler Martin and C.A. Martin
						12-15-1894 Purchased from ↓ James Bond and wife

Broadneck Tract and Rainbow Unit

Tract (Realty No.)	Rainbow (12)	Broadneck Tract (12d) (West RB Road)	Town Swamp(11a,b)	Rainbow (11)
Acres	2739	2000	2116	831
Deed (book/page)	(683/364)	(698/192)	(822/480)	(807/823)
Ownership History	USFWS RRNWR	USFWS RRNWR	USFWS RRNWR	USFWS RRNWR
	9-19-1990 Purchased from ↓ NC TNC	9-24-1992 Purchased from ↓ NC TNC	3-15-2004 Purchased from ↓ The Conservation Fund	3-15-2004 Purchased from ↓ The Conservation Fund
	7-27-90 Purchased from ↓	9-24-1992 Purchased from ↓	12-13-2002 Purchased from	12-13-2002 Purchased from

Tract (Realty No.)	Rainbow (12)	Broadneck Tract (12d) (West RB Road)	Town Swamp(11a,b)	Rainbow (11)
	Union Camp	NCWRC	↓ International Paper Note: IP reserved mineral rights	↓ International Paper Note: IP reserved mineral rights
	12-22-1975 Purchased from ↓ Georgia Pacific	5-17-1985 Purchased from ↓ NC TNC	4-30-1999 Merged with ↓ Union Camp	4-30-1999 Merged with ↓ Union Camp
	6-29-59 Purchased from ↓ Atlas Plywood Company, MA	5-17-1985 Purchased from ↓ Allegheny International Realty	6-3-1974 Purchased from ↓ Broadneck Farms Inc.	7-27-90 Purchased from ↓ Union Camp
	3-1-1947 Purchased from ↓ Marvil Package Company, DE	4-1-1982 Purchased from ↓ True Temper	4-15-1957 Purchased from ↓ W.R. Williams, H.H. Alston, G.L. Alston, and others	Purchased from ↓ Georgia Pacific
	Purchased from ↓ Wicomico Lumber Company, VA	Purchased from ↓ The American Fork and Hoe Company	10-16-1905 15 yr. Timber Deed ↓ Wicomico Lumber Company, VA starting 9-6-1900	6-29-59 Purchased from ↓ Atlas Plywood Company, MA
	Purchased from ↓ F.A. Boyle	12-31-1936 Purchased from ↓	8-30-1900 Purchased from ↓ J. Davis Reed	3-1-1947 Purchased from ↓ Marvil Package Company, DE

Tract (Realty No.)	Rainbow (12)	Broadneck Tract (12d) (West RB Road)		Town Swamp(11a,b)	Rainbow (11)
	9-1-1879 Purchased from ↓ H.G. Spruill (trustee)	3-15-1920 The National Handle Company Purchased from ↓ J. Davis Reed and Anne Shaw Reed	1-14-1909 Purchased from ↓ J.P. Boyle	Purchased from ↓ Wicomico Lumber Company, VA	Purchased from ↓ F.A. Boyle
	7-13-1852 Purchased from ↓ John M.C. Boyle	9-9-1901 Purchased from ↓ Peter Rascoe			9-1-1879 Purchased from ↓ H.G. Spruill (trustee)
	Purchased from ↓ S.S. Simmons	xx-xx-1886 Purchased from ↓ E.R. Outlaw (Sherriff)			7-13-1852 Purchased from ↓ John M.C. Boyle
					Purchased from ↓ S.S. Simmons

Hampton Swamp Tract

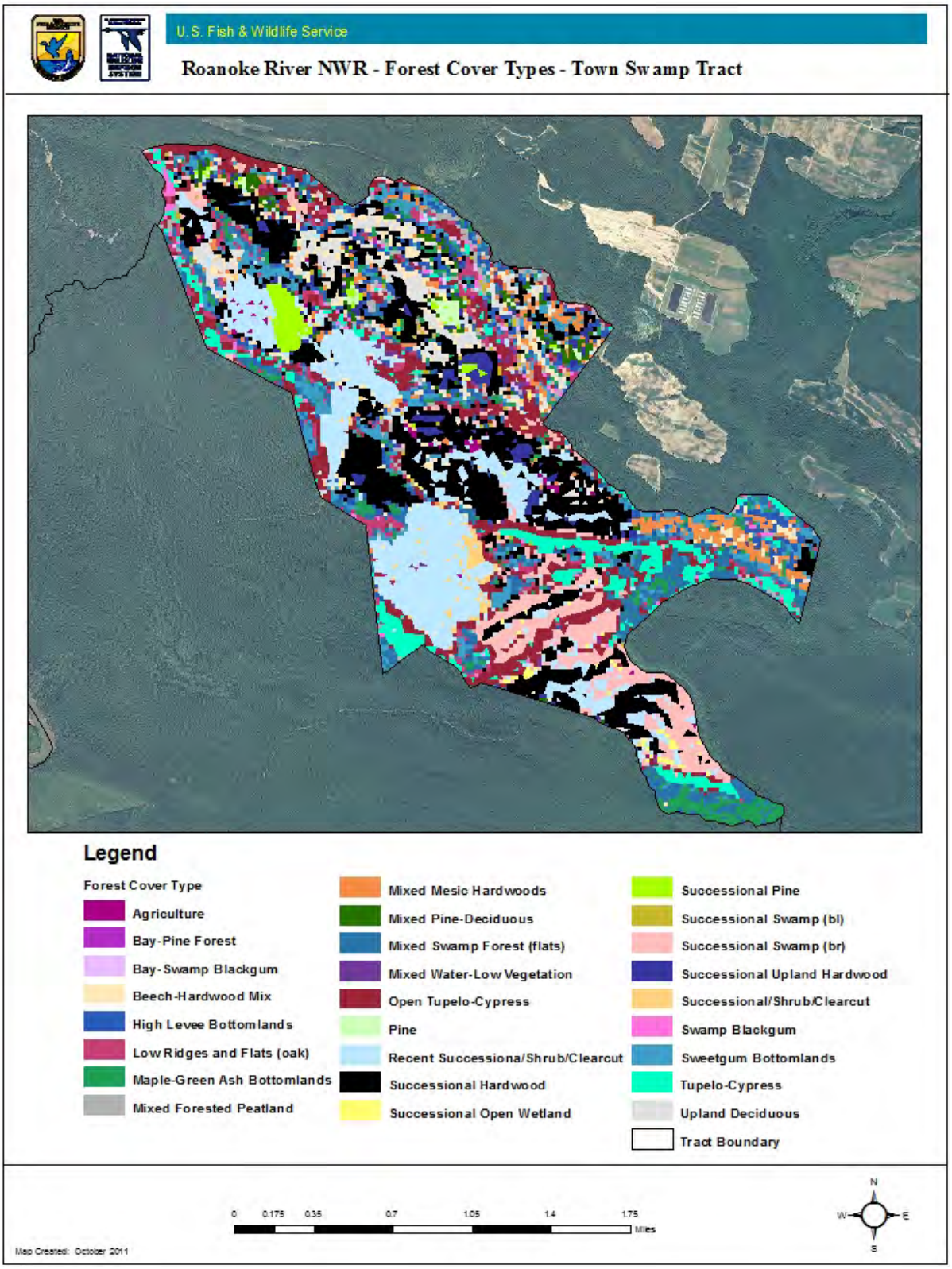
Tract (Realty No.)	Hampton Swamp Tract (12h)	Great Island (2)	Goodman Island (2a)	Sunken Marsh Islands (2b)
Acres	1122	3983	500	10
Deed (book/page)	(718/363)	(1/47)	(1/47)	(1/47)
	USFWS RRNWR	USFWS RRNWR	USFWS RRNWR	USFWS RRNWR
	3-10-1995 Purchased from ↓ NC TNC	1-16-1997 Purchased from ↓ NC WRC	1-16-1997 Purchased from ↓ NC WRC	1-16-1997 Purchased from ↓ NC WRC
	7-27-1990 Purchased from ↓ Georgia Pacific	9-19-1984 Purchased from ↓ NC TNC	9-19-1984 Purchased from ↓ NC TNC	9-19-1984 Purchased from ↓ NC TNC
	6-29-59 Purchased from ↓ Atlas Plywood, NA	11-28-1983 Purchased from ↓ Burrus Timber Assoc. of VA	11-28-1983 Purchased from ↓ Burrus Timber Assoc. of VA	11-28-1983 Purchased from ↓ Burrus Timber Assoc. of VA
	11-16-1945 Purchased from ↓ Plymouth Box and Panel Company, DE (formally Wilts Veneer Company)	6-28-1983 Purchased from ↓ Whichard Group, Inc. (Bankruptcy) Beneficiary Lyme Timber, NH	6-28-1983 Purchased from ↓ Whichard Group (Bankruptcy)Inc. Beneficiary Lyme Timber, NH	6-28-1983 Purchased from ↓ Whichard Group, Inc. (Bankruptcy) Beneficiary Lyme Timber, NH
	6-12-1909 Purchased from ↓ Wilts Veneer Company (formally Dennis Simmons Lumber Company)	12-21-1979 Purchased from ↓ Judge Joseph W. Parker	12-21-1979 Purchased from ↓ Judge Joseph W. Parker	12-21-1979 Purchased from ↓ Judge Joseph W. Parker

Tract (Realty No.)	Hampton Swamp Tract (12h)	Great Island (2)	Goodman Island (2a)	Sunken Marsh Islands (2b)
	6-12-1909 Purchased from ↓ Dennis Simmons Lumber Co.	ROW State HWY Commission (HWY 45 bridge) 3-24-1969 book 558 pg. 339	ROW State HWY Commission (HWY 45 bridge) 3-24-1969 book 558 pg. 339	ROW State HWY Commission (HWY 45 bridge) 3-24-1969 book 558 pg. 339
	12-3-1902 Purchased from ↓ W.H. Hampton	Reservation of oil and mineral rights by Thomas H. Hampton and others 3-19-1965 book 508 pg.616	Reservation of oil and mineral rights by Thomas H. Hampton and others 3-19-1965 book 508 pg.616	Reservation of oil and mineral rights by Thomas H. Hampton and others 3-19-1965 book 508 pg.616
	11-11-1890 after leasing the timber rights on the tract from 10-5-1886 to purchase date Purchased from ↓ W.G.Askew	12-15-1961 Purchased from ↓ W.R. Hampton and others	12-15-1961 Purchased from ↓ W.R. Hampton and others	12-15-1961 Purchased from ↓ W.R. Hampton and others
		6-4-1951 Purchased from ↓ Thomas H. Hampton (Deceased) and others and John L. Phelps	6-4-1951 Purchased from ↓ Thomas H. Hampton (Deceased) and others and John L. Phelps	6-4-1951 Purchased from ↓ Thomas H. Hampton (Deceased) and others and John L. Phelps
				1-1-1869 Purchased from ↓ P.H. Winstom

Tract (Realty No.)	Hampton Swamp Tract (12h)	Great Island (2)	Goodman Island (2a)	Sunken Marsh Islands (2b)
				10-1-1868 Transferred from ↓ Joseph B. Nichols Inherited from ↓ Thomas Riddell

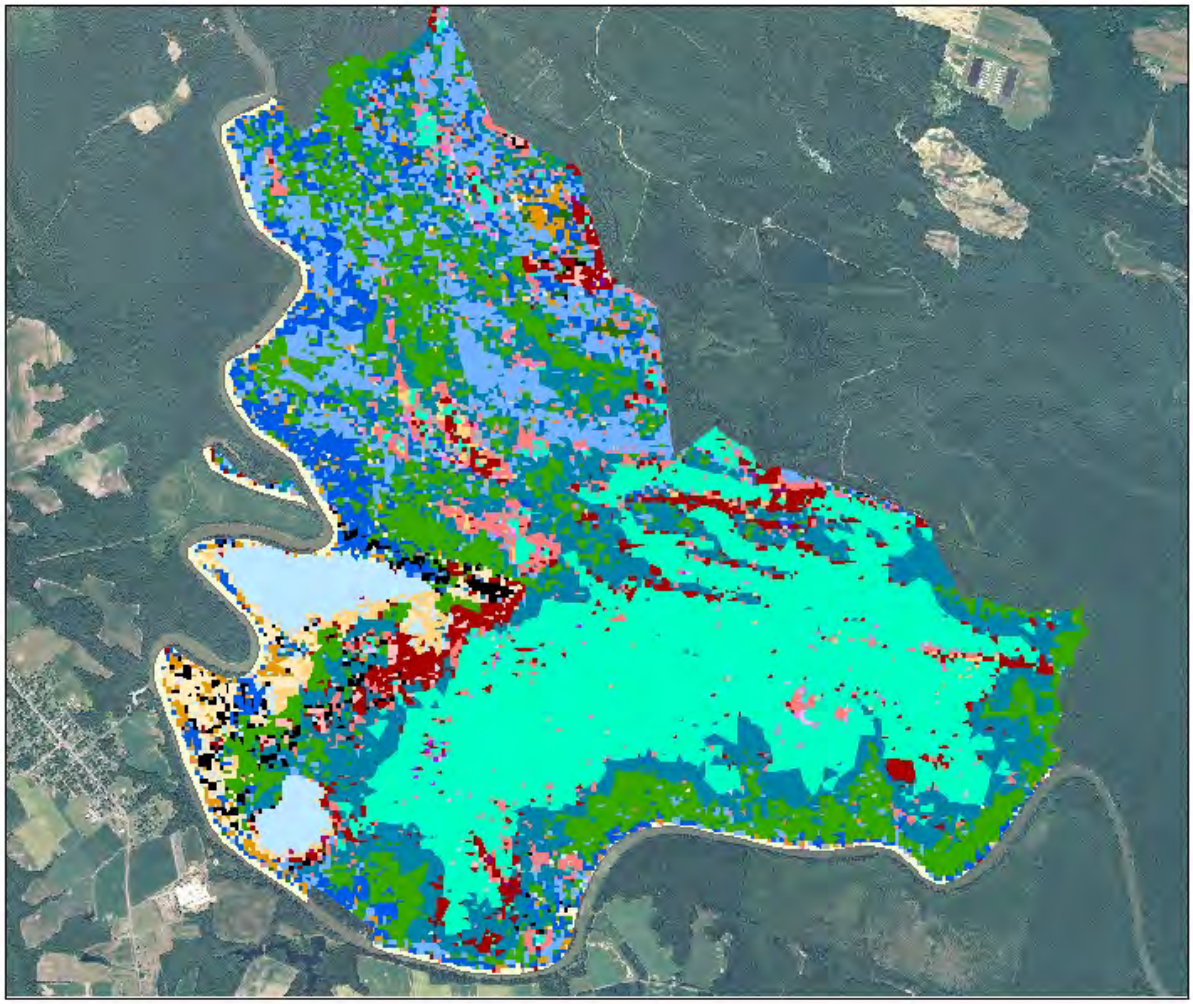
[1]The purpose of the tracking historical ownership is to give some insight on how and when the timber resources on the respective tracts were exploited. Ownership was tracked as far back as the late 1800s on most tracts. If it was too difficult to interpret the legal language or decipher the handwritten entries; further searches for the tract being searched were terminated.

Appendix F. Forest Cover Types of Refuge Lands and Stats Lands



U.S. Fish & Wildlife Service

Roanoke River NWR - Forest Cover Types - Broadneck Swamp Tract



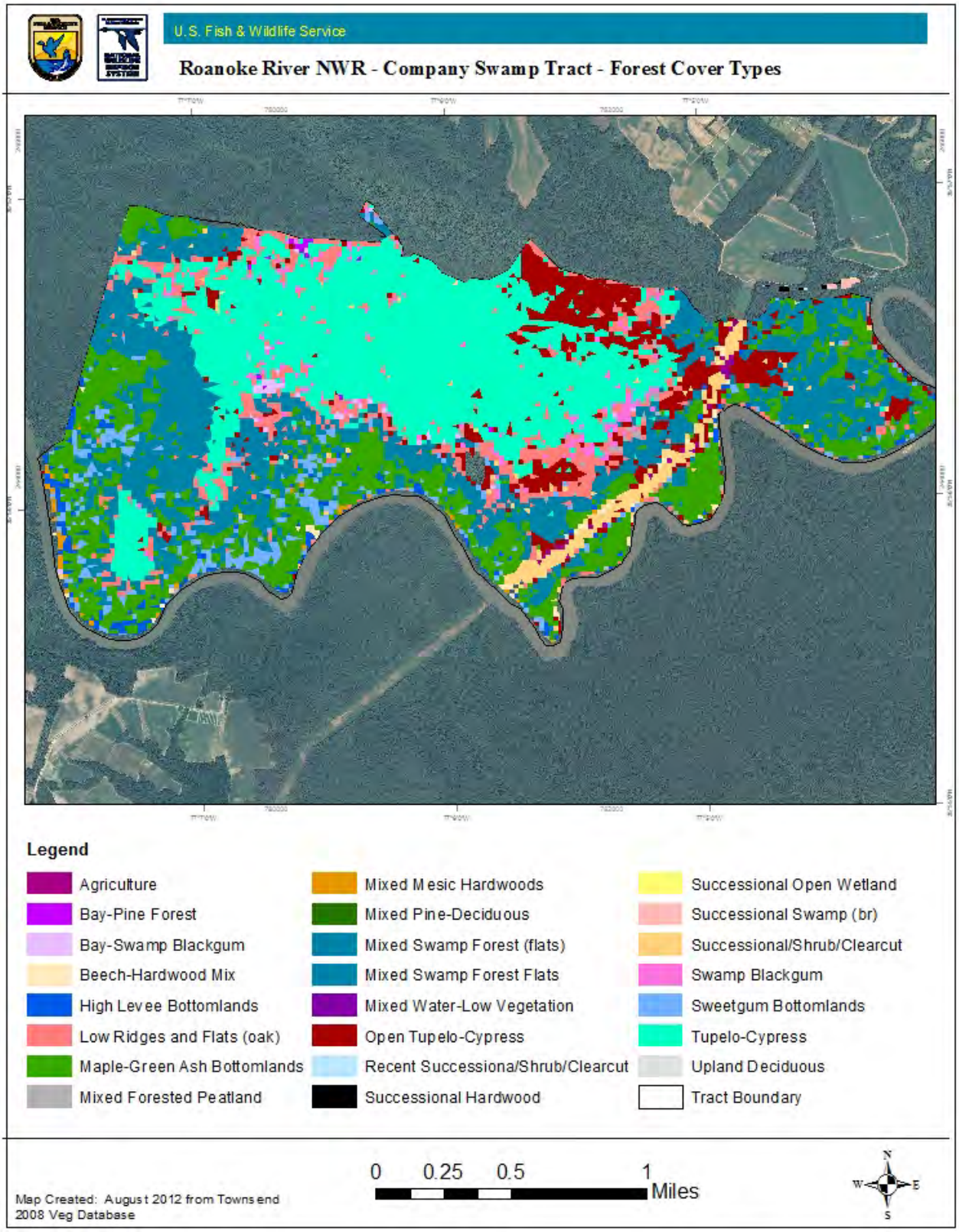
Legend

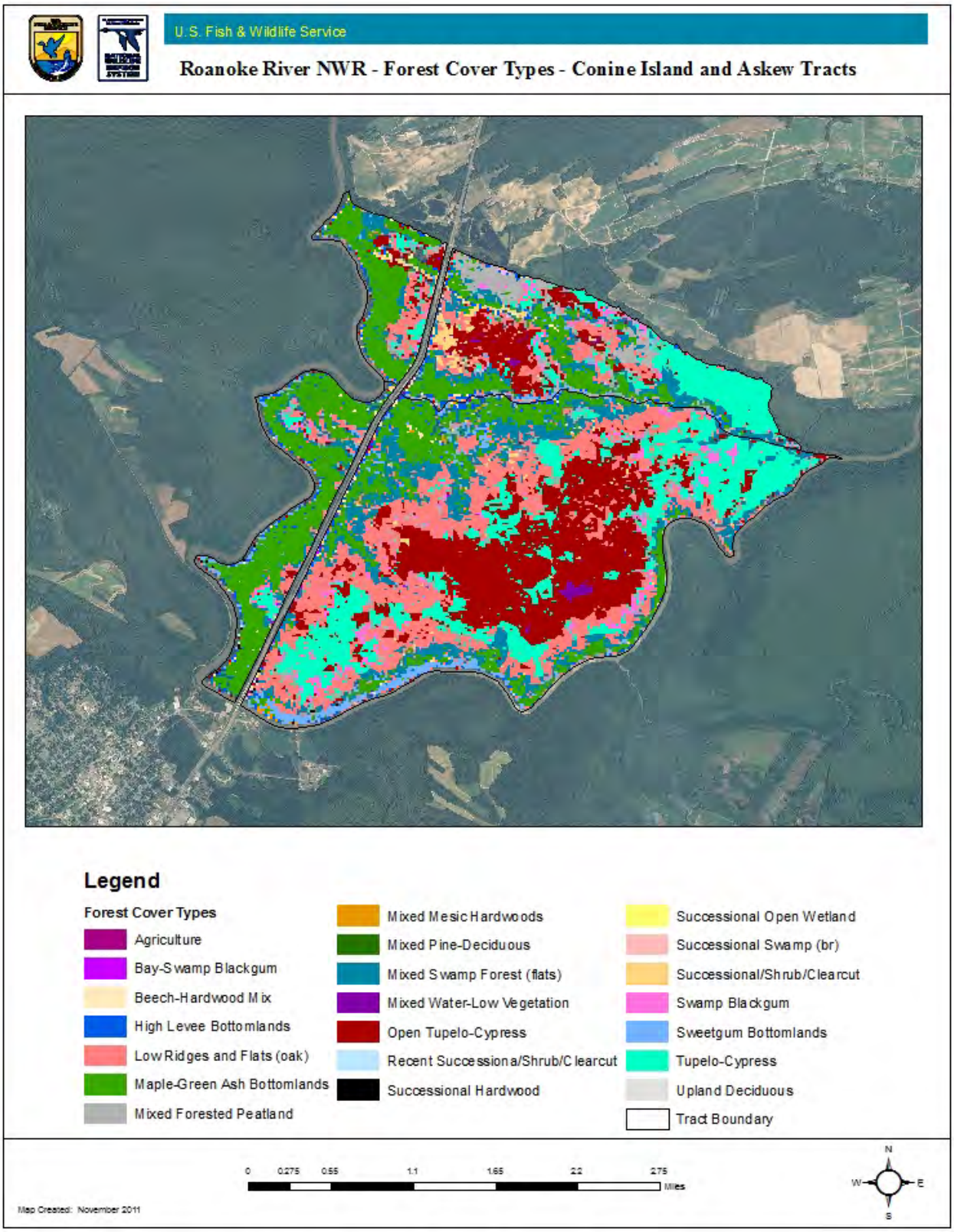
Forest Cover Type

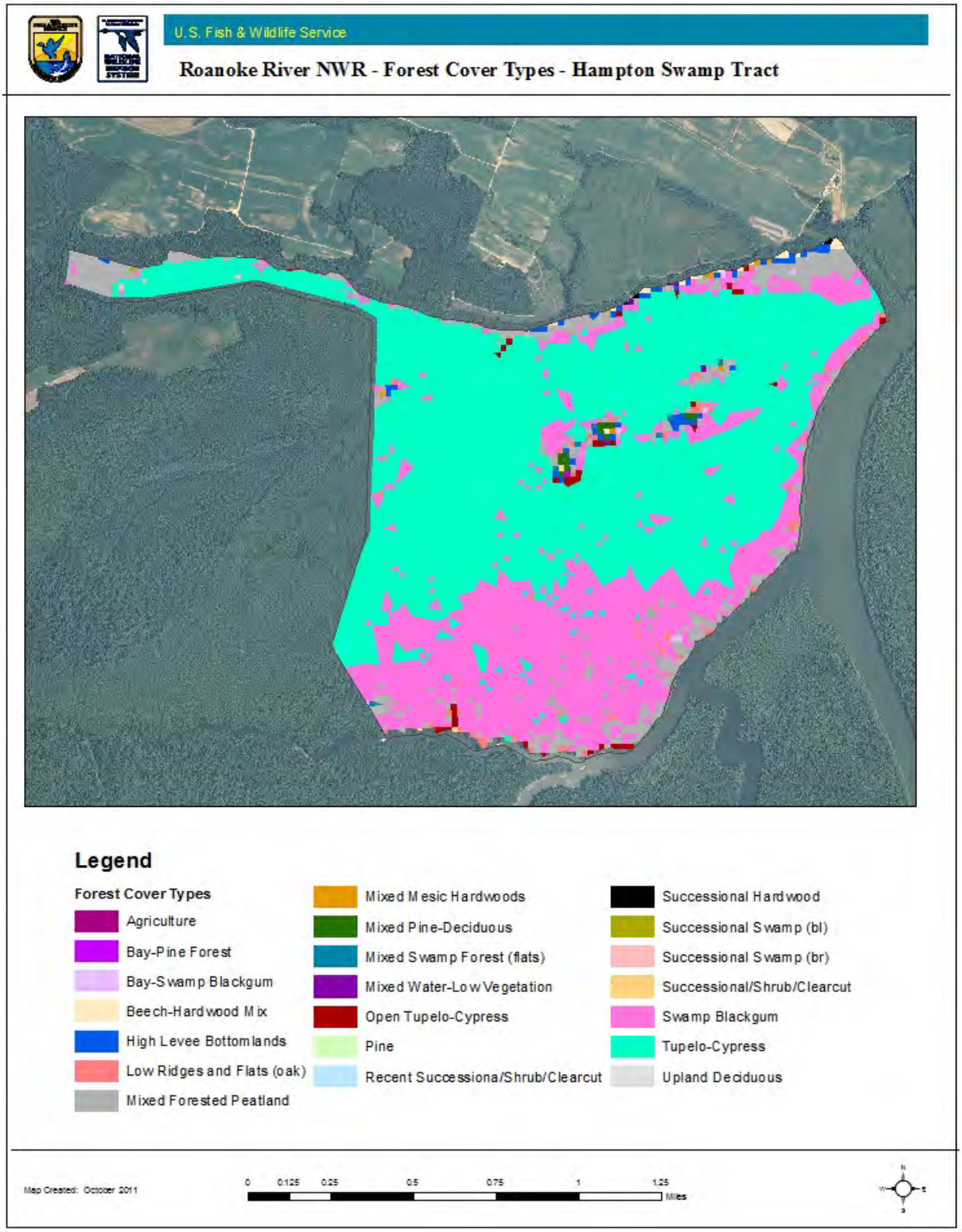
- Agriculture
- Bay-Pine Forest
- Bay-Swamp Blackgum
- Beech-Hardwood Mix
- High Levee Bottomlands
- Low Ridges and Flats (oak)
- Maple-Green Ash Bottomlands
- Mixed Forested Peatland
- Mixed Mesic Hardwoods
- Mixed Pine-Deciduous
- Mixed Swamp Forest (flats)
- Mixed Water-Low Vegetation
- Open Tupelo-Cypress
- Recent Successiona/Shrub/Clearcut
- Successional Hardwood
- Successional Open Wetland
- Successional Swamp (bl)
- Successional Swamp (br)
- Successional Upland Hardwood
- Successional/Shrub/Clearcut
- Swamp Blackgum
- Sweetgum Bottomlands
- Tupelo-Cypress
- Upland Deciduous

0 0.225 0.45 0.9 1.35 1.8 2.25 Miles

Map Created: November 2011

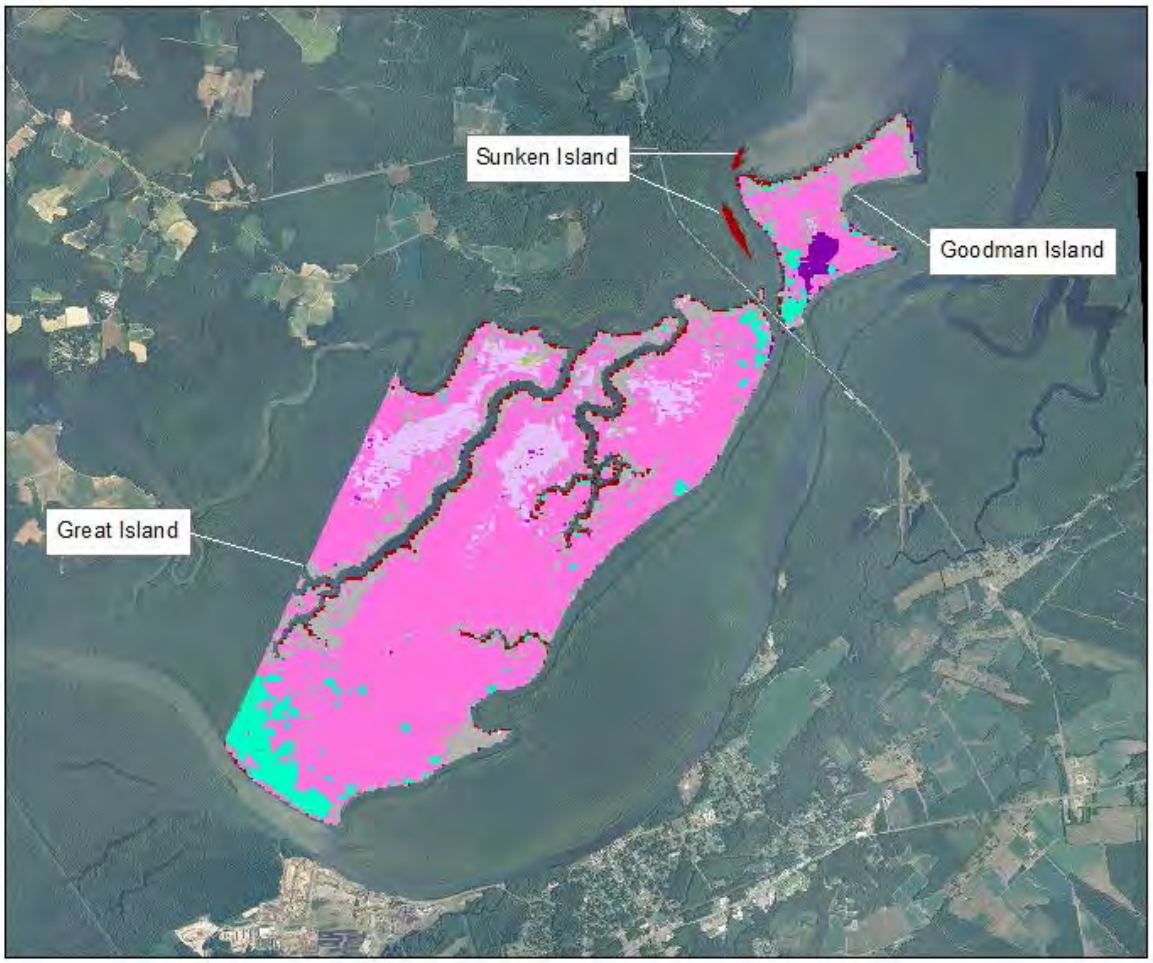

U.S. Fish & Wildlife Service
Roanoke River NWR - Company Swamp Tract - Forest Cover Types
Legend
Agriculture
Bay-Pine Forest
Bay-Swamp Blackgum
Beech-Hardwood Mix
High Levee Bottomlands
Low Ridges and Flats (oak)
Maple-Green Ash Bottomlands
Mixed Forested Peatland
Mixed Mesic Hardwoods
Mixed Pine-Deciduous
Mixed Swamp Forest (flats)
Mixed Swamp Forest Flats
Mixed Water-Low Vegetation
Open Tupelo-Cypress
Recent Successiona/Shrub/Clearcut
Successional Hardwood
Successional Open Wetland
Successional Swamp (br)
Successional/Shrub/Clearcut
Swamp Blackgum
Sweetgum Bottomlands
Tupelo-Cypress
Upland Deciduous
Tract Boundary
0 0.25 0.5 1 Miles
N
W
E
S
Map Created: August 2012 from Townsend
2008 Veg Database


U.S. Fish & Wildlife Service
Roanoke River NWR - Forest Cover Types - Conine Island and Askew Tracts
Legend
Forest Cover Types
Agriculture
Bay-Swamp Blackgum
Beech-Hardwood Mix
High Levee Bottomlands
Low Ridges and Flats (oak)
Maple-Green Ash Bottomlands
Mixed Forested Peatland
Mixed Mesic Hardwoods
Mixed Pine-Deciduous
Mixed Swamp Forest (flats)
Mixed Water-Low Vegetation
Open Tupelo-Cypress
Recent Successional/Shrub/Clearcut
Successional Hardwood
Successional Open Wetland
Successional Swamp (br)
Successional/Shrub/Clearcut
Swamp Blackgum
Sweetgum Bottomlands
Tupelo-Cypress
Upland Deciduous
Tract Boundary
0 0.275 0.55 1.1 1.65 2.2 2.75
Miles
N
W
E
S
Map Created: November 2011


U.S. Fish & Wildlife Service
Roanoke River NWR - Forest Cover Types - Hampton Swamp Tract
Legend
Forest Cover Types
Agriculture
Bay-Pine Forest
Bay-Swamp Blackgum
Beech-Hardwood Mix
High Levee Bottomlands
Low Ridges and Flats (oak)
Mixed Forested Peatland
Mixed Mesic Hardwoods
Mixed Pine-Deciduous
Mixed Swamp Forest (flats)
Mixed Water-Low Vegetation
Open Tupelo-Cypress
Pine
Recent Successiona/Shrub/Clearcut
Successional Hardwood
Successional Swamp (bl)
Successional Swamp (br)
Successional/Shrub/Clearcut
Swamp Blackgum
Tupelo-Cypress
Upland Deciduous
Map Created: October 2011
0 0.125 0.25 0.5 0.75 1 1.25
Miles

U.S. Fish & Wildlife Service

Roanoke River NWR - Forest Cover Types - Great, Goodman and Sunken Islands



Legend

Forest Cover Types

- Atlantic White Cedar
- Bay-Pine Forest
- Bay-Swamp Blackgum
- High Levee Bottomlands
- Low Ridges and Flats (oak)
- Mixed Forested Peatland
- Mixed Swamp Forest (flats)
- Mixed Water-Low Vegetation
- Open Tupelo-Cypress
- Successional/Shrub/Clearcut
- Swamp Blackgum
- Sweetgum Bottomlands
- Tupelo-Cypress

0 0.375 0.75 1.5 2.25 3 3.75 Miles

N W E S

Map Created: October 2011

Breakdown of the different forest community types by refuge tract and management units of special interest[1]

Forest Community Type	Town Swp	HDFF	BN Swp	Company Swp	Conine Is	Hampton Swp	Great Is	Goodman Is	Askew	Askew SE Impound	Askew SW Impound	Askew NW Impound	Askew NE Impound
Bottomland hardwood - totals	***776***	***123***	***2917***	***1098***	***1973***	***22***	***12***	***6***	***666***	***44***	***38***	***30***	***76***
Low Ridges and Flats (oak)	69	1	215	139	781	10	10	1	152	17	24	5	28
Maple-Green Ash Bottomlands	77	7	876	360	649	11	0	0	297	2	6	18	32
Mixed Swamp Forest (flats)	142	4	1017	478	406	2	1	4	149	7	7	5	0
Recent Successiona/Shrub/Clearcut	337	88	195	0	2	0	0	0	0	18	1	0	0
Successional Open Wetland	11	1	0	0	1	0	0	0	0	0	0	0	0
Successional/Shrub/Clearcut	23	3	82	54	26	1	0	1	44	0	0	2	4
Sweetgum Bottomlands	117	19	531	67	108	0	1	1	23	0	0	1	12
Drier hardwoods - totals	***905***	***523***	***2154***	***55***	***94***	***9***	***2***	***0***	***53***	***1***	***0***	***4***	***26***
Agriculture	9	8	1	4	5	0	0	0	0	0	0	0	1
Beech-Hardwood Mix	70	40	81	8	10	1	0	0	9	0	0	2	5
High Levee Bottomlands	99	29	368	34	65	3	2	0	41	1	0	2	5
Mixed Mesic Hardwoods	74	47	82	7	8	1	0	0	1	0	0	0	0
Mixed Pine-Deciduous	32	18	17	0	1	3	0	0	1	0	0	0	15
Pine	12	10	0	0	0	0	0	0	0	0	0	0	0
Successional Hardwood	452	251	68	1	3	1	0	0	1	0	0	0	0
Successional Pine	28	27	0	0	0	0	0	0	0	0	0	0	0
Successional Upland Hardwood	49	33	1	0	0	0	0	0	0	0	0	0	0
Upland Deciduous	80	60	1538	0	1	0	0	0	0	0	0	0	0
Mixedpeatland/blackgum - totals	***58***	***2***	***72***	***47***	***126***	***408***	***3656***	***367***	***153***	***1***	***4***	***4***	***2***
Bay-Pine Forest	1	0	2	3	0	0	8	0	0	0	0	0	0
Bay-Swamp Blackgum	6	1	11	8	2	0	370	3	3	0	0	0	2
Mixed Forested Peatland	34	1	33	6	38	83	599	133	120	1	2	3	0
Swamp Blackgum	16	0	25	30	86	325	2679	230	29	0	2	1	0
Cypress/tupelo - totals	***541***	***7***	***287***	***764***	***1461***	***701***	***354***	***101***	***396***	***31***	***17***	***23***	***20***
Mixed Water-Low Vegetation	8	0	2	1	14	1	4	46	7	2	0	0	17
Open Tupelo-Cypress	240	3	258	159	818	7	114	21	179	28	8	16	0
Successional Swamp (bl)	11	1	1	0	0	0	0	0	0	0	0	0	3
Successional Swamp (br)	162	3	25	2	1	0	0	0	1	0	0	0	0
Tupelo-Cypress	120	0	0	603	627	693	235	34	209	1	9	7	0
Grand Total	***2280***	***655***	***5429***	***1964***	***3654***	***1140***	***4024***	***474***	***1268***	***77***	***60***	***61***	***123***

(1) Data was acquired from a 1993 GIS database developed for the lower Roanoke River and updated in 2008.[1] The acreages listed below are estimates from the GIS database. Some but minor anomalies are apparent due to pixel size overlapping into a neighboring community type; e.g., tupelo/cypress into the Hydrologically Disconnected Floodplain Forest (HDFF) forest type.

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[1] Townsend, P.A. 1997. Environmental gradients and vegetation patterns on the Roanoke River floodplain, North Carolina. Dept. of Geography. Ph.D. Dissertation. University of North Carolina. Chapel Hill

Appendix G. MOU-Dominion Generation

Memorandum of Understanding between

Dominion Power Company

and the

United States Fish and Wildlife Service,

Roanoke River National Wildlife Refuge

RECEIVED
MAR - 1 2006
RRNWR

To establish a

cooperative management strategy of

transmission line rights-of-way on the

Roanoke River National Wildlife Refuge

Subject: Maintenance of Utility Transmission Line Rights-of-Way (ROW) on U.S. Fish and Wildlife Service (Service) Roanoke River National Wildlife Refuge (RRNWR) Properties Company Swamp and Hampton Swamp Tracts

Purpose: To clarify between the Service and Dominion Power or any future named utility company that comes into management authority of the subject ROW the criteria under which certain management activities shall occur.

The refuge management has the responsibility of managing the habitats found within the boundary of the RRNWR for the benefit of all wildlife. It is the purpose of this MOU to work with Dominion Power to enhance the habitat found within the described ROW and ensure the integrity of the habitat found outside of the described ROW while allowing the utility company to meet their objectives. This MOU shall not be construed to limit or modify the legal rights of the parties as defined by the deed and other documents forming the chain of title to the property covered by the MOU. This MOU is not legally binding on either party; rather it represents a good faith effort to address an issue of substantial importance to both parties. Each party reserves the right to terminate this MOU as it deems necessary.

Maintenance within the legal ROW as per Legal Easement and Refuge Special-Use Permit

The following points are understood by both parties and will be adhered to:

1. Any woody debris found within the ROW that may in the opinion of company personnel pose a threat to transmission lines, support poles, or guide wires may be removed by mechanical or authorized chemical means.
2. If herbicides are used, the herbicide must be on the most recent approved pesticide use list see conditions in special use permit number RRNWR 06-42630-01.
3. A pesticide use proposal must be completed by 15 September prior to any applications the following calendar year and Dominion Power must have an approved special use permit before application.

Maintenance outside of the legal ROW

The following points are understood by both parties and will be adhered to:

1. The ROW easement states that the Company will pay the owner of the property outside of the ROW for all trees cut or removed by the Company. However, the Service agrees to one exception (see 8. below).
2. The ROW easement states that all trees cut outside the legal ROW easement will be compensated as appropriate at the local market value using the Doyle's scale of measurement.

3. With certain exceptions, all trees cut outside the legal ROW easement will be cut with no more than six inches of stumpage remaining above ground. One exception would be the removal of a few but not all basal branches from coppiced trees.
4. Compensation funds will be placed in a general account with the U. S. Government.

Criteria for Trees to be Manipulated

5. The ROW easement states that the Company has the legal right to remove trees from outside its legal ROW easement that may in the opinion of the Company pose a threat to proper and efficient operation of the subject lines.
6. Trees present outside the legal ROW will be identified as either a danger tree or a dangerous tree and are defined as follows:
   - A danger tree is tall enough to hit the line if it were to fall in the direction of the line but poses no immediate threat.
   - A dangerous tree is a tree tall enough to hit a line if it falls but has a higher probability due to its physical condition.
7. Danger trees will not be cut or manipulated in any way unless authorized by refuge management.
8. Dangerous trees may be manipulated by Dominion Power contractors or ROW maintenance personnel in such a way that it will no longer pose a threat to a line and the Service will not require compensation from the Company.
9. The following constitutes a dangerous tree: a tree leaning towards a line at more than 30 degrees, a tree with branches that could impair a line, a dying tree whose branches may snap off and impair a line, the base of the tree is impaired jeopardizing the stability of the tree, or other cases as they arise.
10. Before any work outside of the ROW easement commences, a management prescription will be developed between Refuge management and Dominion's ROW managers in an effort to remove the threat of dangerous trees and still maintain the integrity of the adjacent bottomland hardwood forest communities.
11. It is recommended that dangerous trees be manipulated in such a way to prevent a tree from being cut down to ground level. Management prescriptions should consider these and other methods of manipulation: removing selected branches, topping off the tree to reduce height and if suitable, creating a den tree.
12. All tree maintenance activities will occur between 1 September and 31 December unless immediate attention is warranted.

Charles D. Hardy
Manager Transmission Right-of-Way
Dominion Power

2-22-2006
Date

FOR Refuge Manager
Harvey Hill

3/2/06
Date

Appendix H. Askew Tract-Water Management Plan

Water Management Plan for the Askew Impoundment Project
Working Draft

Developed by: Jean Richter
Wildlife Biologist
Roanoke River NWR

March 2009

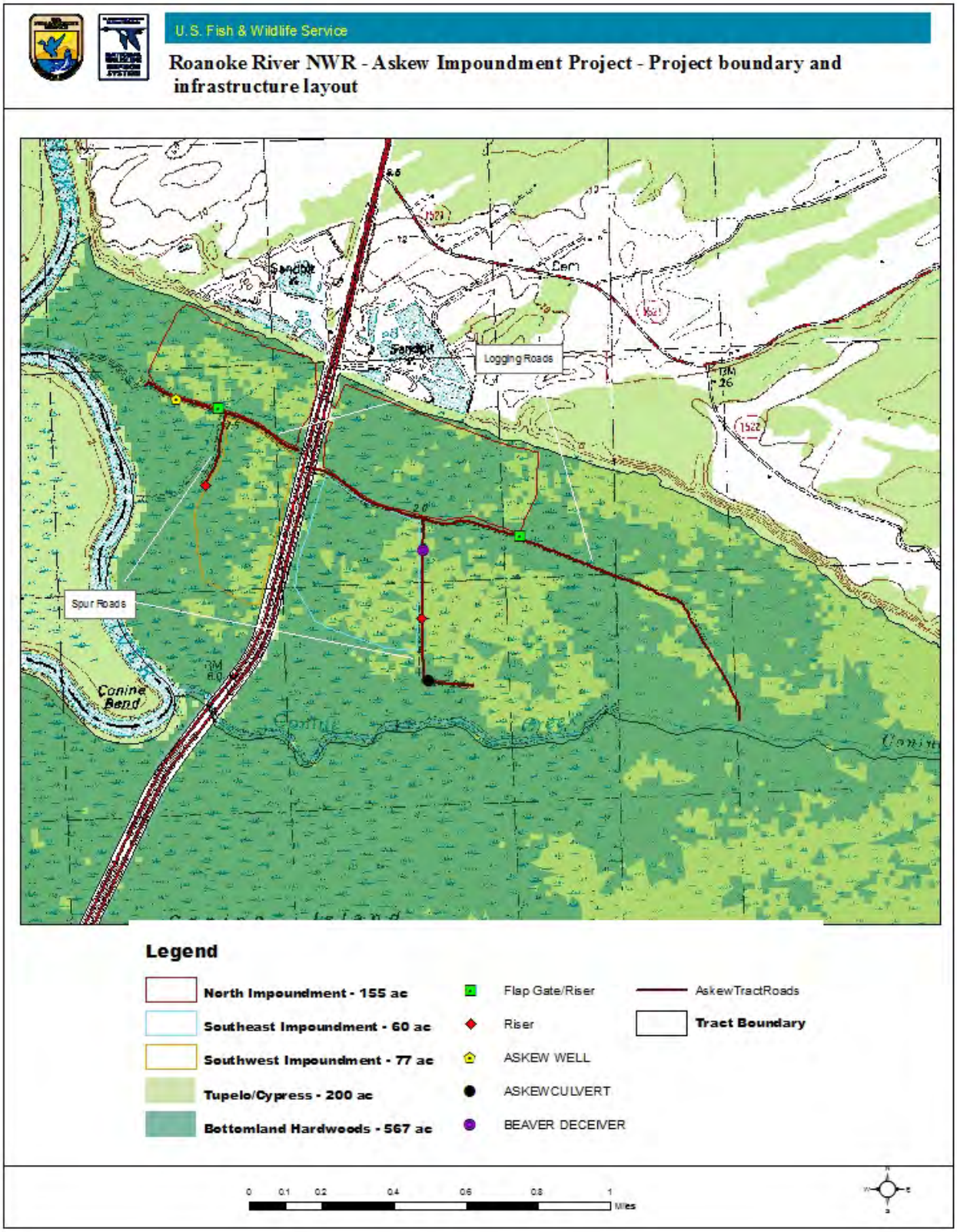
Introduction:

Dams upstream of refuge lands result in aseasonal and prolonged flood events of the bottomland hardwood forests in the lower Roanoke River, disrupting the natural flow regime. Bottomland forest communities can tolerate flooding during the dormant season with no adverse effects but do not do well when flooded for prolonged periods of time during the growing season (Wellner 1989; King 1994). On the coastal plain reach of the river, the growing season has been defined as beginning 1 March and extends through 30 October (USFERC, 2005). The hydrology is further altered in some areas of the floodplain by past silviculture practices. Roads and drainage canals were built through parts of the floodplain to facilitate the removal of valuable timber resources from the floodplain. These features confine water to the deeper canals and cause water to pool behind roads interrupting the flow of water. The Askew Tract of the Roanoke River National Wildlife Refuge (NWR) is impacted by the altered flow regime and is also bisected by drainage canals and old logging roads. In 2001, the Fish and Wildlife Service (Service) partnered with Ducks Unlimited and received money from a North American Wetlands Conservation Act Grant to construct a project designed to restore the hydrology to approximately 411 acres of floodplain habitat on the Askew Tract. The objectives of this project are to: (1) Reduce the occurrence of prolonged growing season floods; and (2) prevent the drainage of water from this area via the drainage canals during the winter.

Project Location:

The project area is located on the Askew Tract; 1,276 acres of forested wetland consisting of cypress-tupelo swamps and bottomland hardwood forests. Bisecting the tract from the north to south is 4-lane State Highway 13/17. Running from east to west on the tract is a remnant logging road with spurs that run south. The project area is divided into three impoundments. Cardinal directions are used to reference the location of the impoundments and are named for their location relative to Highway 13/17 and the main logging road. For example, the southwest impoundment is located on the west side of the Highway 13/ 17 and south side of the logging road. Water levels in the three impoundments can be managed using flap gates and risers located at select locations along the logging roads. See Figure 1 for project layout.

Figure 1. Project boundary and infrastructure layout – Askew Impoundment Project



Project Concept:

North Impoundment
There are two flap gates with risers in the canals on Askew east and west. They can be positioned accordingly to allow the river to enter or leave the floodplain according to what is prescribed in the Habitat Management Plan. Manipulation of water levels in the north impoundment is done by placing the required number of boards in the riser to achieve the prescribed range of water levels. For example, to prevent river water from entering the north impoundment during the growing season, the exterior flap gate will be closed and interior gate held open with all flashboards in place. During the dormant season when river flows are greater than 12,000 cfs, the exterior flap gates can be opened and interior gate closed and all boards left in place to allow for maximum water retention. In times of drought or sustained low river flows during the dormant season, the lower topography on the west side of the impoundment can hold water that is pumped in with an existing well.[2] Although only shallow depths of 6-8 inches of water can be attained from pumping, this would allow waterfowl access to food resources they would otherwise not be able to utilize in dry years. When the gauge on the northwest side of Highway 13/17 reads 1.13', pumping should cease as no additional area to benefit waterfowl can be flooded. Any additional water pumped into the impoundment will be confined to natural drainages and artificial channels as it flows under Highway 13/17 and goes beyond the capacity for which the well was intended.

Southwest Impoundment
On the west side of Highway 13/17, there is a culvert with a flashboard riser at the south end of the spur road. When river flows between 10,000-12,000 cfs, the structure with no boards in place will allow movement of water from the river via a canal into the southwest impoundment. Water can exit from this impoundment by flowing over the spur road. The road is low enough to remove most of the water from the hardwoods. In order to remove ponded water from the tupelo swamp located south of the logging road toward the highway, boards will need to be removed from the riser at the end of the spur road. There is also a culvert that runs under the north end of the spur road. It is not understood what influence this culvert has on the hydrology of the impoundment or if it is even functional.

Note: In order to provide benefits to waterfowl, a significant flood event (18,000 cfs lasting for more than 5 days) must occur during the dormant season. As the floodwaters recede to less than 8,000 cfs, the riser with all boards in it will not be able to effectively hold water in the impoundment, since portions of the spur road are lower than the highest board in the riser.

Southeast Impoundment
When river flows are 12,000 cfs and greater, water flows onto the floodplain via depressions along the levee of Conine Creek, causing the impoundment to flood. Water levels can be manipulated in this area using the flashboard riser located on a culvert that goes under the spur road. Special attention needs to be given to the east side of the spur road that is not identified as being in the project area, but is used to drain unwanted water from the impoundment. When water from the southeast impoundment drains into this area, it will flow through a forested area

[2] An example of drought conditions that would warrant pumping would be no significant flooding during the later part of the previous growing season (>20 days) with a predicted dry dormant season.

eventually out to Conine Creek via natural drainages, some of which have been dredged during the timber harvest days to function more effectively. Beaver activity in these drainages tends to trap water on the floodplain, causing a significant amount of water to pond leaving trees inundated for prolonged periods. Controlling the impact beavers have in the area east of the spur road will be necessary to retain the ability to manipulate waters in the impoundment. If beavers dam drainage routes on the east side of the spur road, it will be difficult to drain water from the southeast impoundment when the time comes to draw down water levels. Controlling the impact beavers have will be important to protecting forest integrity in the entire forested area south of the logging road east of Highway 13/17.

Benefits to Service Trust Species

Restoring the hydrology to the floodplain habitat would promote healthy bottomland hardwood forest communities that when flooded, would provide valuable food resources for migrating and wintering waterfowl. Healthy herbaceous growth of annual and perennial emergent vegetation during the growing season creates greater productivity of terrestrial insects consumed by insectivorous songbirds. Good emergent plant growth will provide food for migrating and wintering waterfowl when flooded during the dormant season. Reducing growing season floods will also allow those tree species that cannot tolerate prolonged growing season floods to become established, providing a more diverse forest with an abundance of hard and soft mast for wildlife. A forest with diverse structure and species composition will also provide good nesting and foraging habitat for forest dwelling birds.

The Service trust species expected to benefit from the project are:

Growing Season -
Prothonotary warbler
Hooded warbler
Wood thrush
Acadian flycatcher
Great crested flycatcher
Eastern wood peewee
Northern parula warbler
Summer tanager
Red-eyed vireo
Yellow-throated vireo
American redstart

Dormant Season -
Wood duck
Mallard
Hooded merganser
American wigeon
American black duck
Green-winged teal
Ring-necked duck
Gadwall

Intermittently flooded areas during the growing season -
Yellow-crowned night heron
Great blue heron
Great egret
Wood duck
Green heron
White ibis
Anhinga

Flooding Schedule

Close attention needs to be given to how, when, and what impoundments are flooded to ensure a healthy, diverse, and sustainable forest exists years from now. In the past, management of impoundments within bottomland forests was a standard: flood the forest in November, drain the water in February. Several studies have demonstrated that when trees are repeatedly flooded during the dormant season on an annual basis, forest structure and vigor are lost over time, reducing the functionality of the project being able to provide the intended benefits to wildlife year-round (Fredrickson 1999, Gray and Kaminski 1999, Hertlein and Gates 1999). Forest structure is lost through dying trees and reduced regeneration over time results in lower mast output and loss of structure that affects food for waterfowl and habitat for nesting birds. The water management plan of the Askew Impoundment Project does not follow this traditional approach to flooding bottomland forests. Instead, AHMPs will be designed to flood the project area periodically during winter to more closely emulate natural hydrological periods.

Inundation of the Askew Impoundments should begin in November and drained during February. Caution must be taken to not hold water longer than this in any one impoundment, because trees may be killed or overly stressed over the long-term. Ideally, at least one impoundment should be left dry each year, rotating with a different one to be dried down each year. In addition, at least one to two impoundments should be allowed to dry down each winter for at least two weeks and then allowed to flood again the same winter if river flows allow. This is to be done on a rotating basis so that at least one to two impoundments will be dry at some point during the winter. Prolonged winter floods or growing season flood events must be considered when developing the AHMP for the Askew Impoundment Project for the upcoming dormant season. If significant growing season floods (i.e., floods lasting longer than 20 days) occurred during the prior growing season, the impoundments targeted for flooding that year should not be flooded until late-December and January and then for no more than 3 to 4 weeks during the dormant season. If prolonged flood events lasting more than two months occur during the dormant season accompanied by growing season flood events lasting more than 21 consecutive days, the impoundments should not be flooded at all the next year. The scenarios described above serve as a guide in the thought process to be used when developing the AHMP for the project.

Note: This project is designed to control water levels when discharges from Roanoke Rapids Dam are less than 12,000 cfs. When discharges are above 12,000 cfs for 5 days or more, the ability to control water levels in the three impoundments will decrease with complete loss of control when discharges of 18,000 cfs are sustained for 5 days or more. Assuming complete control (flows greater than 8,000 cfs but less than 12,000 cfs) for less than 5 days and no beaver activity, the tables below serve as a seasonal guide for water levels in each impoundment. If flows greater than 12,000 cfs occur during the dormant season, the table below will not apply. Efforts will need to be taken to bring impoundments down to levels prescribed in the AHMP. If flooding persists into the growing season, this will influence how the project is to be managed the following year. Hydrographs from the current and previous years should be reviewed and considered when planning the water management prescription for the upcoming dormant season. The water levels in the tables does not mean that in a given year levels should be kept at these levels throughout the dormant season, there should be draw downs or dry downs of one or more of the impoundments during the dormant season as prescribed in the AHMP. If it is not possible to dry down an impoundment as prescribed during the growing season, water levels should be brought down to levels to where water is no longer on the hardwoods.

North Impoundment:
Dormant Season: November 1 through February 28

Time	Gauge Level (West)	Hydrological Condition		
Early-November	0.0”	Drought conditions - Dormant and growing season	Occurrence of previous growing season floods*	Predicted wet dormant season after normal to dry growing season**
		Management Action Required		
		Begin flooding if river flows permit or if drought conditions exist, pump water in via well. Flap gates should be positioned to prevent water from leaving the floodplain and boards placed in risers.		Flap gates should be positioned to allow the river to enter and boards removed from risers (optional).
Mid-November	4”	Flap gates should be positioned to prevent water from leaving the floodplain, and boards placed in risers.		
Late-November	12”	Flap gates should be positioned to prevent water from leaving the floodplain, and boards placed in risers.		
December	6”-12”		Begin flooding. Flap gates should be positioned to allow the river to enter, and boards removed from riser (optional).	
January	6”-12”		Maintain suggested water levels.	
Early February	4”	Remove boards from risers and reverse flap gates to allow floodplain drainage.	Begin drawing down.	

Time	Gauge Level (West)	Hydrological Condition		
Early-November	0.0”	Drought conditions - Dormant and growing season	Occurrence of previous growing season floods*	Predicted wet dormant season after normal to dry growing season**
		Management Action Required		
Mid- to late-February	4”		Maintain suggested water levels if spring floods occur; work on getting water off floodplain.	

** Floods lasting more than 20 days. If impoundments were inundated for more than 21 days the impoundment should not be flooded during dormant season.*
*** Based on rain events and Releases from Roanoke Rapids Dam.*

North Impoundment
Growing Season: March 1 through October 30

Time	Gauge Level	Hydrological Condition	
		***Wet Growing Season**	**Dry Growing Season**
March through October 0.0”		**Management Action Required**	
		Remove all boards from risers. Reverse flap gate so water cannot enter floodplain.	Place boards in risers; trap rain water on the floodplain.

** Floods lasting more than 20 days.*

Southwest Impoundment:
Dormant Season: November 1 through February 28

Time	Gauge Level	Hydrological Condition		
Early-November	?	Drought conditions during previous growing season	Previous growing season floods*	Predicted wet dormant season**
		Management Action Required		
		Begin flooding if river flows permit (must be >12,000 cfs). Remove all boards from risers to allow water to enter.	Place all boards in riser to prevent moderate river flows (between 8,000 and 10,000 cfs) from entering impoundment. If flows > 18,000 cfs occur for 5 or more days, boards should be removed to accelerate water draining from floodplain.	
Mid-November	?	Flap gates should be positioned to prevent water from leaving the floodplain, and boards placed in risers.		
Late-November	?	Flap gates should be positioned to prevent water from leaving the floodplain, and boards placed in risers.		
December	?	Keep boards in risers.	Begin flooding if not already.	
January	?			
Early-February	?	Remove boards from risers and reverse flap gates to allow floodplain drainage.	Remove all boards from risers to allow water to drain from the floodplain.	Remove all boards from risers to allow water to drain from the floodplain.

* *Floods lasting more than 20 days.*
** *Based on rain events, weather patterns and releases from Roanoke Rapids Dam.*

Note: Gauge levels need to be determined.
Southwest Impoundment
Growing Season: March 1 through October 30

Time	Gauge Level	Hydrological Condition	
		*Wet Growing Season	Dry Growing Season
March through October	0.0	**Management Action Required**	
		Remove boards from risers to allow water to leave the impoundment after flood events. Keeping boards in place will not prevent water from river to enter impoundment, as water will enter via low spots on the spur road.	Place boards in risers to trap rain water on the floodplain.

** Discharges from Roanoke Rapids Dam are between 8,000 and 12,000 cfs for more than 5 consecutive days.*

Southeast Impoundment
Dormant Season: November 1 through February 28

Time	Gauge Level	Hydrological Condition		
Early-November	0.0 – 1’	Dry conditions during previous growing season	Previous growing season floods*	Predicted wet dormant season**
		Management Action Required		
		Begin flooding if river flows permit (must be >12,000 cfs). Remove all boards from risers to allow water to enter.	Place all boards in risers to prevent moderate river flows (between 8,000 and 10,000 cfs) from entering impoundment. If flows > 18,000 cfs occur for 5 or more days, boards should be removed to accelerate water draining from floodplain.	Remove all boards from risers to allow water to drain from the floodplain.
Mid-November	1’	Boards should be placed in risers to prevent water from leaving the floodplain.		
Late-November	1’-1.5’	Boards should be placed in risers to prevent water from leaving the floodplain.		
December	1’-1.5’		Begin flooding if not already.	
January	1’- 1.5’			
Early-February	1’ or less	Remove boards from risers and reverse flap gates to allow floodplain drainage.		

* *Floods lasting more than 20 days.*
*** *Based on rain events, weather patterns and releases from Roanoke Rapids Dam.*

Southeast Impoundment
Growing Season: March 1 through October 30

Time	Gauge Level	Management Action Required	
		*Wet Growing Season	Dry Growing Season
March through June	< 1.0' to 0.5	Remove boards from risers to allow water to leave the impoundment when water begins to recede.	Remove boards from risers to allow water to drain to 0.5', to keep available brood habitat for waterfowl through June; avoid dry down at this time of year.
June through October	< 1.0' to 0.5		Remove boards from riser to allow water to drain to level of the culvert riser is on. It is okay to let this impoundment dry down completely, as this is a rare occurrence.

** Discharges from Roanoke Rapids Dam are between 8,000 and 12,000 cfs for more than 20 consecutive days.*

Timber Management

The habitat present in the impoundments is what determines this as a forested wetland area and will be managed as such. Timber management can improve the site's value for wildlife and will be focused around promoting a diverse uneven-aged bottomland hardwood forest. The forest within the designated project area was cut over in the 1980s, leaving behind a closed canopy forest with few large dominant trees and many small diameter trees in the mid-story and canopy. The timber management plan for this area, when developed, will focus on optimizing the abundance of soft and hard mast production, providing cavity trees and creating small 1/4- to 1/2-acre openings in the canopy to promote the growth of emergent plant species in the wetter areas. To adjust the species composition and density of the trees present in the project area, trees will be removed by hack and squirt to minimize environmental impacts, since most likely there is not enough marketable trees to warrant a sale.

Project Maintenance

The following steps are to be taken in order to keep all water control structures, drainages, and the well in working condition:

- Run well for 2 to 4 hours once every 2 to 3 months.
- During each spring and fall, water control structures need to be inspected to ensure they are functioning properly.
- Each structure should be inspected for blockages and cleared of debris.
- Check flap gates periodically to clear out any mud or woody debris that would prevent flaps from closing tightly and make sure they are otherwise functioning properly.

- Keep roads clear of fallen trees.
- Keep canals clear of piles of woody debris that would cause water to back up and not flow freely. Use excavator to clear debris from canals along logging road and spur roads. Canals located interior of the logging and spur roads on the west side of Highway 13/17, south of the logging roads, need to be walked annually during the dormant season when water levels are low to clear debris using pitch forks, rakes, and chainsaws.
- Control beaver numbers to prevent them from plugging up culverts and drainage canals.
- Control aquatic invasive species, using appropriate control measures.
- Dikes should be mowed periodically to suppress the growth of undesirable weeds and woody vegetation.

Problems/Concerns and Suggested Solutions

Beaver
Beaver activity is visible throughout the project area and poses a serious threat to the ability of the refuge staff to control water levels and to the overall integrity of the forested wetlands found within and adjacent to the project. With the project in place, the ability of beavers to trap water on the floodplain has significantly increased, causing beavers to have a greater impact than before the project. Beavers regularly build dams that plug grates to culverts and place dams in strategic locations throughout the floodplain. Of particular concern is the area east of the southeast impoundment. Dams constructed in natural drainages cause water to remain impounded, oftentimes throughout an entire growing season. The toll of prolonged inundation on the trees is evident in the southeast impoundment, where tree vigor is declining and dead trees can be observed in the interior portions of the impoundment.

Solution: Destroy nuisance beavers. It is recommended to blow the dams using explosives or break them apart manually and allow the beavers to build them back again. Repeat this 3 to 4 times, then stake out the area in the evening after damaging the dam again and destroy the beavers when they come back to rebuild.

Drainage of Southeast Impoundment
The 24” culvert with 42” riser intended to manipulate water levels in the southeast impoundment is undersized and does not allow water levels to be adjusted in a timely manner. Boards are removed when staff is available during working hours to prevent beavers from damming up the culvert in the evening. With no rainfall events and low river levels, it can take up to three weeks to drain impounded water off from hardwood trees. If a heavy rain event occurs or discharges from Roanoke Rapids Dam increase to more than 12,000 cfs when trying to drain the impoundment, it can take up to three more weeks of limited and valuable staff time to pull risers in the morning and replace them at the end of the work day. If a high-flow event occurs during the growing season, the staff is pulled from other work activities and is again tasked with opening and closing the riser every day until the water is as low as it can possibly get with the current project design.

Solution: To effectively control water levels in the southeast impoundment in a timely manner and save resources, water needs to be moved from the impoundment at a greater rate than is currently occurring. It is recommended a rock ford approximately 75’ in length be constructed at a pre-project low point in the road that was built up in project construction. The elevation of the

ford should be no more than 10 inches higher than the bottom of the swamp to allow some water to remain impounded and additional water to drain off. This should allow excess water to flow freely from the southeast impoundment, helping the forest and significantly decreasing staff time on the project.

Proliferation of Exotic Aquatics (Parrot Feather, *Myriophyllum aquaticum*)
With water unable to drain from the southeast impoundment, and lack of forest canopy existing due to declining forest health from storm damage and prolonged inundation, the exotic plant, parrot feather, has become well-established, choking out an estimated 30 percent of the impoundment and associated canals north and south of the logging roads. The dense mats that form make the area inaccessible to waterfowl and can alter aquatic ecosystems by shading out the algae in the water column that serve as the basis of the aquatic food web. Transferring water via the riser from the impoundment to the east side of the spur road also promotes the spread of parrot feather to other parts of the Askew Tract.

Solution: Controlling parrot feather using herbicides is recommended rather than mechanical methods such as cutting, harvesting, or rotovation (i.e., underwater rototilling). A 1 3/4 percent solution of Rodeo® (aquatic version of Roundup®) with surfactant applied to the plants in the summer or fall when water levels are low has been known to give about 95 percent control of the plants (http://www.ecy.wa.gov/programs/wq/plants/weeds/aqua003.html). Caution should be taken due to the increased BOD on dissolved oxygen levels in the treatment area.

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Appendix I. Protocol for Bidding and Commercial Timber Sales

1. Execution of Timber Harvest

1.1 Cruising and Marking Timber

Each management compartment and stand where a commercial sale has been prescribed has been assigned a year of entry. There are no commercial timber sales planned in those compartments designated as natural areas (e.g., Nat-BLHW, Nat-CT, Nat-HDFF) in the Habitat Management Plan. A timber cruise was completed in 2008 in stands where a commercial sale is possible. These areas include all hardwood and pine plantations. An estimated year of entry has been assigned to each stand prescribed with a commercial sale. See Stats Table in Appendix B for year of entry data. A follow-up cruise will be conducted for each stand before bidding is commenced, to determine any changes in timber volume. The cruise may be conducted using fixed plot and point sampling techniques. Most cruise sampling will be done using a fixed radius plot of 1/5th acre for saw timber, 1/20th acre plots for pulpwood, and 1/100th acre plots for regeneration and herbaceous ground cover. Point samples utilizing 10, 15, or 20 factor prisms may be used at various times for collecting timber volumes. The following data will be collected during each stand cruise:

1. Timber volumes including basal area for sawtimber and pulpwood.
2. Species composition of woody vegetation.
3. Tree ages.
4. Canopy conditions.
5. Presence of vines, Spanish moss, and switchcane.
6. Herbaceous ground cover.
7. Number and size of den, cavity, and cull trees per acre.
8. Tree and shrub species regeneration.
9. Species composition of each canopy layer (overstory, midstory, understory, and ground cover).
10. Presence of woody debris.

Volume tables for each stand will be expressed in 2-inch diameter classes for both sawtimber and pulpwood. Doyle form class 80 will be used to express volume sawtimber (MBF) and pulpwood (cords) volumes for pine. Doyle form class 76 will be used to express volume sawtimber (MBF) and pulpwood (cords) volumes for bottomland hardwoods. The exception will be green ash volumes, which will utilize Doyle form class 70.
Treatment prescriptions will contain the following information:

Compartment map

1. Stand map designating various timber stands within the compartment.
2. Description of compartment including vegetation profile, soil types, hydrology, and other physiological features.
3. Timber data including tree species composition, sawtimber, and pulpwood volumes, stocking, age, condition, and basal area.

4. Wildlife habitat parameters including plant composition of overstory and understory; number of cavity and den trees; and presence of vines, Spanish moss, and switchcane.
5. Number of dead snags, presence of woody debris, and evidence of wildlife activity (e.g., bird nests, browsing of plants, and wildlife tracks).
6. Composition of woody plant regeneration.
7. Prescription of silvicultural treatment to be conducted in the compartment.
8. Description of desired results.
9. Map of treatment area.
10. Timber data for the treatment area showing what is to be removed during treatment.

After the prescription is written, it will be submitted to the Regional Office for approval. Copies of prescriptions and all other information will be kept on file in the refuge office.

To determine which trees are designated for removal, sound silvicultural procedures prescribed in the stand prescription will be followed. As the refuge forester and/or biologist determine which trees are to be removed, paint will be applied at breast height and at the base of trees to be removed. These two marks allow for the contractor to distinguish which trees are designated for removal during logging operations and help staff identify the stumps of marked trees during administration of the logging contract.

Timber marking is very subjective and varies from one timber marker to another. Though the compartment prescription gives the timber marker guidelines to follow, each individual timber marker has a different opinion on how to reach the desired results of the compartment prescription. To ensure forest diversity and avoid bias, more than one person should be involved with the timber marking of treatment areas on the refuge.

During the timber marking activities, many factors are considered before selecting a tree for removal. These include species composition of the compartment, tree health and vigor, present regeneration, potential regeneration, canopy structure, number of cavities within the area, habitat value of the tree, mast production, and objectives of the compartment prescription. The compartment prescription designates how much timber volume or basal area to remove during a treatment, but the application of the prescription occurs during timber marking.

The timber sale must satisfy certain conditions to be operable by a contractor. For present market conditions, the following guidelines apply to timber sales open to formal competitive bidding; adjustments may be necessary if significant changes in the economy occur. Total sales' volumes could be less in the case of a negotiated sale; however, the average volumes per acre would remain essentially unchanged.

For commercial application of forest management, the total sale volume of pine sawtimber should not be less than 50,000 board feet, with an average of not less than 2,000 board feet per acre. The total volume of pine pulpwood sales should not be less than 50 cords, with an average volume of not less than 2 to 3 cords per acre. The minimum sale volume of hardwood sawtimber is around 50,000 board feet, with at least 1,000 to 1,500 board feet per acre. Total sale volume of hardwood pulpwood should not be less than 100 cords, with the minimum of mixed (pine and hardwood) sawtimber at least 50,000 board feet, and the average volume for such a sale should not be less than 1,200 feet per acre.

Pine saw timber must have a minimum DBH of 10.0 inches and a minimum merchantable length of 12 feet.

The upper limit of merchantability is defined as:

1. A minimum top diameter inside bark of 7.0 inches, or
2. The point in the upper stem at which excessive taper occurs. Excessive taper is generally associated with these limits:
   a. A stem defect.
   b. A limiting whorl. A limiting whorl is branches, at least 1 inch in diameter, radiating from 3 or more faces and situated within a 6-inch vertical span, where the sum of their diameters equals or exceeds 1/2 of the outside stem diameter at the point of occurrence. The term “branch” shall mean live branches or dead branches that still show remnants of branch endings.
   c. If a usable 8-foot or longer section occurs above either (a) or (b) above, take the merchantable height to the top of this section. A usable section is one not having the characteristics of (a) or (b) and not limited by diameter.
   d. Occasionally, there may be two limiters with a usable 8-foot or longer section above them. If the two limiters occur within a vertical 4-foot span, take the merchantable height to the top of the next usable section. Otherwise, measure to the first limiter.

Hardwood saw timber must have a minimum DBH of 10.0 inches and minimum merchantable length of 12 feet. The diameter of swell-butted species, such as bald cypress and water tupelo, shall be measured 1 1/2 feet above swell, when the swell is more than 3 feet high, instead of at DBH.

The upper limit of merchantability is defined as:

1. A minimum top diameter inside bark of 8 inches, or
2. The point at which the tree breaks into forks containing non-merchantable saw logs, or
3. One or more live limbs occurring within a vertical span of 1 foot, whose sum of diameter equals or exceeds 1/3 of the stem diameter outside the bark at that point, or
4. A stem deformity.

Pine pulpwood must have a minimum DBH of 5.0 inches and a minimum merchantable length of 10 feet. The upper limit of merchantability is defined as:

1. A minimum top diameter inside bark of 3.0 inches, or
2. That point at which stem deformity prevents utilization. If at least a full 5-foot usable section occurs above this point, take the merchantable height to the top of this section. A usable section is one that is reasonably straight and sound and whose small-end diameter equals or exceeds 3.0 inches. Inside bark hardwood pulpwood must have a minimum DBH of 6 inches and minimum merchantable length of 10 feet. The upper limit of merchantability is defined as:

1. A minimum top diameter inside bark (DIB) of 4.0 inches, or
2. That point at which stem deformity prevents utilization. If at least a full 5-foot section occurs above this point, take the merchantable height to the top of this section. A usable section is one that is reasonably straight and sound and whose small end diameter equals or exceeds 4.0 inches diameter inside bark.

Trees that fork immediately above DBH will be measured below the swell resulting from the double stem. The longest utilizable stem shall be measured for the merchantable height. Trees that fork below DBH shall be considered as two separate trees, and the diameters shall be measured or estimated 3 1/2 feet above the fork.

Timber harvest operations can occur anytime of the year; however, efforts should be made to avoid harvesting April – July. By restricting harvest activities to this time period, disturbance of bird nesting and breeding activities of most bird species should be minimized (per. com., Chuck Hunter, USFWS). Logging will also be restricted to dry periods of the year to keep soil disturbance and damage to residual vegetation at a minimum.

1.2 Logging Operations

Permanent roads for commercial timber harvest operations will be limited to existing roads only. This will help reduce fragmentation of the habitat and limit disturbance to soil and plants throughout the refuge. Road edges that receive direct sunlight may provide substantial amounts of soft mast (fruit), where otherwise closed canopy forests make this important food source rare (Perry et al. 1999). Edge habitats along roads may be important for reasons stated above, but should still be limited because of concerns of increased predation and parasitism of bird nests, and effects of roads on amphibian movements.

Logging operations will be allowed to use skidders, crawler tractors, and wheeled tractors to skid logs to loading areas where they are loaded onto trucks. Tree-length skidding will be allowed, but the trees must have the tops and all limbs removed before skidding. Removal of tops and limbs will reduce chances of damage to residual trees. Harvests should be avoided, when possible, outside of breeding season for birds (April-July), but management can be conducted during this period. Other special conditions and/or restrictions, as determined by refuge staff, may be stated in the Timber Sale Bid Invitation (Exhibit 3) and special use permit awarded to the highest bidder for the Timber Sale Bid.

In order to confirm harvest procedures and address any questions, a pre-entry conference will be held between the refuge manager and/or refuge forester, permittee, and the logging contractor, if different than the permittee. The permittee is to notify the refuge when harvesting operations begin and are completed.

Close inspection and supervision of all timber sales are necessary to ensure that harvesting operations meet the conditions of the special use permit and refuge objectives. Frequent inspections of harvesting operations will ensure that only designated trees are cut, and problems are rectified before becoming major issues. Timber harvesting operations may be suspended or restricted any time that continued operation might cause excessive damage to the forest stands, soil, wildlife habitat, or cultural resources. Reasons for suspension or restriction may include, but are not limited to periods of high wildfire potential, insects or disease hazard, times when harvesting may interfere with essential refuge operations, during periods of heavy rains or wet conditions which may cause rutting and erosion of soils,

when harvesting operations present a safety hazard, or when harvest operations reveal new or may damage existing cultural resources. Furthermore, operations may be suspended or terminated if the permittee violates the conditions of the special use permit.

When harvesting is complete, the refuge forester or designated refuge staff will inspect the site for compliance with all requirements of the contract. If any deficiencies are found, the permittee will be notified and given reasonable time to achieve compliance. If full compliance is achieved, the permittee's performance deposit will be returned in full. If not, an amount to mitigate damages will be deducted from the performance deposit and the remaining amount returned.

1.3 Monitoring

Upon completion of prescribed timber harvest operations, each treatment area will be monitored the next year, and every 5 years after, to see if desired results of the stand prescription have been met. Monitoring will consist of the refuge biologist walking through the treated area and taking basal area measurements at several points. This will help the refuge staff in determining what changes, if any, may be needed for future forest management prescriptions.

To monitor the impact of timber management activities on wildlife, annual avian point counts and herpetofaunal surveys will continue in those treatment areas where already in place. The information gathered from the bird-monitoring system assists in identifying the impacts of timber harvest on bird populations, as well as other wildlife species, before and after treatment.

The above monitoring efforts will help adapt timber management activities to the needs of the many plant and animal species utilizing the forested habitat of the refuge.

A good Geographical Information System (GIS) and Global Positioning System (GPS) database has been developed on the refuge. The current Refuge GIS database consists of various image files including Digital Orthophoto Quarter Quads (DOQQ's) from 1930s, 1998, 2008, 2010; Digital Raster Graphs (DRG's) of USGS topographic quad maps; and 10-15-30-meter resolution satellite images; 20-meter digital elevation model; 3-m resolution1996 and 2008 forest community database; 2d and 3d hydrological 1-meter resolution with 25cm depth digital elevation models. Shapefiles, from a variety of different state and federal agencies provide mapping layers for federal and state highways, local roads, county boundary lines, powerline and pipeline rights-of-way, private and public conservation boundaries, public and private ownership of all lands; and various other layers providing information about the area surrounding the refuge

For this plan, GIS shapefile layers have been developed on a local scale to reflect refuge management activities. To enhance the development of a GIS database that is specific to the refuge, GPS technology has, and will continue to be, used to establish compartment and stand boundaries, maps, cruise lines, treatment area maps and boundaries, monitoring programs, logging access routes, areas of special concern, refuge roads, forest cover types, map reforestation areas, and all other management activities related to habitat manipulation on the refuge.

To ensure the refuge is in compliance with the Forestry Best Management Practices (FBMP) manual regulations (http://ncforestservice.gov/publications/WQ0107/BMP_cover_TOC_Howto.pdf) concerning all forest management operations, there will be a 200-foot buffer

along the banks of Roanoke River NWR. Logging will be recommended during the summer and early fall, which are generally the driest times of the year, to reduce soil compaction and erosion potential. Logging access roads will be limited to existing woods' roads left over from previous ownership whenever possible. New road construction must be approved by the refuge manager. New road construction will be kept to a minimum and will not be maintained after the logging operation.

1.4 Archaeological and Cultural Resources

The Archaeological Resources Protection Act of 1979 obligated refuges to protect all sites of archaeological and historical significance. In 2002, a cultural resources reconnaissance of the refuge was conducted by Richard Kanaski, Southeast Region Cultural Resources Officer, NWRS. Presently, there are two archaeological sites that have been located on the refuge, both on the riverbanks. Flooding is slowly eroding the sites down and would not be impacted by any logging operations.

It is possible that forest management activities on the refuge could disturb some unknown archaeological site. To minimize the chance of such disturbances, the following actions will be taken:

1. All forest management prescriptions will be submitted to the regional archaeologist for approval prior to the start of any logging activities.
2. Logging will be limited to dry soil conditions, thus limiting soil disturbance and erosion.
3. Limit new road construction to reduce the chance of disturbance.
4. Cease logging operations and flag any suspected archaeological sites that may be discovered during logging operations.
5. Contact the regional archaeologist if any suspected archaeological sites are discovered and follow instructions given to protect the site until a thorough investigation of the site can be conducted.

1.5 Aesthetics

Aesthetic values fall under the category of wildlife observation, which is one of the six priority public uses of refuges designated in the National Wildlife Refuge System Improvement Act of 1997. Although aesthetic values vary from person-to-person, forest management activities will use the following guidelines to ensure that wildlife observation opportunities for the public are not impeded:

1. Keep logging loader sets at least 100 feet away from designated hiking trails.
2. Maintain a 200-foot buffer along the boundary of all major waterways where logging will not be allowed. Road construction, loader sets, and skidding of logs will also be prohibited within this buffer. All logging debris will be removed from within the buffer boundary.
3. Keep logging slash piles away from designated hiking trails.
4. Limit height of slash piles to less than 4 feet in logging areas and loader sets, unless otherwise directed for wildlife habitat improvement purposes.
5. Ensure all logging access roads are maintained and free of litter and debris while logging activities are in progress.

1.6 Forest Openings

Forest openings on the refuge will be managed as temporary openings. These are openings created during logging operations either as patch-cuts or loader sets. The patch-cuts, 1 to 3 acres in size, are designated during timber marking to develop temporary openings in the forest canopy large enough to encourage the development of shade intolerant plant species. Loader sets are areas opened up by the logging contractor for the loading of forest products onto trucks. Loader sets usually range in size from 1/4 - to 1/2- acre in size and soil disturbance is greater in these areas than any other areas within the timber sale area. In an effort to lessen the risk of soil erosion during wet periods in loader sets, these areas may be planted with winter grasses to serve as a temporary vegetative cover until normal vegetation has a chance to reclaim the site. Rotation of timber harvest areas between the forest compartments will allow for temporary openings to be created throughout the refuge on a continual basis, to replace older forest openings as they close up.

1.7 Insect and Disease

Insects and diseases that may affect the forested habitat on the refuge can be most effectively controlled by promoting stand conditions favoring healthy vigorous trees. Trees stressed by overstocking, flooding, drought, over-maturity, fire, etc., have an increased susceptibility to insects and diseases. Forest management activities, such as thinnings and group selection cuts, will help promote tree health and vigor by reducing competition and stocking as well as maintaining tree species diversity.

Most of the disease and insect damage found on the refuge presently is limited to individual trees or small groups and should not pose a threat to the health of the forest. The presence of tree diseases and insects is a normal occurrence in the forest. Many neotropical bird species forage on insects that damage trees, while other wildlife species forage on the conks and other fruiting bodies of various diseases. Portions of trees damaged by insects and diseases may eventually develop into cavities available for wildlife use.

Upon entry into a compartment, insect and disease damage will be evaluated and taken into consideration as part of the compartment cruise. In situations where insect and/or disease conditions are considered severe, the refuge forester will try to identify the problem and consult with the Forest Health Unit of the USDA Forest Service's Southern Region and the state's Division of Forest Resources for advice on how to effectively control the problem.

In the event of extensive disease or insect infestation, the refuge manager or refuge biologist may request an expedited treatment. This request must be approved at the regional level and should eliminate most of the formal prescription approval process, though sound biological and silvicultural principals will still apply. The formal bidding process for such treatments may be scaled back in order to expedite the treatment.

1.8 Timber Salvage and Unscheduled Harvesting

Salvaging damaged timber and dead or down trees following natural events, such as ice storms, tornadoes, disease/insect outbreaks, windstorms, and wildfires, is a common practice in forest management. Forest management on Roanoke River NWR will only consider salvaging timber to reduce fire hazards or prevent the likelihood of insect or

disease outbreaks. These natural events usually provide wildlife species with many habitat needs, such as snags for cavities, new denning locations, diversifying the canopy structure, increased plant diversity on the forest floor, etc. Unscheduled harvesting may need to occur to prevent the loss of timber due to outbreaks of insects or disease. If an outbreak of insects or diseases should occur, it may be necessary to enter into a compartment ahead of the entry cycle to stop or slow the outbreak.

Threatened and Endangered Species

The refuge currently has no listed species. An Intra-service Section 7 Consultation will be conducted before timber activities commence.

2. Administration of Sales

2.1 Conditions Applicable to Timber Harvesting Permits

1. A pre-entry conference between the appropriate refuge staff and the designated permittee representative will be a requirement before the purchaser starts logging operations. The purpose of the pre-entry conference is to be sure that the purchaser completely understands what is expected of him and thus avoids misunderstanding or serious conflict.
2. If requested, satisfactory scale tickets for timber products shall be submitted to the refuge forester.
3. Bottomland hardwood species will be cut so as to leave a stump not more than 18 inches high for sawtimber and pulpwood. Upland hardwood stump height shall not exceed 18 inches for sawtimber and 12 inches for pulpwood. Stump height for pine shall not exceed 12 inches for sawtimber and 6 inches for pulpwood-sized trees. All stump heights are measured at the side adjacent to the highest ground. In the case of swell-butted species or trees with metal objects in the butt, stumps may be higher.
4. Tree length skidding in sawtimber sales is prohibited, unless special conditions are permitted.
5. Ground level paint spots must remain visible after the tree has been cut. All marked trees are to be cut, unless otherwise approved by Service personnel overseeing the timber operation.
6. Trees and tops shall not be left hanging or supported by any other tree and shall be pulled down immediately after felling.
7. Tops and logging debris shall be pulled back 20 feet from public roads and lopped within 150 feet.
8. All roads, rights-of-way, fields, openings, streams, and firebreaks must be kept clear of tops and debris. Permittee shall also repair all damage to same resulting from operations conducted under this permit.
9. Littering in any manner is a violation of the Code of Federal Regulations. The entire work area shall be kept free of litter at all times. Repairs and cleanup work will be accomplished to the satisfaction of the refuge manager and/or refuge forester.
10. Additional trees removed to prepare loading sites will be paid for at bid prices. Unmarked trees, which are cut or injured through carelessness, shall be paid for at double the bid price.

11. The permittee will remove plugs, dams, and bridges constructed by the permittee upon completion of the contract. There are areas on the refuge where temporary plugs or dams in an intermittent stream will not be allowed. These areas will be indicated on sale maps.
12. Loading sets will be determined cooperatively between the refuge staff and permittee.
13. Ownership of all products remaining on a sale area will revert to the U.S. Government, upon termination of the permit.
14. The refuge manager and/or refuge forester shall have authority to temporarily close down all or any part of the harvest operation during a period of high fire danger, wet ground conditions, or for any other reason deemed necessary. An equal amount of additional time will be granted to the permittee.
15. The U.S. Government accepts no responsibility to provide right-of-way over private lands for materials sold under this contract.
16. The permittee and his employees will do all within their power to prevent and suppress wild fires.
17. The decision of the refuge manager shall be final in the interpretation of the regulations and provisions governing the sale, cutting, and removal of the timber covered by this permit.
18. When a timber sale area is adjacent to private land, all logging debris will be pulled back onto the refuge to avoid damage to private property.

2.2 Control Records

The primary purpose of records is to show progress made in fulfilling the habitat management plan objectives. These records include but are not limited to: compartment prescriptions, compartment geographical information system (GIS) maps, sale area GIS maps, timber sale contracts and special use permits, compartment timber volume tables, order of entry plan and progress reports, non-commercial treatments, wildlife information gathered by compartment, and data collected from bird counts conducted throughout the length of the Habitat Management Plan.

2.3 Sale Folders

A sale folder will be prepared and maintained for each individual timber sale. The folder shall contain copies of all data collected for the sale. This includes tally sheets, volume estimates, maps, bid invitation, special use permits, payment records, correspondence with permittee, sale compliance inspection notes, copies of deposit checks, payment transmittal forms, etc. The sale folder shall be kept in a separate folder within the compartment folder for each individual compartment, thus keeping all information pertaining to a compartment within a single file.

2.4 Bid Invitations

Commercial timber sales are the most practical method available for creating and maintaining desired forest habitat conditions. All timber sales will be conducted in accordance with the requirements listed in the Refuge Manual, and the guidelines and specifications detailed in the Roanoke River NWR's CCP, HMP, and compartment prescriptions.

Small sales (estimated receipts less than $2,500) will be negotiated as authorized by Service policies. The refuge forester will make a reasonable effort to obtain at least three bids from potential buyers. These bids will be documented and a permit will be issued to the successful bidder.

Larger timber sales (estimated receipts more than $2,500) will be conducted through a formal bid procedure. Invitations to bid will be prepared and administered by refuge personnel. Formal bid invitations will be mailed to all prospective bidders **(**Exhibit 2**).** Bid invitations will contain the following information:

1. A Formal Bid Information Form containing sales and estimated volume information.
2. A bid form, which the bidder fills out, signs, and returns to the refuge.
3. Maps giving general sales location information and detailing all sales units.
4. General conditions applicable to harvest of forest products.
5. Special conditions applicable to the timber sale.
6. Certificate of Independent Price Determination.
7. Equal Employment Opportunity Clause (Form 3-176).
8. Information on dates when prospective bidders can evaluate sales areas before bid opening.

2.5 Bids and Performance Deposits

For all bid sales, a bid opening date and time will be set to occur at refuge headquarters. All bids received prior to the opening time will be kept, unopened and locked in the refuge cashier's safe until the specified opening time. Any bids received after the specified opening time will not be accepted. The refuge retains the right to reject any and all bids, particularly those that are incomplete or otherwise unacceptable.

A deposit of $5,000 to $10,000 in the form of a cashier's check or money order made out to the U.S. Fish and Wildlife Service, must accompany all bids received through the formal bid process. The deposit amount will reflect the size of the sale and potential for damage. The amount of the deposit will be stipulated in the bid invitation. This deposit is to ensure the sincerity of the bidder's intention to purchase the offered sale at the bid price. In the event the successful bidder chooses not to purchase the offered timber, the bid deposit will be forfeited to the U.S. Government. When the successful bidder is named, all unsuccessful bidders' deposits will be immediately returned. The successful bidder's deposit will then become his performance guarantee deposit and will be retained by the government as such. Before the completion of the operation, the successful buyer will repair any and all damages caused by his operation. The performance guarantee deposit may be used to cover any un-repaired damages caused by the successful bidder, his agents, employees, or contractors. The balance of the deposit will be refunded to the successful bidder when the sale and all related repairs are completed.

Small sales through the negotiated process will also require a performance guarantee deposit to be received by the government prior to any timber harvest.

2.6 Special Use Permit

Upon selection of a successful bidder by the refuge manager, or designated representative, a special use permit will be issued containing information relevant to the timber sale, such as terms of payment, authorized activities, general and special conditions, and location map. The refuge manager or designated representative, upon receipt of payment, signs the permit, if the value is within their warranted authority. If the value is above that amount, an authorized representative of the Regional Director signs the special use permit.

2.7 Payment for Forest Products and Administration of Receipts

The permittee will have ten business days after notification of award of bidding to make total or partial payment (according to what is specified in the special use permit). Under no circumstances will harvest operations begin prior to receipt of payment. The purpose of an advance payment is to encourage the permittee to begin harvesting operations as quickly as possible. All payments will be in the form of a cashier's check or money order payable to the U.S. Fish and Wildlife Service.

For pay-as-cut sales, the buyer shall provide weekly scale totals and/or scale tickets along with a weekly payment. All receipts for forest products along with proper documentation will be forwarded the same day received to the Fish and Wildlife Service's Finance Center. Any receipts, that cannot be processed the same day received, will be stored in the refuge cashier's safe until processing can be completed. Presently, receipts for the sale of products of the land are deposited into the Revenue Sharing account at the Finance Center. Other arrangements can only be made in accordance with policy, regulations, and laws.

Refuges are authorized to enter into Timber for Land Exchanges. In this process, land within the approved refuge acquisition boundary may be purchased indirectly through exchange of normal timber sale volumes. Requirements for timber for land exchange sales are as follows:

1. Authority, which allows the Service to exchange timber for lands: National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-ee).
2. Lands acquired must be located within the approved refuge acquisition boundary. No preliminary project proposal or any other studies are required. The merit of the acquisition is a judgment call by the refuge manager.
3. Forest management plans are followed, and no deviation from planned schedules should be considered. No additional timber harvest is considered for the sole purpose of acquiring land.
4. The land is conveyed to the United States in exchange for refuge timber or other refuge products. The timber is transferred via special use permit, much the same as a timber sale. If timing requires the timber to be harvested prior to closing on the land, the permittee can make a performance deposit equal to the value of the deed. That deposit is refunded upon completion of the deed transfer.
5. The Service receives compensation for the timber when the third party acquires the subject property and conveys it to the United States.
6. The value of the land to be acquired, and the timber exchanged should be approximately equal or the value of the timber higher than the land. Any excess value of the timber can be made as a payment to the Service for the difference.

7. The Service's Division of Realty will be responsible for land appraisals, title insurance, reimbursement of relocation costs, and recording fees resulting from the conveyance of the property to the United States. These miscellaneous costs will be paid from Division of Realty funds.

A sequence of steps for a hypothetical timber for land exchange is as follows:

1. Refuge manager identifies areas within the approved refuge acquisition boundary for acquisition.
2. Refuge manager and Division of Realty determine if landowner(s) are willing sellers.
3. If seller is willing to sell, the refuge manager notifies the Regional Office (District Manager and Division of Realty).
4. Division of Realty contacts the landowner, orders the appraisal, and makes an offer to the landowner.
5. If the landowner is willing to sell, Division of Realty advises the refuge manager.
6. The Refuge Manager and Refuge staff shall determine which upcoming timber sales, awaiting the timber sale bid process, to use in the exchange.
7. Timber sales bids are sent out with a description of the responsibilities of the winning bidder pertaining to the timber for land exchange. This gives the bidders an opportunity to determine if they are willing to participate in the timber for land exchange. This also ensures that bidding for the timber is competitive.
8. The refuge manager selects the winning bidder following the normal timber sale bid process. The winning bidder is now referred to as the third party.
9. Division of Realty advises the landowner that the third party will intercede to acquire the subject property on the Service's behalf.
10. Division of Realty obtains an exchange agreement with the third party. The agreement (1) identifies and states the price of the subject property and (2) stipulates the volume and value of timber involved in the refuge's timber sale.
11. The third party acquires the subject property at the appraised value.
12. The third party conveys the subject property to the United States via a warranty deed. A special use permit is issued by the refuge manager, which specifies the requirements that must be followed by the third party while cutting on the refuge. The special use permit becomes part of the closing documents.
13. The third party completes logging operation within the specified time frame, as detailed in the special use permit.

Exhibit A: Roanoke River National Wildlife Refuge Timber Sale 200x-xx

SPECIAL CONDITIONS APPLICABLE TO TIMBER HARVESTING

Before starting logging operations, the refuge forester and the permit holder and his logging contractor will discuss the following special conditions. The goal of the following conditions is to protect the refuge forest from unnecessary damage. If the forest is logged carefully, it will look like a job well done, which will, in turn, lessen the chance of public disagreement with refuge forest management philosophy.

1. All timber marked with two spots of blue paint will be cut, except as otherwise agreed by both parties. The permit holder is subject to paying $700 per MBF for leave pine saw timber trees which are cut or excessively damaged through carelessness. The penalty for cut or excessively damaged hardwood leave trees will be $500 per MBF on saw timber and $25 per cord on pulpwood-sized trees.

2. Trees are to be cut so as to leave a stump not more than 12 inches high. In the case of swell-butted trees or trees with metal objects in the butt, stumps may be higher. The lowest practicable stumps that can be left are preferred on all trees.

3. Trees and tops shall not be left hanging or supported by any other living or dead tree and shall be pulled down immediately after felling. This applies especially to pines to lessen the chance for pine beetles.

4. Access roads for the removal of trees shall be coordinated with the refuge forester. See compartment 2 map for present road locations. Roads, rights-of-way, and stream beds must be routinely kept clear of tops and logging debris. The permit holder shall provide and install any necessary culverts in the sale area. Roads will be maintained regularly. To avoid excessive damage following heavy rains, loggers should be prepared to stop all hauling for at least one day. Excessive or extended rains may result in overly wet ground conditions that would prevent logging for an undetermined period of time. The refuge forester expects close cooperation from all logging crews. At the completion of sale, roads will be left in at least as good as original condition. Location of additional roads must be pre-approved by the refuge forester. Leave trees cannot be removed for access or loading sets without prior approval from the refuge forester. The permit holder shall promptly repair all damage resulting from operations conducted under this permit to the refuge forester's satisfaction.

5. There are a significant number of leave trees which can be protected by careful logging activity. Logging will be restricted to ground conditions dry enough to minimize rutting. Besides being unsightly, rutting will often damage the root systems of leave trees. Soft spots (e.g., springs and wet creek bottoms) will be avoided whenever possible. The majority of the area has ample room for skidding between leave trees without damaging leave trees. Skinning butts and damaging roots of all leave trees will be avoided as much as practicable. Whole tree skidding will be allowed where minimal damage to leave trees would be expected. Skidding of hardwoods with large crowns – potentially more damaging to leave trees – will be strictly controlled where excessive damage to leave trees is likely to occur. In general, hardwoods or pines with large crowns will be lopped prior to skidding.

6. The entire work area shall be kept free of litter at all times. Petroleum products must be properly disposed of and may not be dumped on the ground. Note: The logger agrees to remove soil contaminated by petroleum product spills from the refuge when directed by the refuge forester.

7. The refuge forester shall have the authority to temporarily close down all or part of the operation during a period of high fire danger or wet ground conditions. An equal amount of additional time will be given to the permit holder when necessary.

8. Should the permit holder's logging operation expose any archaeological or cultural resources, the logger will immediately cease operations in that area and notify the Service.

9. Logging contractors will do all in their power to prevent and suppress forest fires, and will be held liable for damages and suppression costs resulting from logging contractor-caused fires, except as may otherwise be allowed under state or federal laws.

10. Failure by the permit holder to meet any applicable conditions may result in penalties levied against the performance bond. The decision of the refuge manager shall be final in interpreting regulations and provisions governing the sale, cutting, and removal of forest products under this permit.

Exhibit B: Bid Form (Example)

BID FORM

Roanoke River National Wildlife Refuge Timber Sale 200x-xx

The following is my bid for the stumpage offered in this invitation.

Lump sum bid for compartment x **$**_____

Reminder: Don't forget to include the $10,000 good faith deposit with your bid. Without the good faith deposit, the bid will have to be automatically rejected.

I have inspected the sale area and trees designated for removal. If I am adjudged the successful bidder, I agree to accept the terms and special conditions of the permit agreement. I also agree to give at least two weeks' notice of my desire to move on site to start cutting. However, entry onto the area with logging equipment will not be allowed until the ground is sufficiently dried out as determined by the refuge forester.

Name of Firm: _____

Address: _____

_____Zip Code: _____

Signature of Bidder: _____Date: _____

Telephone: _____

Comments: _____

_____

_____

_____

Exhibit C: Bid Invitation (Example)

Roanoke River National Wildlife Refuge
114 West Water Street
Windsor, NC 27983
Telephone: 252-794-3808
FAX: 252-794-3780
[Date]

Roanoke River National Wildlife Refuge
Compartment x
Timber Sale 200x-xx

BID INVITATION

The purpose of this sale is to thin the forested area in a portion of compartment x to promote general forest health and understory/midstory development for wildlife.

To locate the sale area, see maps (Figures x and x). All trees to be cut were marked with blue paint. This will be a general thinning of [insert whether it is for pine or hardwood pulpwood or sawtimber] products on +/- xx acres. [Pine or hardwood] saw timber estimates are xxx MBF and [pine or hardwood] pulpwood estimate is xx cords (not including top wood). Close merchandising of timber products could cause the pine saw timber volume to be greater than the estimate.

NOTE: Much of the sale area has flat woods which are very wet much of the year because of a high water table. Dry ground conditions will be necessary to support logging equipment and log trucks.

A permit will be issued for cutting until [insert date]. Unusually wet summers and falls may allow for an extension. The extension, if granted, would be at the discretion of the refuge manager and refuge biologist.

Prospective buyers can contact the Service or contract forester [insert forester's name] at the above phone number if they want to arrange a visit to the sale area. Otherwise, buyers are free to go look at the timber unescorted.

Formal sealed bids will be accepted at the refuge office until 3:00 p.m., [date], for the sale of the marked timber. Bids will be opened at 3:05 p.m., [same date] at the Refuge Office which is located at 114 W. Water Street, Windsor, NC. The U.S. Fish and Wildlife Service (Service) reserves the right to reject any and all bids**.** The refuge may take up to five (5) working days before determining whether any of the bids will be accepted.

Each Bidder will submit with their bid a CERTIFIED OR CASHIER'S CHECK in the amount of $10,000 made payable to the U.S. Fish and Wildlife Service as a good faith deposit. The successful bidder's deposit will be retained by the Service and may be forfeited to the government if that bidder fails to accept and agree to execute the special use permit agreement.

After the permit agreement is finalized, the deposit will be retained by the Service as a performance guarantee to cover any damages or claims the Service may have against the permit holder as a result of the logging operation. The balance will be returned to the permit holder upon satisfactory completion of the operation. In the past most operators have been refunded the entire bond. The special use permit will be issued as a sale document to the buyer. The Service does not issue "timber deeds." All subsequent payments will also be made to the U.S. Fish and Wildlife Service.

Note: The successful bidder will be required to hold 10 percent of the lump sum in reserve for road repairs required by the refuge. The refuge manager will determine where repairs will be done. The timber buyer will pay for road repairs with this set aside money when notified by the refuge manager. As soon as the permit holder is notified that no more of the set aside funds are required for road repairs, the permit holder will be required to promptly submit payment to the U.S. Fish and Wildlife Service for the remaining set aside funds.

Bids mailed or hand delivered must be securely sealed in an envelope plainly marked:

"Bid: Roanoke River National Wildlife Refuge Timber Sale 200x-xx"

If you have any questions about this packet, feel free to call [name of refuge staff] at (252-794-3808) for additional information. If you're not planning on submitting a bid, a negative reply would be greatly appreciated.

Exhibit D: Certificate of Independent Price Determination

U.S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service

CERTIFICATE OF INDEPENDENT PRICE DETERMINATION
(101-45.4926 Fed. Prop. Mgt. Reg.)

(1) By submission of this bid proposal, each bidder or offeror certifies, and in the case of a joint bid or proposal each party thereto certifies as to its own organization, that is in connection with this sale:

(a) The prices in this bid proposal have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices, with any other bidder or offeror or with any competitor;

(b) Unless otherwise required by law, the prices which have been quoted in this bid or proposal have not been knowingly disclosed by the bidder or offeror and will not knowingly be disclosed by the bidder or offeror prior to opening, in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly to any other bidder or offeror or to any competitor; and

(c) No attempt has been made or will be made by the bidder or offeror to induce any other person or firm to submit or not to submit a bid or proposal for the purpose of restricting competition.

(2) Each person signing this bid or proposal certifies that:

(a) He is the person in the bidder's or offeror's organization responsible within that organization for the decision as to the prices being bid or offered herein and that he has not participated, and will not participate, in any action contrary to (1) (a) through (1) (c), above; or

(b) He is not the person in the bidder's or offeror's organization responsible within that organization for the decision as to the prices being bid or offered herein but that he has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated, and will not participate, in any action contrary to (1) (a) through (1) (c), above, and as their agent does hereby so certify; and

(c) He has not participated, and will not participate, in any action contrary to (1) (a) through (1) (c), above.

(3) This certification is not applicable to a foreign bidder of offeror submitting a bid or proposal for a contract, which requires performance or delivery outside the United States, its possessions, and Puerto Rico.

(4) A bid or proposal will not be considered for award where (1) (a), (1) (c), or (2), above, has been deleted or modified. Where (1) (b), above, has been deleted or modified, the bid or proposal will not be considered for award unless the bidder or offeror furnishes with the bid or proposal a signed statement which sets forth in detail the circumstance of the disclosure and the head of the agency, or his designee, determines that such disclosure was not made for the purpose of restricting competition.

Exhibit E: Equal Employment Opportunity Clause

During the performance of this contract, the contractor agrees as follows:

(1) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The contractor will, in all solicitations or advancements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(3) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the contractor's commitments under Section 202 of Executive Order No. 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) The contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

Appendix J. Continuous Forest Inventory Plots-Methodology

Continuous Forest Inventory Procedures
For
Roanoke River NWR

Introduction

The Habitat Management Plan (HMP) developed for the Roanoke River National Wildlife Refuge (NWR) contains a strong forestry component. The forest communities on the refuge are either monoculture stands, where one or two species dominate, or are in varying states of succession recovering from past cutting, where certain species were culled more heavily than others. The overall objectives of the HMP are to bring the forest communities found throughout the refuge back to a diverse, uneven-aged stand of functional forest that can provide habitat for those wildlife species known to utilize southeastern alluvial floodplain forest habitats. Different management techniques will be employed in order to achieve the objectives outlined in the HMP, ranging from thinning, group cut selection, and individual culling to passive management. The Forest Resource Conservation Working Group of the Lower Mississippi Valley Joint Venture published a document titled: *Restoration, Management and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat*. This document was referenced in the development of the habitat objectives in the HMP. Specifically, a section titled: *Management of Bottomland Hardwood Forests--The desired stand conditions for bottomland hardwood forests within the Mississippi Alluvial Valley* are outlined. The forest characteristics outlined are thought to provide preferred habitat for forest dwelling wildlife species. Forest attributes, ranging from percent of cover, basal area, regeneration, cavity trees, and coarse woody debris, are defined numerically and categorized as to conditions that are desirable to conditions where management action needs to be taken. Even though these forest characteristics were derived in the bottomland forests of the Mississippi Alluvial Valley, they should also be applicable to the bottomlands found throughout the Roanoke River due to the similar geomorphic processes that formed the landscape and similar structural characteristics of bottomland forests.

The habitat objectives in the HMP have been built around the forest variables outlined in the referenced Mississippi Alluvial Valley document. A target has been identified for each listed forest attribute. Forest management strategies have been developed to work toward achieving the different habitat objectives. To determine whether the forest habitat objectives are being met, a monitoring component has been built into the HMP. The Continuous Forest Inventory Plots (CFI) as developed at White River NWR in 2000, with modifications for Roanoke River NWR, will be used as the primary monitoring tool to determine how the different forest variables mentioned in the objectives compare to actual measurements in the field. This monitoring effort is to determine whether the objectives are being achieved by the prescribed management actions and also to gain a better understanding of forest dynamics over time.

The protocol outlined below is aimed at getting at the wildlife values of the forest ecosystem instead of the traditional merchantability of the timber. The protocol follows:

Methods

Permanent plots will be established throughout the refuge, with emphasis on the hardwood forest communities and less so on the tupelo/cypress swamps. Once established, and the first set of data recorded for each plot, the plots will be re-measured once every five years. Inventory configuration is based on a nested plot design, which includes five subplots arranged around a single plot center. Four of the subplots are located four chains in cardinal directions from plot center. The fifth subplot is located on plot center.

Location

The center plot locations will be determined from an unbiased grid pattern. Grid pattern is set up with plot centers 88 chains apart, both horizontally and vertically. Plot centers are located using a Garmin GPS unit in latitude/longitude, datum is NAD83. Plot centers are marked with stamped survey monument atop rebar. All subplot centers are marked with 1/2-inch rebar (minimum of 12 inches in length, and a 2-inch, right angle bend at the top). Three “witness” trees will be tagged at the base with aluminum tag and facing toward plot center.

Plot Characteristics

Characteristics of the site will be taken at each plot center and subplot center. Unless otherwise noted, make judgments of the following items as they occur on a 1/5-acre circular plot around the subplot center:

1. Stand Origin

   Planted
   Old Field
   Existing Forest (i.e., single-tree selection, diameter limit, clear-cut, etc.)

   Codes for stand origin are as follows:

   PLA - planted field
   OLF - old field (i.e., naturally regenerated)

   Existing Forest:

   SEL - selective thinning
   DIA - diameter limit
   GSE - group selection
   CLC - clear-cut
   UNK - unknown

2. Stand Structure

   1 - Early Succession<30 years old
   2 - Single Canopy

3 - Multiple Canopy
4 - Species Composition Simple, 1-2 species comprise>50% of BA
5 - Species Composition Complex, 3 or more species comprise >50% of BA
6 - Trees greater than 30” dbh present
7 - Trees greater than 30” dbh absent

3. Topographic Position

   Levee (Lev), Flat (FLA), Swale (SWA), Low Ridge (LRID), High Ridge (HRID), Swamp (SWP) or any combination

4. Down woody material within the plot and greater than 4” in diameter estimate cubic feet for entire plot.

5. Age: Take increment bore on a dominant or co-dominant tree and age to the nearest year. Core to be taken at breast height and add 2 years for hardwoods and 3 years on pine.

6. Growth: Measure most recent 10 years of growth on aged tree to 0.1”.

7. Flooding: Enter to the nearest foot the usual high water mark.

8. Damage: Record the dominant damaging factor in the plot area (e.g., wind, flood, wild hogs, and beaver).

9. Percent cover and dominant 2-3 species: May add to more than 100% due to overlapping layers.

   Overstory>30 feet
   Mid-story 10-30 feet
   Understory 4.5-10 feet
   Ground<4.5 feet

10. Total Height: Taken on dominant or co-dominant tree within 1/5-acre plot when possible, using clinometers, to nearest 5’. Also take height of any emergent (>75% of crown above general forest canopy) nearby.

11. Forest Type: Use types found in habitat management plan. Types for Roanoke River NWR are as follows:

    1 - Cypress
    2 - Tupelo
    3 - Cypress-Tupelo
    4 - Levee Forest
    5 - Low Ridges and Flats (oak)
    6 - Mixed Swamp Forest (flats)
    7 - Recent Successional/Shrub/Clear-cut
    8 - Sweetgum Bottomlands
    9 - Maple-Green Ash Bottomlands
    10 - Mixed Pine Deciduous

11 - Upland Deciduous
12 - Pine

12. Floodplain Inundation Zone (determine influence of dams). May have to refer to floodplain inundation maps or field check. Inundation zones are determined by releases of 5 days or greater.

Code	Inundation Zone
1	Floods <8,000 cfs
2	Floods 8,000 to 12,000 cfs
3	Floods 12,000 to 15,000 cfs
4	Floods 15,000 to 20,000 cfs
5	Floods 20,000 to 35,000 cfs
6	Floods > 35,000 cfs (disconnected from river)

Measurement Plot Arrangement

Plot measurement will be conducted as follows:

- Sawtimber size trees: 1/5-acre, fixed area, 52.7' radius, circular, plot center
- Pulpwood sixe trees: 1/25-acre, fixed area, 23.6' radius, circular, plot center.
- Shrubs: 1/100-acre, fixed area, 11.8' radius, circular, plot center.
- Vines: will utilize same plot as shrubs.
- Regeneration Potential: will utilize same plots as shrubs.
- Ground Flora: 1/500-acre, fixed area, 5.7' radius, plot center located 23.6 feet north and south, respectively, of plot center.

Sawtimber Plot Criteria

The following variables will be measured on the 1/5-acre plot, radius 52.7 feet:

- All live trees greater than 15 inches diameter at breast height.
- All dead trees greater than 15 inches diameter and at least 3 feet tall.

The following measurements will be taken for each live tree:

1. Witness

Code	Description
W	Witness trees are also sample trees.
WO	Trees that are witness only, and do not fall in the sample area(s).
A	Trees that were used to determine age.
AO	Trees that were used for age only, and do not fall in the sample area.

2. History - (*also record for dead trees)

Code	Type
1	New - new, live tree.
2	Re-measure - surviving, live tree measured on prior survey.
3	Harvested - tree recorded as live in prior survey, but harvested or killed by cultural treatments.

4	Dead - tree recorded as live in prior survey, but has since died by other than cultural treatments.
5	Snag - dead tree free standing or not in contact with the ground (i.e., lodged or leaning).
6	Missed tree - tree missed in prior survey, but now qualifying for measure.

3. Species – (*also record for dead trees)

Code	Description
XXXXXXX	A six character code, the first three letters of the genus, the first three of the species (e.g., Sugarberry = CELLAE).

4. Azimuth

Code	Description
XXX	Recorded to the nearest degree, azimuth scale, using compass with declination set for True North. In 2005, it is 5° West for eastern North Carolina.

5. Distance

Code	Description
XX	Recorded to the nearest 0.1-foot.

6. D.B.H – (*also for dead trees)

Code	Description
XX.X	Diameter at breast height recorded to lowest half-inch under existing vine structure. If taken over vines note with O/V.

7. Snag Classification and Degree of decline – (*measure for live and dead trees)

Code	Description
1	Nearly all limbs live, only minimal mortality of small, lower limbs.
2	<1/3 of crown dieback.
3	1/3 to 2/3 of crown dieback.
4	>2/3 of crown dieback.
5	Recently dead, retains all limbs.
6	Retains only large limbs.
7	Only bole > 16 feet remains.
8	Only bole < 16 feet remains.
9	Only stump 2 to 4.5 feet remains.

8. Tree class

Code	Type
ST	Sawtimber - Minimum dbh of 15 inches, minimum log length 8 feet, and top dob of 12 inches or greater.

PW	Pulpwood - Minimum dbh of 8 inches, minimum length of 16 feet, minimum top dob of 4 inches or greater, and maximum height of 20 inches.
IM	Immature - saplings with a minimum d.b.h. of 5 inches and less than 8 inches.
CU	Cull - tree that possesses a merchantable dbh, but does not meet minimum merchantability standards and does not have the potential to in the future, and offers no particular benefit to wildlife in its current position.
SH	Shrub - a generally small woody plant that exhibits several erect, spreading, or prostrate stems and has a bush appearance; occupies the understory or midstory, or occasionally the lower strata of the canopy.
WL	Wildlife Tree - an uncharacteristic tree that exhibits traits that are particularly beneficial to wildlife (i.e., large quantity mast producing capability, multiple cavities, large limbs).

9. Merchantable Height

Code	Description
XX	Recorded only for merchantable individuals to nearest half-log.

10. Crown class

Code	Type
1	Dominant - tree with crown extending above the general level of the crown cover and receiving full light from above and partly from the side; larger than the average trees in the stand and with crowns well-developed, but possibly somewhat crowded on the sides.
2	Co-dominant - trees with crowns forming part of the general level of the crown cover and receiving full light from above, but comparatively little light from the sides; usually with medium-sized crowns more or less crowed on the sides.
3	Intermediate - trees shorter than those in the two preceding classes, but with crowns either below or extending into the crown cover formed by co-dominant trees, receiving little direct light from above, and none from the sides; usually with small crowns considerably crowded on the sides.
4	Overtopped - trees with crowns entirely below the general level of the crown cover, receiving no direct light either from above or from the sides.
5	Unrestricted growth pattern - trees with crowns that received full light from above and from all sides throughout most of the life of the tree, particularly during its early developmental period.
6	Super-emergent - tree with crown extending above the general level of the dominants and co-dominants; larger than the average trees in the stand, and with crowns well-developed, generally extending roughly 20 feet (or 25%) or more above dominant and co-dominant trees.

Vine Codes

Code	Description
C	Canopy - vines that extend into the general overstory
M	Midstory - vines that extend into the midstory
U	Understory - ground layer below 4.5 feet

1. Total Height

Code	Description
XXX	Record total height of the first specimen measured of each crown class in 5' size class.

2. Cavities – (*also record for dead trees)

First Code

(size)	Type
1	< 2 inch potential cavity
2	2 to 4 inch potential cavity
3	4 to 12 inch cavity
4	12 inch or greater
5	Hollow*

* a tree is considered to have a hollow when the internal hollow space is three or more times longer than the dbh of the tree or five feet or more in length. If there is no opening to the hollow record the height of the largest opening to the hollow. Also, record the opening size as a second number.

Record the height of the cavity as the second code, separated by a period from the first code.

Second Code

(height)	Description	Alternative
.0	0 – 5 feet	1. Basal (ground up to 5 feet)
.1	5 – 15 feet	2. Mid-level (5 – 30 feet)
.2	15 – 25 feet	3. Canopy (30 +; typically above first limb)
.3	25 – 35 feet	
.4	35 – 45 feet	
.5	45 – 55 feet	
.6	55 – 65 feet	
.7	65 – 75 feet	
.8	75 – 85 feet	
.9	85 – 95 + feet	

Face:		
	N	North
	E	East
	W	West
	S	South

For trees with multiple cavities, record each size once and then the height(s) for each size class.

Example: 2.340E represents 3 separate cavities on the east side of the tree that all have an opening of 2 to 4 inches. The heights of the cavities are 25 to 35 feet, 35 to 45 feet, and 0 to 5 feet, respectively.

3. Damage - (* also record for dead trees)

** Record damage as M=minor, I=intermediate, E=extensive. Minor is visible damage which does not adversely affect the tree; intermediate is visible damage which will adversely affect the tree; extensive immediately threatens the life of the tree.

Code	Type
1	Weather
2	Animal
3	Disease
4	Human Induced
5	Water
6	Insect
7	Form (suppression/stagnation)

Pulpwood Plot Criteria

The following trees will be measured on the 1/25-acre plot (23.6 feet radius):

- All live trees greater than 5 inches in diameter at breast height that were not sampled on the sawtimber plot.
- All dead trees greater than 5 inches in diameter and at least 3 feet tall that were not sampled on the sawtimber plot.

The following measurements will be taken for each qualifying tree:

1. Witness
2. History
3. Species
4. Azimuth
5. Distance
6. DBH
7. Decay
8. Form
9. Merchantable Height
10. Cavities
11. Damage

Refer to description of measurements found in sawtimber plot criteria section, with exception of merchantable height; merchantable height estimated in 2-foot increments.

Shrub Plot Criteria

The following trees or woody vegetation will be measured on the 1/100-acre plot (11.77-foot radius):

- All vegetation greater than 4.5 feet tall that was not sampled on sawtimber or pulpwood plots.
- All dead vegetation greater than 2 inches in diameter and greater than 4.5 feet tall that was not sampled on sawtimber or pulpwood plots.
- Species/Species Group
  - Stems (record number of stems present in the specimen group)
  - Cavities
  - Decay

Record percent of plot covered for each species rooted within the plot.

Regeneration Potential

The following regeneration on 1/100-acre plot will be measured:

- Species
- Height
- Diameter for each individual in plot

Tally should include stem count by species and size class (i.e., <1', 1'-2.9' and > 3').

Point system

- 1 point for each tree <1.0'
- 1 points for each tree 1.1 to 2.9'
- 1 points for each tree >3' but less than 5" dbh

Ground Flora Plot Criteria

All vegetation will be measured with a total height less than 4.5 feet

- Classification (i.e., Cane, Grass, Forb, Vine, Fern, Woody (trees/shrubs<1.5')
- Percent Cover
- Dominant Species

Record percent cover for each vegetation class rooted within the plot.

- 1% = .87-square foot
- 5% = 4.3 square feet
- 10% = 8.7 square feet
- 20% = 17.4 square feet

Appendix K. Environmental Action Statement

U. S. FISH AND WILDLIFE SERVICE

ENVIRONMENTAL ACTION STATEMENT FOR CATEGORICAL EXCLUSION

Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA), and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and determined that the following action is categorically excluded from NEPA documentation requirements consistent with 40 CFR 1508.4, 516 DM 2.3A, 516 DM 2 Appendix 1, and 516 DM 6 Appendix 1.4.

Action and Alternatives. The action is the approval and implementation of the Habitat Management Plan (HMP) for Roanoke River National Wildlife Refuge (NWR). This HMP is a step-down management plan providing the refuge manager with specific guidance for implementing goals, objectives, and strategies identified in the Comprehensive Conservation Plan for Roanoke River National Wildlife Refuge (2005).

The Comprehensive Conservation Plan (CCP) action is the preferred alternative among three alternatives considered in the Final Environmental Impact Statement. In the CCP, the preferred alternative states that: *"The FWS will protect, maintain, restore, and enhance refuge lands for resident wildlife, waterfowl, migratory nongame birds, and threatened and endangered species. The refuge staff will initiate extensive wildlife and plant census and inventory activities to develop the baseline biological information needed to implement management programs on the refuge. The refuge will direct all management actions toward achieving the refuge's primary purposes: (1) Conserving nesting and migratory habitat for neotropical migratory songbirds; (2) providing production habitat for wood ducks; and (3) helping to meet the habitat conservation goals of the North American Waterfowl Management Plan. In addition, the staff will manage the refuge to contribute to other national, regional, and state goals for protecting and restoring populations of wildlife. The refuge will implement active habitat management through forest management and beaver pond management designed to provide a historically diverse complex of habitats that meet the foraging, resting, and breeding requirement for a variety of species."*

The CCP has defined goals, objectives, and strategies to achieve the stated action. The actions further detailed in the HMP have been identified, addressed, and authorized by the CCP for Roanoke River NWR. These include:

- Bottomland Hardwood and Hydrologically Disconnected Floodplain Forest Management Strategy: "Develop and implement a habitat management plan that will restore plant diversity to previously logged areas within 10 years. The following techniques will be considered: thinning to create favorable understory structure, creating tree fall gaps, and thinning to selectively manage for target species." Stated in the CCP Bottomland Hardwoods Habitat Objective 1 (pages 74 and 75).
- Tupelo-Cypress Forest Management Strategy: "Develop and implement a habitat management plan that will restore plant diversity to previously logged areas within 10 years. The following techniques will be considered: thinning to create favorable

conditions for regeneration, retaining trees with cavities and hollow bases, and thinning to selectively manage for target species." Stated in the CCP Tupelo/Cypress Habitat Objective 4 (pages 76 and 77).

- Waterfowl Management Strategy: "Manipulate water levels and vegetative cover in forested impoundments to provide wintering waterfowl habitat." Stated in CCP Objectives (pages 71 and 72).
- Chemical Management Strategy: "Improve plant communities and limit impacts to refuge resources by monitoring and controlling pest plants…." Stated in CCP (page 93).
- Pest Species Strategy: Beaver, nutria, feral pigs. "…develop a proactive approach to developing and implementing a plan to monitor and control pest animals. Control beaver damage to allow for healthy bottomland hardwood forests." Stated in the CCP Land Protection Objectives 6 and 7 (Page 92).

CATEGORICAL EXCLUSION(S)

Departmental Manual [516 DM 6, Appendix 1, 1.4 B (10)], states: *"the issuance of new or revised site, unit, or activity-specific management plans for public use, land use, or other management activities when only minor changes are planned. Examples could include an amended public use plan or fire management plan."* These would applicable to implementation of the action.

Consistent with Categorical Exclusion (516 DM 6, Appendix 1, Section 1.4 B (10)) the HMP is a step-down management plan which provides guidance for implementation of the general goals, objectives, and strategies established in the CCP, serving to further refine those components of the CPP specific to habitat management. The HMP does not trigger an Exception to the Categorical Exclusions listed in 516 DM 2, Appendix 2.

Minor changes or refinements to the CCP in this activity-specific management plan include:

- Habitat management objectives are further refined by providing numerical parameter values that more clearly define the originating objective statement.
- Habitat management objectives are restated so as to combine appropriate objectives or split complicated objectives to provide improved clarity in the context of the HMP.
- Specific habitat management guidance, strategies, and implementation schedules to meet the CCP goals and objectives are included (e.g., location, timing, frequency, and intensity of application).
- All details are consistent with the CCP and serve to provide the further detail necessary to guide the refuge in application of the intended strategies for the purpose of meeting the habitat objectives.

PERMITS/APPROVALS

Endangered Species Act, Intra-Service Section 7 Consultation was conducted during the CCP process. The determination was a concurrence that the CCP will not likely adversely affect the shortnose sturgeon or any other federally listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for federal listing under the Endangered Species Act, as amended (signed December 10, 2004, Roanoke River National Wildlife Refuge Comprehensive Conservation Plan, pages 204-206).

Other Items that can be found in the Environmental Impact Statement accompanying the CCP include:

- Executive Orders 11988 (Floodplain Management) 11990 (Protection of Wetlands)
- Form DI-711, Intergovernmental Notice of Proposed Action, March 29, 2006
- National Historic Preservation Act, Protection of Cultural Resources, March 29, 2006

PUBLIC INVOLVEMENT/INTERAGENCY COORDINATION

The HMP is a step-down plan of the approved CCP for Roanoke River NWR. The development and approval of the CCP included appropriate NEPA documentation and public involvement. A draft Environmental Impact Statement was developed (Draft CCP and EIS 2004), which proposed and addressed management alternatives and environmental consequences. Public involvement included public notification (Notice of intent in the Federal Register and Notice of availability also published in the Federal Register 2004) and news releases (Bastrop Daily Enterprise, Ruston Leader, Farmerville Gazette, Monroe The News-star, KEDM 90.3FM, KJLO 104 FM, KNOE 102 FM), public scoping (public meetings May 15, 2005, Windsor, North Carolina, and May 16, 2005, Halifax County Agricultural Center, Halifax, North Carolina), and public review (50-day availability period: March 30, 2005-July 18, 2005). The attendance at the public meetings was fair—one federal, four state, and one local (city and county) agency representatives attended, five non-governmental organization representatives attended, and one business representative attended; no public citizens attended. Written comments were submitted by fifteen members of the general public and two organizations. No comments were submitted by other federal agencies. Refer to CCP for specific comments and Service response.

SUPPORTING DOCUMENTS

Supporting documents for this determination include relevant office file material and the following key references:

- U.S. Fish and Wildlife Service. 2009. Roanoke River National Wildlife Refuge, Fire Management Plan.
- U.S. Fish and Wildlife Service. 2009. Water Management Plan for the Askew Impoundment Project.
- U.S. Fish and Wildlife Service. 2005. Roanoke River National Wildlife Refuge, Comprehensive Conservation Plan.
- U.S. Fish and Wildlife Service. 2005. Roanoke River National Wildlife Refuge, Environmental Impact Statement for the Draft Comprehensive Conservation Plan.

Matt Connolly, Refuge Manager — Date: 7/15/12

Mike Bryant, Project Leader — Date: 7/18/13

Richard Warner, Regional Refuge NEPA Coordinator — Date: 7/19/2013

David Viker, Regional Chief, Southeast Region — Date: 7-19-13

Habitat Management Plan for
Roanoke River National Wildlife Refuge

U.S. Fish and Wildlife Service
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