

HABITAT MANAGEMENT PLAN FOR
**ERNEST F. HOLLINGS ACE BASIN
NATIONAL WILDLIFE REFUGE**

Beaufort, Charleston, Colleton, and Hampton Counties, South Carolina

Southeast Region



Ernest F. Hollings ACE Basin National Wildlife Refuge

Habitat Management Plan



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

March 2014

Submitted by: _____
Larry Hartis, Refuge Biologist, ACE Basin NWR

Date: _____

Submitted by: _____
Mark Purcell, Refuge Manager, ACE Basin NWR

Date: _____

Concur: _____
Chuck Hunter,
Division Chief of Strategic Resource Management,
Southeast Region

Date: _____

Concur: _____
Elizabeth Souheaver, Area Supervisor, Southeast Region

Date: _____

Approved by: _____
David Viker, Regional Chief, Southeast Region

Date: _____

Table of Contents

HABITAT MANAGEMENT PLAN

Chapter I. Introduction.....	10
Scope and Rationale	10
Refuge Vision	11
Legal Mandates.....	11
Relationship to Other Plans	12
Ecosystem Context.....	16
Chapter II. Background, Inventory and Description Of Habitat	18
Location.....	18
Management Unit Descriptions.....	18
Physical or Geographic Setting.....	19
Historic Habitat Conditions	23
Current Habitat Conditions	24
Habitat Changes from Historic to Current Condition	30
Changes Associated with Global Climate Change	31
Chapter III. Resources Of Concern	36
Endangered, Threatened and Imperiled Species.....	36
Wintering Waterfowl	45
Wood Ducks (<i>Aix sponsa</i>)	48
Shorebirds.....	51
Wading Birds.....	53
Marsh Birds.....	55
Migratory Land Birds	57
Invasive and Nuisance species	61
Chapter IV. Habitat Goals and Objectives	66
Freshwater Moist-Soil Habitat Management Goal.....	66
Brackish Water Habitat Management Goal.....	69
Greentree Reservoir Habitat Management Goal.....	70
Natural Marsh Habitat Management Goal.....	71
Forested Upland Habitat Management Goal.....	72
Forested Wetland Habitat Management Goal.....	74
Early Successional/Grassland Habitat Management Goal	75
Chapter V. Habitat Management Strategies.....	77



Freshwater Moist-Soil Management	77
Brackish Water Management	81
Greentree Reservoir Management	84
Natural Marsh Management	85
Forested Uplands Management.....	88
Forested Wetlands Management.....	91
Early Successional/Grassland Management	95
Chapter VI. Management Strategy Documents	98
Necessary Resources	98
Documentation of Compliance.....	99
Documentation of Special Use – COMMERCIAL SALE OF TIMBER.....	100
Chapter VII. Literature Citations	110
APPENDICES.....	114
Appendix A. ACE Basin NWR Cover Type Maps: Compartments 1-9	115
Appendix B. Ace Basin NWR Cover Type Inventory: Compartments 1-9	124
Appendix C. ACE Basin NWR Cover Type Inventory Compartment Summary.....	133
Appendix D. Refuge Biota	134
Appendix E. Lower Mississippi Valley Joint Venture Guidelines for Desired Stand Conditions for Bottomland Hardwood Forests within the Mississippi Alluvial Valley.....	145
Appendix F. Timber Sales Exhibits.....	146
Appendix G. Environmental Assessment	154

List of Figures

Figure 1. Combahee Unit Map20
Figure 2. Edisto Unit Map.....21

List of Tables

Table 1. ACE Basin NWR HMP Planning Team.....11
Table 2. Compartment Summary Table, ACE Basin NWR19
Table 3. Summary of ACE Basin NWR Cover Type Acres25
Table 4. Forested Site Classification28
Table 5. Priority shore, wading, and marsh bird species and habitats for BCR 2752
Table 6. Priority land bird species and habitats for BCR 2758
Table 7. Proposed Habitat and Wildlife Population Management Projects99

CHAPTER I. INTRODUCTION

SCOPE AND RATIONALE

The statutory authority for conducting habitat management planning on National Wildlife Refuges is derived from the National Wildlife Refuge System Administration Act of 1966 (Refuge Administration Act), as amended by the National Wildlife Refuge Improvement Act of 1997 (Refuge Improvement Act), 16 U.S.C. 668dd - 668ee. Section 4(a)(3) of the Refuge Improvement Act states: "With respect to the National Wildlife Refuge System (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 Refuge Improvement Act provides the U.S. Fish and Wildlife Service (USFWS or Service) the authority to establish policies, regulations, and guidelines governing habitat management planning within the System.

The HMP is a step-down management plan of the Comprehensive Conservation Plan (CCP) for a refuge. The CCP describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purpose(s) of the refuge; helps fulfill the mission of the System; maintains and, where appropriate, restores the biological integrity, diversity, and environmental health of each refuge and the System; helps achieve the goals of the National Wilderness Preservation System, if appropriate; and meets other mandates. A CCP was approved for the Ernest F. Hollings ACE Basin National Wildlife Refuge (ACE Basin NWR or refuge) in September 2009. Appropriate information from the final CCP will be incorporated into this HMP.

HMPs comply with all applicable laws, regulations, and policies governing the management of the National Wildlife Refuge System. The lifespan of an HMP is 15 years and parallels that of refuge CCPs. HMPs are reviewed every 5 years and revised every 15 years or, based on peer review recommendations, sooner if appropriate. Annual Habitat Work Plans (AHWP) are developed from HMPs and contain management specifics.

In March 2004, a first and only comprehensive biological review of the refuge was conducted by a team of 14 biologists. Participants in the biological review were drawn primarily from the refuge, the USFWS, the Nemours Wildlife Foundation, Ducks Unlimited, and the South Carolina Department of Natural Resources (SCDNR). Two years later a final report, the ACE Basin National Wildlife Refuge 2006 Final Biological Review (Biological Review) was completed and approved (USFWS 2006). The Ace Basin NWR CCP was developed from that Biological Review and this HMP is a step down plan of the CCP.

Initial drafts of the ACE Basin NWR HMP as step-downs from the CCP were begun in late 2009 and continued with revisions into 2011.

Table 1. ACE Basin NWR HMP Planning Team

Name and Title	Affiliation
Mark Purcell, Refuge Manager	USFWS, ACE Basin NWR
Larry Hartis, Wildlife Biologist	USFWS, ACE Basin NWR
Brett Craig, Wildlife Refuge Specialist	USFWS, ACE Basin NWR
Bryan Woodward, Park Ranger	USFWS, ACE Basin NWR
Melissa Pope, Office Assistant	USFWS, ACE Basin NWR

REFUGE VISION

Established in 1990, the ACE Basin NWR provides resources for migratory birds, endangered species and compatible public uses. Through a motivated, experienced, and well-trained staff and volunteers and with active participation of partners, the refuge will strive to maintain its unique ecological landscape features and be an active partner to achieve the goals and objectives of the ACE Basin Project, originally a 350,000 acre estuary/ecosystem conservation partnership, now 1.2 million between State, Federal, corporate, private land owners and non-governmental organizations. Through team development, the refuge will strive to be a model of excellence in natural resource management and celebrate our achievements with the public and our partners. The management of wildlife and habitat on the refuge will be an adaptive, science-based, comprehensive endeavor that links biological needs with resource management. The refuge will actively seek to expand partnerships to further conservation stewardship and protection of natural resources. We will actively seek research to support the informational needs of the refuge, being able to adapt and being responsive to change including the recent awareness of climate shifts. We will seek and develop appropriate and compatible public use opportunities and enhance awareness and appreciation of the refuge and National Wildlife Refuge System. Through outreach and public participation, the neighboring communities within the ACE Basin Project area will share our values for the National Wildlife Refuge System and a fish and wildlife heritage for all Americans.

LEGAL MANDATES

The ACE Basin National Wildlife Refuge was established on September 20, 1990 and was renamed the Ernest F. Hollings ACE Basin National Wildlife Refuge (ACE Basin NWR) on May 16, 2005 in honor of South Carolina's retired U.S. Senator Ernest F. Hollings. The ACE Basin NWR is located within the 1.2 million acre Ashepoo–Combahee–Edisto (ACE) Basin Project. The ACE Basin Project is widely recognized as a unique and critical environment marked by a wide diversity of wildlife and plants and representing the largest estuarine resource in South Carolina. The refuge is a partner in the ACE Basin Task Force, a coalition consisting of the U.S. Fish & Wildlife Service, South Carolina Department of Natural Resources, Ducks Unlimited, The Nature Conservancy, The Low Country Open Land Trust, Mead Westvaco and private landowners of the ACE Basin Project. Recognizing the importance of the area for wetland and habitat protection, migratory bird benefits and conservation opportunities served by the lands and waters of the refuge, the Service administratively designated ACE Basin NWR in 1990 under the Emergency Wetlands Resources Act of 1986, the Fish and Wildlife Act of 1956, and the Migratory Bird Conservation Act of 1929, thus outlining the primary purposes of these lands and waters:

"...the conservation of the 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. 3901(b) (Emergency Wetlands Resources Act of 1986)

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. 742f(a)(4) (Fish and Wildlife Act of 1956)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956)

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act of 1929)

"...to conserve and protect migratory birds...and other species of wildlife that are listed...as endangered species or threatened species and to restore or develop adequate wildlife habitat." 16 U.S.C. § 715i (Migratory Bird Conservation Act of 1929)

So important to waterfowl are these wetland areas that the North American Waterfowl Management Plan identified the ACE Basin Project as one of two "flagship" projects within the Atlantic Coast Joint Venture. A task force at that time consisting of the U.S. Fish and Wildlife Service, the South Carolina Wildlife and Marine Resources Department, Ducks Unlimited, The Nature Conservancy, and private landowners in the ACE Basin Project, was established to coordinate efforts and identify the best options for accomplishing the over-all goal of protection of the area. The task force identified several options for accomplishing this, one of which was that the establishment of a National Wildlife Refuge would be necessary for the success of the Joint Venture project.

The primary purpose of the refuge is to preserve a nationally significant wildlife ecosystem that will provide a complex of habitats for wintering waterfowl, endangered species, other migratory and resident birds, mammals, reptiles, amphibians, and plants. The refuge acquisition boundary currently includes approximately 18,000 acres.

RELATIONSHIP TO OTHER PLANS

Multiple partnerships have been developed among government and private entities to address the environmental problems affecting regions. There is a large amount of conservation and protection information that defines the role of the refuge at the local, national, international, and ecosystem levels. Conservation initiatives include broad-scale planning and cooperation between affected parties to address declining trends of natural, physical, social, and economic environments. The conservation guidance described below in international initiatives, national plans, regional plans, ecosystem goals, and local project missions, along with issues, problems, and trends, was reviewed and integrated where appropriate into the CCP and this HMP.

North American Bird Conservation Initiative. Started in 1999, the North American Bird Conservation Initiative (NABCI) is a coalition of government agencies, private organizations, academic institutions, and private industry leaders in the United States, Canada, and Mexico working to ensure the long-term health of North America's native bird populations by fostering an integrated approach to bird conservation to benefit all birds in all habitats. The four international and national bird initiatives that follow include the North American Waterfowl

Management Plan, Partners-in-Flight North American Landbird Conservation Plan, North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan.

North American Waterfowl Management Plan. The North American Waterfowl Management Plan is an international action plan to conserve migratory birds throughout the continent. The plan's goal is to return waterfowl populations to their 1970s' levels by conserving wetland and upland habitat. Canada and the United States signed the plan in 1986 in reaction to critically low numbers of waterfowl. Mexico joined in 1994, making it a truly continental effort. The plan is a partnership of federal, provincial/state and municipal governments; non-governmental organizations; private companies; and, many individuals, all working toward achieving better wetland habitat for the benefit of migratory birds, other wetland-associated species and people. Plan projects are international in scope, but implemented at regional levels. The refuge contributes by protecting migratory birds, other species associated with wetlands, and their habitats thereby contributing to the protection of habitat and wildlife species across the North American landscape.

Partners-in-Flight North American Landbird Conservation Plan. This plan provides a continental perspective on North American landbird conservation, presenting geographic, species, and habitat priorities. An international approach is essential because most species breed, migrate, and winter in more than one country, such that Canada, the U.S., and Mexico share many of the same birds at different times of year. Migratory birds are an international resource that requires conservation planning at a continental scale and beyond. This is a different approach from that suitable for non-migrating wildlife. Managed as a regional step down of this plan, the Southeastern Coastal Plain Partners in Flight Bird Conservation Plan (containing Bird Conservation Region 27 physiographic area) represents a scientifically based land bird conservation planning effort that ensures long-term maintenance of healthy populations of native, primarily non-game, land birds. Management of refuge habitats will, whenever possible, support the priority species of BCR 27. Non-game land birds have been vastly under-represented in conservation efforts and many are exhibiting significant declines. This plan is voluntary and non-regulatory, and focuses on relatively common species in areas where conservation actions can be most effective, rather than the frequent local emphasis on rare and peripheral populations.

An additional physiographic division in the regional approach is the South Atlantic Migratory Bird Initiative (SAMBI), a southern coastal portion of the larger Atlantic Coast Joint Venture area. SAMBI proposes to deliver a habitat conservation strategy for the conservation of "all birds across all habitats," consistent with and complimentary to international, national, regional, and local migratory bird planning efforts. This conservation strategy is based on a strong biological foundation and fostering partnerships at all levels of implementation (international, national, regional, local) through a strong network of conservation partners, including federal, state, non-governmental organizations, and private landowners. SAMBI also proposes to integrate planning efforts between the four major migratory bird planning initiatives; North American Waterfowl Management Plan, Partners In Flight, United States Shorebird Conservation Plan, Waterbird Conservation for the Americas; and, other single species bird conservation initiatives (e.g. Northern Bobwhite Conservation Initiative) seeking common goals and objectives for habitat conservation to sustain, maintain, and increase populations of resident, migrating, and wintering birds in the SAMBI area.

U.S. Shorebird Conservation Plan. The U.S. Shorebird Conservation Plan is a partnership effort throughout the United States to ensure that stable and self-sustaining populations of

shorebird species are restored and protected. The plan was developed by a wide range of agencies, organizations, and shorebird experts for separate regions of the country, and identifies conservation goals, critical habitat conservation needs, key research needs, and proposed education and outreach programs to increase awareness of shorebirds and the threats they face. As a partner, the refuge integrates management actions designed to benefit shorebirds into the overall manipulation of managed wetlands throughout the refuge but more particularly during spring and fall in brackish impoundments. As a step down, the Southeastern Coastal Plains-Caribbean Shorebird Conservation Plan articulates what is needed in the Southeastern Coastal Plains and Caribbean Region to advance shorebird conservation. A separate Caribbean Shorebird Plan is under development and will be based in part on principles outlined in this plan. We identify priority species, outline potential and present threats to shorebirds and their habitats, report gaps in knowledge relevant to shorebird conservation, and make recommendations for addressing identified problems. This document should serve as a template for a regional strategic management plan, with step-down objectives, local allocations and priority needs outlined.

North American Waterbird Conservation Plan. This plan provides a framework for the conservation and management of 210 species of waterbirds in 29 nations. This group utilizes practically all habitats on the refuge except uplands. Refuge actions in support of the plan include management of hydrology in impounded wetlands, protection from disturbance for the species' utilizing the areas, and acquisition of additional wetland habitats. Threats to waterbird populations include destruction of inland and coastal wetlands, introduced predators and invasive species, pollutants, mortality from fisheries and industries, disturbance, and conflicts arising from abundant species. Particularly important habitats of the southeast region are pelagic areas, marshes, forested wetlands, and barrier and sea island complexes. Fifteen species of waterbirds are federally listed, including breeding populations of wood storks, Mississippi sandhill cranes, whooping cranes, interior least terns, and Gulf Coast populations of brown pelicans. A key objective of this plan is the standardization of data collection efforts to better recommend effective conservation measures. As a step down, the Southeastern United States Waterbird Conservation Plan will provide an outline or blueprint for guiding waterbird conservation in the Southeastern U.S. planning region to support the overarching goals presented in the continental plan. The Plan provides specific information about species and habitats in the region, describes major threats to waterbirds, and provides recommendations for explicit conservation actions that can be taken which contribute to meeting regional goals and objectives.

South Carolina Comprehensive Wildlife Conservation Strategy. The South Carolina Department of Natural Resources (SCDNR) is an important partner with the refuge in the effort to implement conservation strategies. In 2005, SCDNR published the South Carolina Comprehensive Wildlife Conservation Strategy. The goal of the Comprehensive Wildlife Conservation Strategy is to emphasize a cooperative, proactive approach to conservation while working with state and local governments, local businesses, and conservation-minded individuals to join in the effort of maintaining all of the wildlife resources of South Carolina. More than 50 high-priority species identified in South Carolina's Comprehensive Wildlife Conservation Strategy are expected to benefit as a result of this project. The refuge will actively seek to expand this kind of partnership to further conservation stewardship and protection of natural resources.

Local Conservation Plans and Initiatives

ACE Basin Project. The ACE Basin Project, of which the refuge is a part, was initiated in 1988, when Ducks Unlimited, Inc., The Nature Conservancy (TNC), the USFWS, the South Carolina Department of Natural Resources (SCDNR), and a number of private landowners came together and formed the ACE Basin Task Force. ACE stands for three major rivers in the basin—the Ashepoo, Combahee, and Edisto. The 1.2 million acre ACE Basin Project is one of the largest undeveloped estuarine-wetland ecosystems remaining along the U.S. Atlantic Coast. By the year 2013, more than 207,000 acres of the ACE Basin Project had been brought under various forms of conservation management.

The mission of the ACE Basin Project is to maintain the natural character of the area by promoting wise resource management on private lands and protecting strategic tracts through conservation agencies. A major goal of the protection efforts is to ensure that traditional uses such as farming, forestry, recreational and commercial fishing, and hunting will continue in the area.

Landscape Conservation Cooperatives

South Atlantic Landscape Conservation Cooperative.

The refuge intends to support landscape conservation cooperatives (LCCs) as conservation-science partnerships between the U.S. Fish and Wildlife Service, U.S. Geological Survey (USGS), and other federal agencies, states, tribes, NGOs, universities and stakeholders within a geographically defined area. The LCCs assist resource management decisions to address landscape-scale stressors that may include habitat fragmentation, genetic isolation, spread of invasive species, and water scarcity, all of which are accelerated by climate change. LCCs provide scientific and technical support for conservation at “landscape” scales, the entire range of an identified priority species or groups of species. They support biological planning, conservation design, prioritizing and coordinating research, and designing species inventory and monitoring programs. LCCs also have a role in helping partners identify common goals and priorities to target the right science in the right places for efficient and effective conservation. By functioning as network of interdependent units rather than independent entities, LCC partnerships can accomplish a conservation mission no single agency or organization can accomplish alone.

The South Atlantic Landscape Conservation Cooperative (SALCC) will facilitate conservation planning and design across state boundaries in the South Atlantic Coastal Plain and Piedmont physiographic provinces, from southern Virginia to northern Florida. The efforts of the SALCC will supplement the State Wildlife Action plans and provide better coverage for wider ranging species. It will also provide a broader geographic scale to address the effects of climate change and other critical challenges such as competition for water, wildlife disease, and exotic species invasion. The scientific and technical expertise provided by the SALCC will support a landscape-scale, collaborative approach to conservation. This expertise will assist the conservation community as they carry out the functional elements of Strategic Habitat Conservation. These functional elements are: biological planning, conservation design, conservation delivery, monitoring, and research. As the SALCC develops, the refuge will integrate the biological planning and conservation design that it provides into the refuge’s management program.

ECOSYSTEM CONTEXT

Savannah-Santee-Pee Dee (SSPD) Ecosystem. An ecosystem is a geographic area including all the living organisms (people, plants, animals, and microorganisms), their physical surroundings (such as soil, water, and air), and the natural cycles that sustain them. The U.S. Fish and Wildlife Service has adopted an ecosystem approach to conservation, of which the refuge is an active participant. Comprising one of the 53 ecosystems around the country, the U.S. Fish and Wildlife Service's SSPD Ecosystem includes the state of South Carolina, as well as the northeastern portion of Georgia, and the southwestern portion of North Carolina.

The SSPD Ecosystem encompasses approximately 52,500 square miles and is divided into four main physiographic provinces including the Blue Ridge Mountains, Piedmont, Carolina Sandhills, and Coastal Plain provinces. Two major types of river systems traverse these provinces. Alluvial rivers originate in the mountains and piedmont and include the Great Pee Dee, Savannah, Congaree, Wateree, Catawba, and Santee. Blackwater rivers originating in the coastal plain include the Cooper, Ashley, Edisto, Salkahatchie, Combahee, Ashepoo, New, Four Holes, Little Pee Dee, Waccamaw, Black, and Lumber. The SSPD Ecosystem includes several important areas with protective designations, including 14 National Wildlife Refuges, six National Forests, four National Fish Hatcheries, two National Estuarine Research Reserves, and more than 50 state parks.

A considerable acreage of tidal freshwater swamp and marsh are associated with these major river systems. In addition, the SSPD Ecosystem contains numerous palustrine wetlands that are isolated or contiguous with freshwater stream and river systems. The river basins drain into an extensive estuarine network of saltwater marsh with tidal creeks, inlets, and sounds intermixed with barrier, sea, and marsh islands. The estuarine system provides tremendous nursery grounds for commercially important fish and shellfish and fuels the base of the marine food chain.

The SSPD Ecosystem supports large populations of wading birds, marsh birds, shorebirds, waterfowl, game and non-game mammals, reptiles, amphibians, and anadromous fish. The habitats within the SSPD Ecosystem fall within the Atlantic migratory bird flyway. Forage, refuge, cover, and staging areas for a variety of migrating waterfowl, neotropical migrants, raptors, and shorebirds are provided. The several species of flora and fauna listed as federally endangered or threatened in the SSPD Ecosystem are indicators of the development pressures and habitat loss incurred. Approximately 37 animal and 31 plant species are listed as federally endangered or threatened within the SSPD Ecosystem. Numerous species of plants and animals that are candidates for listing are not currently receiving federal protection. Many federally protected species depend on the SSPD Ecosystem for some portion of their life cycle: such as Eastern cougar, West Indian manatee, red wolf, five species of whales, Carolina northern flying squirrel, Virginia big-eared bat, Indiana bat, bald eagle, peregrine falcon, wood stork, piping plover, red-cockaded woodpecker, Bachman's warbler, Eastern indigo snake, loggerhead and other sea turtles, shortnose sturgeon, Carolina heelsplitter, and many plant species.

The biggest problem facing the SSPD Ecosystem is the loss of habitat through direct destruction and fragmentation. The predominant stresses for the SSPD Ecosystem are: population growth, tourism, agriculture, silviculture, shipping ports, water channelization, urbanization, aquifer depletion, fire suppression, exotic species proliferation, non-point source pollution, and point source pollution. The SSPD Ecosystem Team is a group of stakeholders representing various land managers within the SSPD Ecosystem. They are elected and

charged with the direction of the SSPD Ecosystem approach. Their actions are guided by two considerations: trust resources and management issues. The trust resources include: migratory birds, anadromous fish, endangered species, and marine mammals. The management issues focus on: habitat protection and management, habitat restoration, contaminants, regulatory compliance, law enforcement, and biodiversity.

To address these threats, management issues, and needs of the trust resources, the SSPD Ecosystem Team pursues a mix of objectives under the following seven goals as denoted in the Ace Basin NWR CCP:

- To protect, restore and enhance the biodiversity of aquatic resources, wetlands and their associated habitats on a landscape scale.
- To recover and enhance endangered, threatened and species of special concern and the habitats upon which they depend.
- To protect, enhance and manage migratory bird populations and the habitats upon which they depend.
- To manage National Wildlife Refuges and National Fish Hatcheries to serve as models of effective conservation of natural resources.
- To increase and enhance public awareness, support and participation in carrying out the Service's mission through cooperative outreach efforts.
- To protect, enhance and manage interjurisdictional and diadromous fish populations and the habitats upon which they depend.
- To perpetuate healthy native plant and animal communities threatened by invasive native and non-native plants and animals.

CHAPTER II. BACKGROUND, INVENTORY AND DESCRIPTION OF HABITAT

LOCATION

The ACE Basin NWR is located within the 1.2 million acre Ashepoo, Combahee, Edisto (ACE) Basin Project. The ACE Basin Project is widely recognized as a unique and critical environment marked by a wide diversity of wildlife and plants and representing the largest estuarine resource in South Carolina. The refuge is composed of two primary units, together comprising approximately 11,909 acres. The Edisto Unit consists of 7,294 acres and is located approximately 20 miles southwest of the city of Charleston, SC in Charleston County (Figure 2). The Combahee Units consist of 4,615 acres in Beaufort, Colleton and Hampton Counties and is located approximately 20-25 miles northwest of the city of Beaufort, SC (Figure 1). Within these two varied drainage systems, the refuge contains exceptionally diverse wildlife habitat including high quality forested wetlands, forested uplands, brackish natural marsh, freshwater natural marsh, managed wetlands, marsh islands, and pristine estuarine rivers.

MANAGEMENT UNIT DESCRIPTIONS

The refuge's two primary units (Edisto Unit and Combahee Unit) are further broken down into sub-units with the Edisto Unit containing the Barrelville, Grove and Jehossee sub-units, and the Combahee Unit containing the Bonny Hall, Combahee Fields and Yemassee sub-units. These refuge sub-units were further separated into nine (9) management compartments by the ACE Basin NWR 2005 Forest Habitat Management Plan (FHMP). This organizational structure is utilized for forestry purposes as well as general cover type information. The compartments range in size from 335 to 3321 acres and are utilized in this plan (Table 1). The compartment boundaries were established along geographic features that could be easily identified on the ground (i.e. rivers, roads, trails, etc.). Refuge general cover type maps and cover type inventories for each unit are shown in Appendix A and B (Exhibits 1-9 in each) and are utilized to delineate individual sites for habitat management purposes.

The 2005 FHMP compartment designations (1-9) and the plan's forestry guidance in general, were utilized throughout this plan, except for the 2005 hand-drawn maps. Instead the current refuge staff incorporated forest stand delineations and locations from those 2005 maps, with acreage from the Division of Realty in Atlanta, and other information to create new 2011 maps utilizing a Geographical Information System (GIS). Refuge acreage from the new GIS maps totaled 11,909 acres. The 2005 FHMP total was 11,815 acres and the 2011 Division of Realty figures totaled 11,836 acres. Reasons for these discrepancies are not apparent. They can include differences in interpretation and measurements from original King's Grant deeds calling for ownership to begin anywhere from the mean high to the mean low tidal stage, where land or natural marsh meet tidal waters. Add to this the fact that some of the 4330 refuge natural marsh areas may be accreting land and marsh vegetation while other areas may be receding from erosion. There is also the chance that one method included right-of-ways of roads and utilities while another did not. We have used the GIS total acreage of 11,909 for this plan, cover type maps and inventories, and for resource management purposes proposed within the plan. Table 2 below is a summary in acres of the nine refuge individual compartments according to the GIS figures.

Table 2. Compartment Summary Table, ACE Basin NWR

Edisto Unit	County	Acres
Compartment 1 (Barrelville)	Charleston County	707 Acres
Compartment 2 (Grove North)	Charleston County	589 Acres
Compartment 3 (Grove South)	Charleston County	1,508 Acres
Compartment 4 (Jehossee East)	Charleston County	3,321 Acres
Compartment 5 (Jehossee West)	Charleston County	1,169 Acres
Subtotal		7,294 Acres
Combahee Unit		
Compartment 6 (Combahee Fields)	Colleton County	1,842 Acres
Compartment 7 (Bonny Hall)	Beaufort County	1,425 Acres
Compartment 8 (Yemassee South)	Beaufort County	11,013 Acres
Compartment 9 (Yemassee North)	Hampton County	335 Acres
Subtotal		4,615 Acres
Grand Total		11,909 Acres

PHYSICAL OR GEOGRAPHIC SETTING

Climate

The refuge is characterized by generally pleasant weather. The southerly latitude, proximity of the ocean and sea level elevation, are the determining climatic factors which produce warm, humid summers and relatively mild temperate winters. The average maximum/minimum temperatures for July and January respectively are 89 F/73 F and 60 F/40 F and nearly 240 frost-free days are reported annually. Roughly 15% of the area's rainfall is associated with tropical storms. The coastal area of South Carolina is a moderately high risk zone with respect to hurricane occurrences and destruction. Rainfall averages about 50 inches per year (USDOI 2009).

Geology and Topography

The refuge is part of the Atlantic Coastal Plain physiographic province and consists of low-lying broad sand ridges and terraces which are relic Pleistocene coastal deposits. The seaward edges of these sand ridges and terraces are buried by coastal marshes which are from middle to late Holocene (less than 5,000 years old). The major river valleys are composed of broad flood plains containing oxbow lakes, meander scroll or point bar deposits, natural levees and sand dunes. During the Wisconsin glacial event of the late Pleistocene, these rivers flowed into an ocean 100 to 200 meters below its present level. A rising sea level in late Wisconsin and early Holocene periods (15,000 to 10,000 years ago) resulted in the formation of the various river valley dune sheets and caused a shift from wide, sandy, braided river beds to present day narrow, meandering channels. Topography for all portions of the refuge is essentially flat ranging from sea level at estuary and river banks sites to generally less than 20 feet in elevation at the highest upland ridge and terrace sites.

Figure 1. Combahee Unit Map

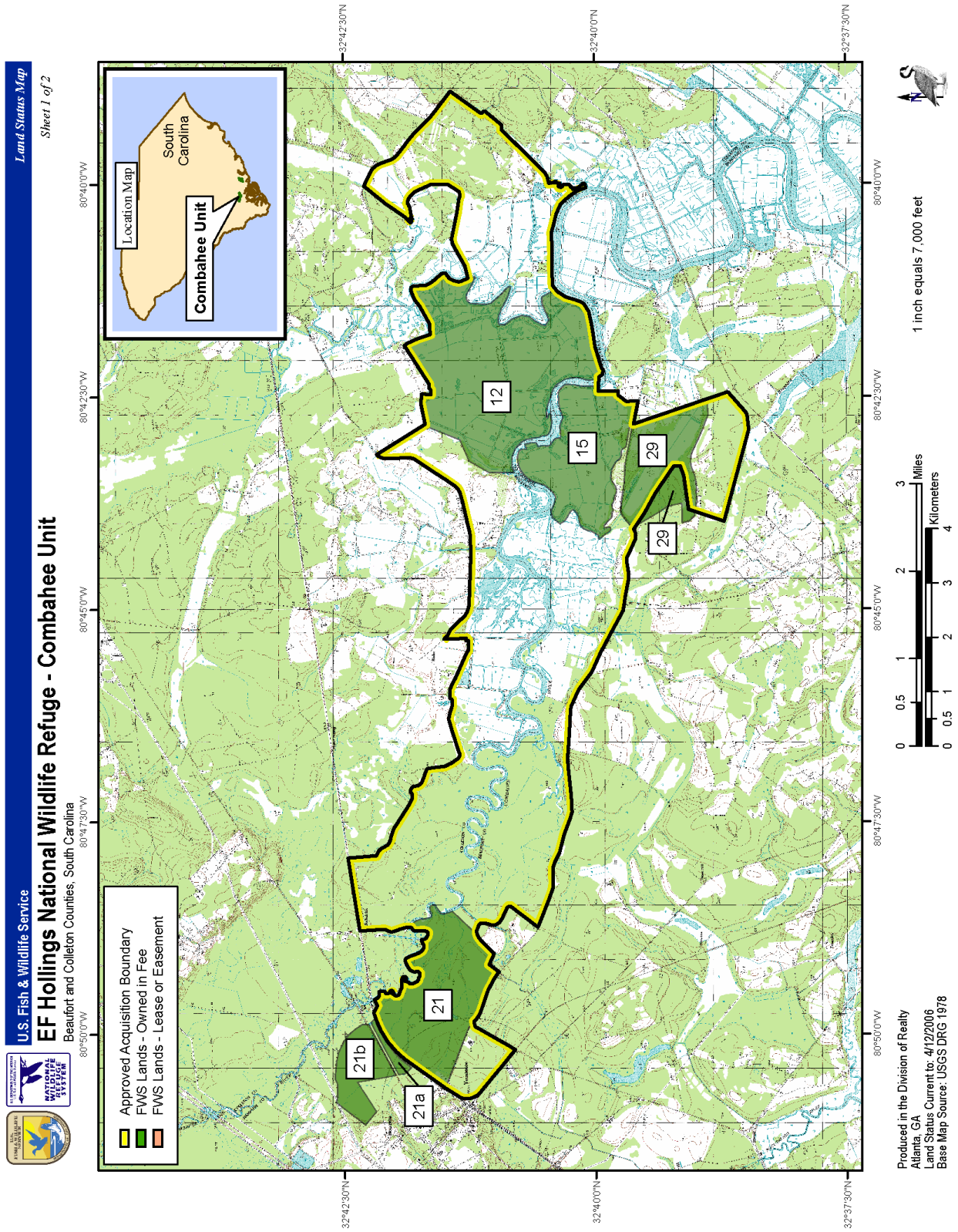


Figure 2. Edisto Unit Map



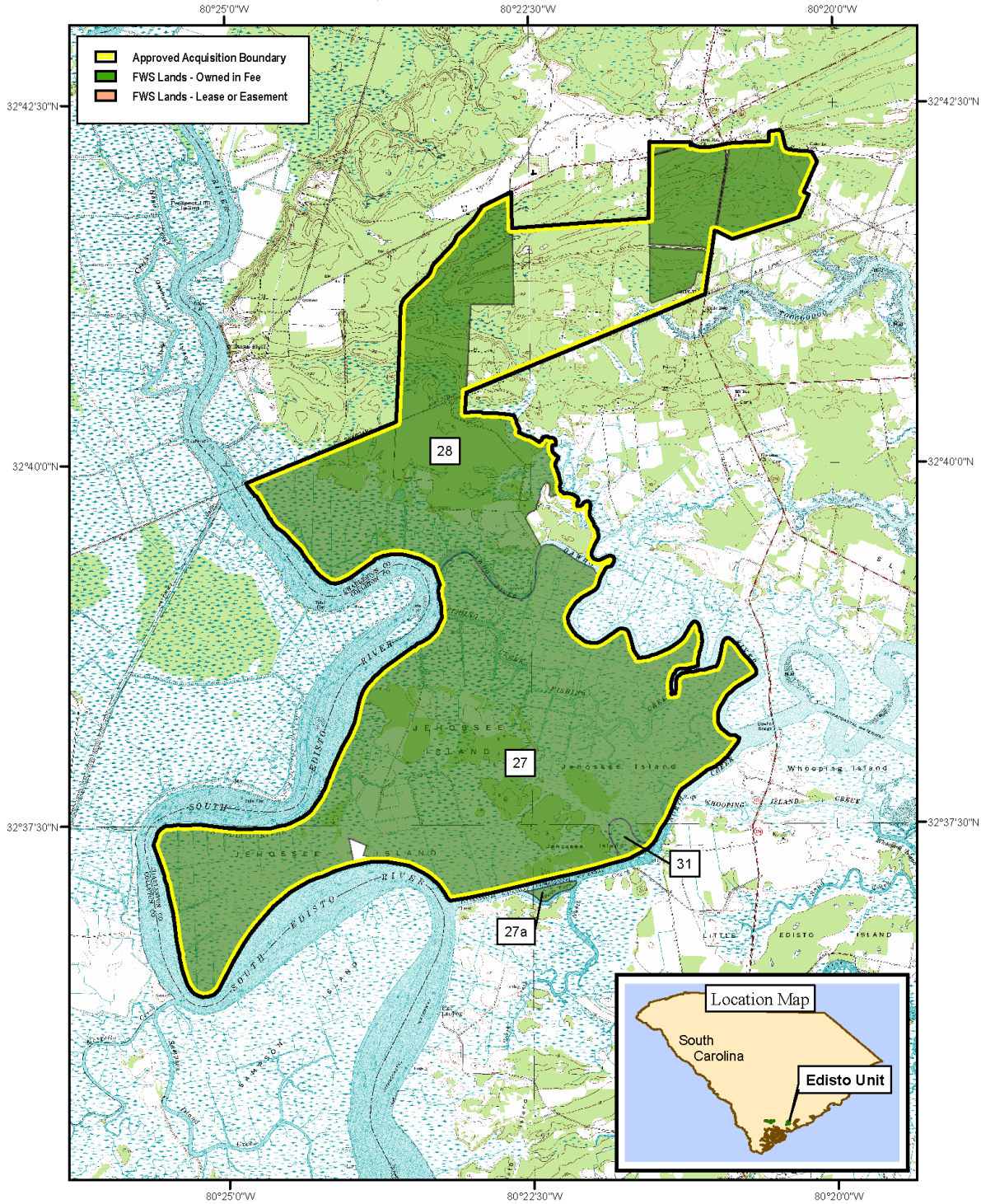
U.S. Fish & Wildlife Service

Land Status Map

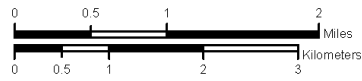
EF Hollings ACE Basin National Wildlife Refuge - Edisto Unit

Beaufort and Colleton Counties, South Carolina

Sheet 2 of 2



Produced in the Division of Realty
Atlanta, GA
Land Status Current to: 4/12/2006
Base Map Source: USGS DRG 1978



1 inch equals 1 mile



Hydrology

The refuge is drained by two significant river systems: the Combahee-Salkahatchie which flows through the Combahee Unit and the South Edisto, which flows adjacent to the Edisto Unit. Many broad, low-gradient interior drains are present as either extensions of tidal streams and rivers or flooded bays and swales. The major rivers combined average freshwater flow of approximately 2500 cubic feet per second empties into St. Helena Sound, a drowned river valley/bar- built estuary. St Helena Sound is relatively deep (15-30 ft.) except on large banks and flats and has a mean tidal amplitude of 6.1 feet at the mouth to 7.2 feet at the ocean reaches. South Edisto River salinities range from sea strength of about 30 ppt. at the mouth to fresh water of 0 ppt. in the upper reaches.

The refuge's mean tidal amplitude ranges from around 2 feet on the upper reaches of the Combahee River to 5 feet on the lower refuge area along the South Edisto River. Combahee River Salinities range from fresh water in the upper reaches to 6-7 ppt. and higher on the lower reaches, with season deviations occurring, depending on precipitation amounts.

Soils

The refuge vicinity contains 5 major soil associations. These include the Coosaw-Williman and Torhunta-Osier-Pickney associates which are dominantly loamy soils; the Bladen-Argent-Wahee association which is dominantly loamy soil having a clayey subsoil; and the Pungo-Levy and Bohicket-Capers- Hansboro associations, which are dominantly mucky and clayey soils that are flooded. Soil characteristics are closely associated with natural drainage characteristics. Generally, these soils are saturated or seasonally wet except on slight ridges where drainage is good. Most are acidic to strongly acidic. The tidal marsh soils consist of a sediment layer deposited over an older sand layer. The sediments contain a thin, dark brown, layer and a black, lower layer rich in reduced compounds (sulfides of iron and other metals) resulting from anaerobic decomposition of organic matter. The pH of the sediments in this anaerobic layer is generally neutral. However, if the sediments are subjected to drying and consequent aeration, as occurs during impoundment construction or management, the pH can be lowered to 2.0 as the sulfides are oxidized to form sulfates, including sulfuric acid. The resulting soil, known as cat clay, can inhibit plant growth and impoundment utilization for many years (USDOI 1992).

Air and Water Quality

The refuge counties of Charleston, Colleton, Beaufort and Hampton generally have good air quality. It is within National Ambient Air Quality Standards (NAAQS), including lead, particulate matter below 2.5 microns in diameter (PM-2.5), particulate matter below 10 microns in diameter (PM-10), and sulfur dioxide (USDOI 2009).

Water quality standards in the Basin are designated as Class SA by the S.C. Department of Health and Environmental Control. Class SA waters are suitable for the harvest of shellfish and other fishery resources, swimming and other water-body contact sports and high-quality uses. The South Edisto River is classified as SAA, the highest possible rating given to water bodies in South Carolina (USFWS 1992).

HISTORIC HABITAT CONDITIONS

Prehistoric Habitat/Land Use

The first people to occupy South Carolina's coastal plain were hunters (Paleo-Indians, 10,000 B.C. to 6000 B.C.). During the late Archaic Period (6000 B.C. to 2000 B.C.) coastal inhabitants began exploiting shellfish resources. Both shell rings and middens, formed from accumulating shellfish refuse, are still evident at some occupation sites. Most of the recorded prehistoric sites in the coastal area appear to be of either the Woodland period from 2000 B.C. to 1000 A.D. or the Mississippian period from 1000 A.D. to European Contact. Fire both natural and manmade during this period essentially burned unstopped across the higher portions of the landscape where longleaf pine habitat dominated and was perpetuated. Fire natural outs occurred where they met the lower elevations of swamps, bottomland hardwoods, and maritime oak habitat (USFWS 1992).

Historic Habitat/Land Use

European influences began in the early 1500's as first Spanish, then French, and finally English attempted to establish landholds. A successful British settlement was eventually established in 1670 at present day Charleston, approximately 35 miles up-coast (USFWS 1992). Shortly thereafter, the most significant event affecting the ACE Basin's natural resources occurred; the onset of the rice culture. Rice plantations were developed on the Combahee, Ashepoo, and Edisto Rivers by clearing first the inland swamps and eventually the freshwater tidal swamps. Most of the presently discernible rice fields were once gum/cypress freshwater tidal swamps. Between 1850 and 1860 approximately 20,856 acres of rice fields were planted in the tri-river system (USFWS 1992).

Archaeological sites have been recorded primarily from the Edisto Unit and include rice plantations (the Grove, Brisbane's, Pineberry and Aiken's Plantation) on Jehossee Island. An archaeological and historical investigation of Jehossee Island was conducted in 2002 (USDOI 2009). A total of 16 archaeological sites were identified based on the survey conducted. Of these 16 sites, 13 were located on Jehossee Island; one in the waters between Jehossee and the island to the north, and two on the northern island where yet another plantation, called the Brisbane Plantation, was situated. The island itself has been assessed for eligibility both as a rural historic landscape and also as an historic district. A description and location of these sites is found in the Publication "Archaeological and Historical Investigations of Jehossee Island, Charleston County, South Carolina", Chicora Foundation Research Series 61. These areas will be provided full protection as provided by Archaeological Resources Protection Act of 1979.

The area now known as the Grove Plantation was originally a land grant to Robert Fenwick in 1694. It has had many owners through the years, unlike most plantations which belonged to the same family for numerous generations. From 1695 until 1825, the property changed hands nine times. In 1825, George Washington Morris purchased the land and named it Grove Plantation. G.W. Morris died on August 22, 1834, leaving his wife, a son, and three daughters. After his death, his wife, Maria, kept control of the Grove until passing management to her son, George Morris, Jr. After his death, the plantation was sold to John Berkely Grimball in 1857. John Grimball was married to Margaret Ann (Meta) Morris, G. W. Morris' niece, and owned the adjacent plantation, Pinebury. He combined Pinebury and the Grove into one large property and the family moved into the Grove House early in 1858. After the war, John Grimball was unable to make his mortgage payments on the Grove. Therefore the land reverted back to G. W. Morris' heirs, Josephine M. Porter & Sabina Ann Morris in 1870 (USDOI 2009).

The Civil War and emancipation of the slaves, coupled with several devastating hurricanes in the late 1800's, effectively ended the rice culture era. After the rice culture declined in the late 1800's, wealthy sportsmen purchased the plantations as hunting retreats. The new owners successfully managed the former rice fields for waterfowl and adjacent upland sites for resident wildlife.

CURRENT HABITAT CONDITIONS

The Grove plantation property that is currently refuge headquarters, changed hands numerous times until it was purchased by Owen Winston in 1929. President of Brooks Brothers, Winston did a restoration of the house. He is also probably the one who had the outbuildings put in. The plantation once again had another owner when Thompson Brown purchased it in 1930. The Brown family used the Grove as a winter vacation residence and hunted waterfowl and deer. The plantation was also a place where Mr. Brown's daughter, M. T. could recuperate from polio. The Browns planted pecan, persimmon, cedar, palmetto, magnolia, and azaleas around the house between 1934 –1951. In 1947, the SC Power Company ran power lines to the house. R. Carter Henry purchased the Grove in 1964. The Henry's did an extensive renovation on the house. They changed the stairwell in the foyer to an open design. They also put the duck tiles around the fireplace in the conference room. In addition, they did extensive renovations to the outbuildings. Mr. Henry sold the Grove to A. Leigh Baier in the early 1970's. During the Baier family's ownership, numerous rice field trunks (water control structures) were rebuilt or replaced and many of the dikes around the rice fields were repaired. Mr. Baier sold the Grove to Margaret B. Hendricks, who owned the plantation until The Nature Conservancy purchased it in 1991 (USDOJ 2009).

The US Fish & Wildlife Service purchased the Grove in 1992 and designated it as the ACE Basin National Wildlife Refuge. The Grove Plantation House is one of only three antebellum mansions in the ACE Basin Project area to survive the Civil War. Former owners ensured it would be preserved by placing it on the National Register of Historical Places. Another extensive renovation was done on the house in 1996 - 1997. Today it houses the offices of the US Fish and Wildlife Service's ACE Basin National Wildlife Refuge.

The enormous natural values found on the refuge today are still here mainly because past private landowners tended the area so wisely. Since 1990, the nearly 12,000 acre total refuge area has been managed as a national wildlife refuge. During that time, tracts of the refuge that were purchased included Bonny Hall, Grove North, Grove South, Combahee Fields, Jehossee East, Jehossee West, Yemassee South, Yemassee North, and Barrelville.

Current refuge habitats are composed of cover types which include: natural tidal marshes (mostly brackish and some freshwater), managed wetlands (impounded fresh water, brackish water, and greentree reservoir sites), forested wetlands, forested uplands, and early successional/grasslands. These are shown in Table 2 below as a summary of cover types for the entire refuge. A breakdown by Compartment for these same cover types is depicted in Appendix C. Although these habitat types may be different in composition, all of these communities are interacting components of a dynamic system through which organisms and materials constantly move. The two primary forested cover types above, designated as forested wetlands and forested uplands, were derived from the ACE Basin NWR 2005 Forest Habitat Management Plan and were utilized throughout this plan.

Table 3. Summary of ACE Basin NWR Cover Type Acres

TYPE	ACRES
Natural Pine	424
Pine-Hardwood Mixed	1563
-Greentree Reservoir	(1)
Pine Plantations	682
Bottomland Hardwood	1524
-Greentree Reservoir	(70)
Upland Hardwood	4
Natural Marsh	4330
Managed Wetlands	2860
-Moist-Soil	2494
-Fresh Water	52
-Brackish Water	314
-Greentree Reservoir*	(71*)
Early Succession	189
Grassland	51
Canal, Pond, Open Water	80
Dredge Spoil	172
Borrow Area	5
Administrative Area	25
REFUGE TOTAL	11909

*Greentree Reservoir acres above are already included within the cover type acres where they are located i.e. Bottomland Hardwoods and Pine-Hardwood Mixed above. The refuge sum of those Greentree Reservoir acres is shown in the above table under Managed Wetlands but that sum (71) is not included in the Managed Wetland acres total of 2860 shown.

The refuge cover types and acres in Table 2 above are a summary. Complete cover type maps and cover type inventories are shown by compartment in Appendix A and B. Common names and descriptions of each refuge cover type are listed below followed by the equivalent April 2007 NatureServe Key to Ecological Systems or Alliance of map zones 55 and 58 of the Atlantic Coastal Plain:

Natural Marshes (NM) – 4,330 acres - NatureServe equivalent Atlantic Coastal Plain Tidal Marsh Systems (2490)

Brackish marshes are the most prevalent on the refuge and are dominated by black needlerush (*Juncus roemerianus*), smooth cordgrass (*Spartina alterniflora*), giant cordgrass (*Spartina alterniflora*), narrow-leafed cattail (*Typha angustifolia*), and saltmarsh bulrush (*Scirpus robustus*). Dominant plants in less common freshwater marshes include giant cutgrass (*Zizaniopsis miliacea*), common cattail (*Typha latifolia*), Northern wild rice (*Zizania palustris*), pickerelweed (*Pontederia cordata*), arrowheads (*Sagittaria spp.*), smartweeds (*Polygonum spp.*), various rushes, and sedges.

Managed Wetlands (impounded MW) – 2,931 acres – NatureServe equivalent Modified/Managed Wetland Vegetation

These impounded areas are referred to as managed wetlands on refuge cover type maps and the majority is abandoned rice fields. They are managed as either brackish water wetlands (314 acres), fresh water moist-soil wetlands (2494 acres), or fresh water semi-permanently flooded sites (52 acres). All are impounded by dikes and hydrology is managed with water control structures. Other areas classified as bottomland hardwoods are impounded, flooded seasonally with fresh water (approximately 71 acres), and have become refuge greentree reservoirs. The management of naturally occurring plant communities within these impoundments provides cover and food resources required to meet the behavior and nutritional needs of waterfowl, as well as a broad spectrum of other wildlife species. In fresh water moist-soil impoundments managed through spring and summer drawdowns, waterfowl food plants include panic grasses, smartweeds, flat sedges and wild millets. In other smaller less productive fresh water impoundments managed as semi-permanently flooded sites, plant cover for rails and marsh birds include panic grasses (*Panicum spp.*), giant cutgrass, black needlerush (*Juncus roemerianus*), cypress (*Taxodium distichum*), sawgrass (*Cladium mariscus*), common cattail, and occasionally watershield (*Brasenia schreberi*), white waterlily (*Nymphaea odorata*), and pondweeds (*Potamogeton spp.*). Important waterfowl food plants encouraged in brackish impoundments include wigeongrass (*Ruppia maritima*), saltmarsh bulrush (*Scirpus robustus*) and dwarf spikerush (*Eleocharis parvula*). Greentree reservoirs provide mast and invertebrates as additional and diverse food sources for avian species.

Forested Wetlands – 3,087 acres including– [Pine/Hardwood Mix (PH) – 1,563 acres – NatureServe equivalent Atlantic Coastal Plain Mesic Hardwood Forest (2343)] and [Bottomland Hardwood (BH) – 1524 acres – NatureServe equivalent Gulf and Atlantic Coastal Plain Small Stream Riparian Systems (2474)]

The refuge contains forested wetlands that occur primarily on old natural levees, floodplain terraces and flats. Mixed pine-hardwood (1,563 acres) and bottomland hardwood (1,524 acres) are the principal forest types represented. Within the mixed pine-hardwood type, the hardwood component exhibits dominance on certain sites and may be considered hardwood-pine stands. These forests are temporarily inundated or saturated, with flooding occurring periodically for up to 1 month of the growing season (Wharton. et al 1982). A minor but ecologically important additional forest wetland type occurring in the bottomlands is the cypress-tupelo swamp forest. This type occupies deep sloughs, margins of oxbows and wet flats and is flooded for the major portion of the year. These occur primarily in the upper portion of the floodplains of the Combahee Unit. Forested wetlands are extremely important for supporting healthy populations of many vulnerable Neotropical migratory land birds including the Swainson's warbler (*Limnothlypis swainsonii*) and the prothonotary warbler (*Protonotaria citrea*) as well as possibly the swallow-tailed kite (*Elanoides forficatus*). Forested wetlands include:

a. Mixed Pine-Hardwood Type (PH) - This type, including Live Oak-Maritime, occurs on higher flats and is composed of tree species that tolerate limited periods of moderately high soil saturation and flooding (Wharton et.al. 1982). Dominant tree species include: loblolly pine (*Pinus taeda*), swamp chestnut oak (*Quercus michauxii*), cherrybark oak (*Quercus pagota*), laurel oak (*Quercus hemisphaerica*), and swamp red oak (*Quercus shumardii*). Co-dominant species are represented by live oak (*Quercus virginiana*), willow oak (*Quercus phellos*), water oak (*Quercus nigra*), white oak (*Quercus alba*), overcup oak (*Quercus lyrata*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylvatica*) and pignut hickory (*Carya glabra*). A diverse shrub layer is composed of horse sugar (*Symplocos tinctoria*), wax myrtle (*Myrica cerifera*), switch cane (*Arundineria tecta*), sweet pepperbush (*Clethra alnifolia*), American holly (*Ilex opaca*), fetterbush (*Lyonia lucida*), persimmon (*Diospyros virginiana*), dwarf palmetto (*Sabal minor*), gallberry (*Ilex glabra*) and blueberry (*Vaccinium spp.*). Vines include greenbriar (*Smilax spp.*),

cross vine (*Bignonia capreolata*) and Virginia creeper (*Parthenocissus quinquefolia*). The ground layer is comprised of cinnamon fern (*Osmundastrum cinnamomeum*), royal fern (*Osmunda regalis*), marsh fern (*Thelypteris palustris*), nut rush sedge (*Scleria pauciflora*), partridge berry (*Mitchella repens*), panic grasses (*Panicum spp.*) and rushes (*Juncus spp.*) interspersed throughout the forest.

b. Bottomland Hardwood Type (BH) - While including a number of species found in the pine-hardwood type, bottomland hardwood forests occur on lower flats and are dominated by species tolerant of slightly longer periods of soil saturation and flooding (Wharton et al. 1982). Dominant tree species include overcup oak, swamp chestnut oak, water oak and red maple (*Acer rubrum*). Although loblolly pine is present, spruce pine (*Pinus glabra*) is the principal co-dominant pine species found on these wetter sites. Other co-dominants are: water hickory (*Carya aquatica*), pignut hickory, American hornbeam (*Carpinus caroliniana*) and green ash (*Fraxinus pennsylvanica*). Shrubs and vines include switch cane (*Arundinaria tecta*), wax myrtle, fetterbush (*Lyonia lucida*), dwarf palmetto, catbrier (*Smilax spp.*), poison ivy (*Toxicodendron radicans*) and Virginia creeper. The ground layer is less dense than that of the pine-hardwood type and consists of a variety of herbs, grasses and sedges including netted chain fern (*Woodwardia areolata*), partridge berry, nut rush sedge, beak rush (*Rhynchospora spp.*), sedges (*Carex spp.*), plume grass (*Saccharum alopecuroides*) and panic grass. The Bald Cypress-Water Tupelo Swamp community occurs in the wettest parts of floodplains that have standing water for most of the year. As a result, few herbs occur. Along with bald cypress, water tupelo dominates the canopy. It is commonly found along the Combahee River.

Forested Uplands – 1,110 acres including – [Natural Pine (NP) – 424 acres – NatureServe equivalent Pinus taeda Forest Alliance (A.130)] and [Pine Plantations (PP) – 682 acres – NatureServe equivalent Introduced Upland Loblolly Pine] and [Upland Hardwood (UH) – 4 acres – NatureServe equivalent Upland Southern Coastal Plain Oak Dome and Hammock (CES203.494)]

Forested uplands include the following forest types: 424 acres of natural pine (loblolly, longleaf and pond pine), 682 acres of pine plantations and 4 acres of small marginal bands of upland hardwood. The natural pine type occurs on old fields that have been left to succeed into pine forests and are maintained by the regular influence of fire. On well drained sites, a mixture of loblolly and longleaf pines occur. On wetter sites, pond pine integrates within the stand. Longleaf pine, also maintained by a regular fire regime, is found on dry flatwoods. Pine plantations were planted prior to refuge ownership generally on any clearcut harvested site that was high enough in elevation to support logging and replanting equipment. The upland hardwood type occurs in sporadic localities adjacent to pine-hardwood sites. The forested uplands include:

Natural Pine (NP) - This type occurs on somewhat poorly drained soils of broad, flat, low areas and knolls. Dominant canopy species are loblolly pine, longleaf pine and pond pine. Loblolly is the dominant pine species on all pine sites with the exception of Stand 3 in Compartment 3 (Grove North) where longleaf dominates. The understory is dominated by sweetgum with mockernut hickory, swamp red oak, laurel oak and switch cane also occurring. Shrub species include wax myrtle, sparkleberry and persimmon. Yellow jessamine, greenbriar and blackberry are the principal vines. The ground layer is composed of begger's ticks (*Bidens spp.*), sedges (*Cyperaceae spp.*), broom straw (*Andropogon spp.*), goldenrod (*Solidago spp.*) and plume grass (*Erianthus spp.*).

Pine Plantations (PP) - The plantations are located on transition zones between forest wetlands and upland pine. Loblolly is the single tree species. Past logging and agricultural practices combined with present day forestry management have resulted in monotype loblolly pine plantations being established on the Barrelville, Bonny Hall and Yemassee South Tracts. These plantations were established prior to refuge acquisition.

Upland Hardwood (UH) – This type occurs in small bands adjacent to pine-hardwood and bottomland hardwood sites on slopes with moderately poorly drained soils. Dominant tree species include water oak, white oak, post oak, Southern red oak (*Quercus falcate*), sweetgum, American beech (*Fagus grandifolia*), and Southern magnolia (*Magnolia grandiflora*). Wax myrtle is the principal shrub.

All forested sites on the refuge are categorized according to forest types which includes dominant species and size class. Forest types present on the refuge are included in maps for each forest management compartment. These forest types that describe the vegetative cover are also included in cover type inventories, as well as in the maps, and are both located in Appendix A and B, respectively, of this plan. The species symbols shown below are used to describe the dominant tree species followed by the size classes as in BH (2) for example. These symbols customarily refer to commercial applications but are also used for habitat management purposes in this plan. The following criteria are used to describe forested sites on the refuge:

Table 4. Forested Site Classification

Number	Class	Size
1	Sawtimber Size	Pine – 9.6 inches DBH and above
		Hardwood – 10.6 inches DBH and above
2	Mixed Pulpwood and Sawtimber Size	Pine – 4.6 inches DBH and above
		Hardwood – 5.6 inches DBH and above
3	Pulpwood Size	Pine – 4.6 inches to 9.5 inches DBH
		Hardwood – 5.6 to 10.5 inches DBH
4	Sapling Size (Pre-commercial Size)	Pine – 1 inch to 4.5 inches DBH
		Hardwood – 1 inch to 5.5 inches DBH

Early Successional (ES) – 189 acres – NatureServe equivalent Runderal Upland – Old Field and Grassland Areas (GL) – 51 acres – NatureServe equivalent Perennial Grassland and Forbland

Plans for abandoned agriculture fields and pastures on the refuge are for them to be maintained in early successional grass/shrub mosaic habitats or grasslands. Maintenance of these sites through periodic mowing, mechanical manipulation, plowing, herbicide treatment, or burning to provide for this particular early stage is intended to primarily benefit landbirds, especially those of priority concern in the local bird conservation region. At acquisition, the ACE Basin NWR obtained a small scattered acreage of these abandoned agriculture fields or pastures that required some type of management. Most of this habitat is located in the Grove South Compartment, as approximately 151 acres, comprised of 15 sites of a potential grass/shrub mosaic composition. An additional 15 acres is located in the Jehossee East Compartment and another 23 acres in Bonny Hall. Many of these sites in the past few years had been unintentionally allowed to become much too overgrown with woody vegetation. However, most of them recently have been mechanically converted back to early succession. Original plans were to reforest these sites, but the refuge recognized their importance for painted buntings (*Passerina ciris*), and Henslow's sparrows (*Ammodramus henslowii*), among other grass/shrub mosaic or early successional priority bird species. In addition, these sites could also be important for supporting local American woodcock (*Scolopax minor*) populations. Old pastures, especially in moist locations, could provide good wintering woodcock habitat. Woodcocks have not shown recent short-term declines in the eastern or central management units, but both regions have experienced a long-term (1968-12) declining trend of -0.8 % per year. This is thought to be due primarily to loss of early successional habitat.

Other sites of grassy forest openings and grassland edges play a vital role in providing diversity for nesting, resting and feeding for many wildlife species. These grassy upland forest openings and edges are permanently or sometimes temporarily maintained in the grass stage primarily by mowing, burning, or plowing. Typical forest regeneration areas provide only temporary openings which are generally useful for three or more years depending on location, species and regeneration method used. In comparison, scattered refuge maintained grassland openings, as shown in this plan's cover type maps totaling 51 acres, are mowed and maintained annually. These grassy areas include abandoned fields, an occasional wildlife food plot, and loading areas created during timber harvest operations prior to refuge acquisition.

Approximately 75 additional acres, more or less, of small dispersed strip/edge type grasslands containing native and commercial grasses are maintained primarily by mowing throughout the refuge. These are strips or borders, not depicted in this plan's cover type maps that are usually very narrow ribbons or edges associated with much larger areas. These sites include permanent firebreaks, refuge roads closed to public vehicular traffic, road shoulders, dike slopes/berms, road rights-of-way, and utility rights-of-way. The habitat objectives for both the early successional grass/shrub mosaic and the grassland sites are to encourage arrangements of shrubs and grasses that provide preferred forage conditions for summer breeding migratory and resident songbird species as well as potential wintering habitat for other avian species. Rights-of-way and refuge roads traverse forested areas on the refuge breaking up blocks of homogenous habitat to provide edge. A combination of openings, edges, and forests help provide the variety of habitats necessary to meet multiple management objectives.

HABITAT CHANGES FROM HISTORIC TO CURRENT CONDITION

After the initial increase in sea level following the last ice age, sea level rise has been only incremental and marshes remained essentially stable or migrated slightly inland. However with climate change anticipated, the current predicted “rates” of overall sea level rise during this century, according to the Intergovernmental Panel on Climate Change, are accelerating, at least in the short term. Therefore, the chances of marshes within the refuge being permanently flooded or migrating inland are increasing. Occasional hurricanes have not altered local refuge marsh areas to any meaningful extent, but some upland forested sites may have received significant but very local amounts of wind effects from storm events. The primary natural marsh management tool of the refuge has been fire. Fire is used to naturally set back woody shrub succession temporarily to accommodate the habitat needs of several bird species. As a result, there has essentially been no permanent natural marsh alteration of any significance.

Present day refuge managed marshes or managed wetlands (2,860 acres) on the other hand, have changed in the respect that they were former natural marshes that were impounded to grow rice and then, in more recent times, have been converted to support wildlife management purposes. The footprints of the old rice fields are evident today in both actively managed and unmanaged wetlands. In South Carolina approximately 74,000 acres of abandoned rice fields with eroded dikes have been left to revert back to a natural tidal marsh system. Presently over 70,000 acres remain functional with earthen dikes and water control structures (DeVoe 1986). On the refuge it is likely that as much as half of the original rice field areas have already reverted back to a natural tidal marsh system.

Unlike refuge natural marshes above, essentially all local former forested areas, including the refuge, were cleared for various reasons from the time of European settlement through the late 1800's. Easily harvested upland and bottomland tracts were often cut for timber value but were then cleared for agricultural crops or pasture land. Rice plantations were developed on the Combahee, Ashepoo, and Edisto Rivers by clearing first the inland swamps and eventually the freshwater tidal swamps. Most of the presently discernible rice fields were once gum/cypress freshwater tidal swamps. Current refuge bottomland hardwood (1,524 acres) and to some extent mixed pine-hardwood (1,563 acres) have remained essentially intact since the mid 1900's. Approximately twenty percent of the mixed pine-hardwood was thinned, cleared for agriculture, or replanted in loblolly pine before being purchased by the refuge. Other refuge forested sites likely sustained small patches of fallen trees due to wind damage from storms. No silviculture action by the refuge in any forested type has been done since acquisition, as the refuge has only recently had an approved forest management plan. Before that, prescribed burning has been the only management tool of the refuge.

The refuge forested uplands include the following forest types: natural pine with 424 acres of loblolly, longleaf and pond pine; pine plantations with 682 acres of loblolly pine; and upland hardwood with less than 1% of total forested acres. All pine plantation acres were either cutover hardwood or mixed pine-hardwood sites that were replanted in loblolly pine by Westvaco Timber Company before refuge acquisition. Most of the small bands of refuge upland hardwood sites are assumed to have developed during the last 50-75 years from the last clearing. Probably one third of the refuge's natural pine acres were thinned at least to some degree by previous owners judging from remnant stump evidence.

Refuge early successional/grassland areas (189/51 acres) were all altered from various upland habitats during the 1700-1900's to be used primarily for agricultural purposes. Likewise, altered

from all habitats were the nearly 300 acres traversing the refuge landscape of what is now roads, clearings, right-of-ways, canals, ditches, and borrow areas.

Changes already in the activities and the landscapes surrounding the refuge from an historic to a current perspective have the potential to at least indirectly affect refuge habitats as well as the natural resources of the ACE Basin Project area. Two of the most obvious changes are in the direction of local residential and industrial development. The primary industry-related activities in the refuge surrounding areas include light manufacturing, the service sector, forestry, and agriculture. Three key strategies were established by the ACE Basin Economic Task Force to encourage economic growth while preserving the natural characteristics of the Basin: (1) create a framework for responsible growth; (2) enhance awareness, understanding, and appreciation of the Basin; and (3) promote environmentally compatible business development. In particular, natural resource-based industries such as agriculture, forestry, seafood, and local crafts have played a key role in the ACE Basin's heritage, and recommendations were established for exploring new ways to make these industries develop higher value-added products and operate in a more sustainable fashion. New and increased nature-based tourism development is highly desirable and environmentally compatible, thereby allowing the area to capitalize on and protect the region's character and natural assets (ACE Basin Economic Forum 1996).

The population of the area surrounding the refuge is centered near the three incorporated municipalities of Walterboro, Cottageville, and Edisto Beach. Presently, Walterboro is the only urban area in Colleton County with public water and sewer facilities that can support an increase in the population (Colleton County Land Use Planning Task Force 1997). In 1990, educational attainment was low in the ACE Basin Project Area and 24% of residents in the five incorporated areas lived in poverty. Low educational attainment represents a potentially significant economic barrier for the region. The average earnings per job were only \$19,497 in 1996 for Colleton County (U.S. Dept. of Commerce 1998), with a racial gap in the earnings (USCB 1990). It is misleading to assume that average figures are representative of the whole region. The urban areas, and especially the pocket resort and high-end residential communities, have higher relative wealth and educational backgrounds than is apparent from the county or subdivision averages.

That nearly 27% of Colleton County residents travel to work outside the county, compared to approximately 7% and 2% in Charleston and Beaufort Counties respectively, highlights the need for more opportunities in the Colleton area (USCB 1990). It also highlights the potential for Colleton to become a bedroom community to more prosperous areas and the increased threat of the subdivision of natural areas into residential developments. Land use planning in the ACE Basin Project area will be an important tool to guide development in a way that does not compromise the potential benefits of the area's natural resources. If the Basin's proximity to the economic resources of neighboring areas is used to support sustainable economic development of the local natural resources, then the out-flowing tide of economic benefits can be turned back toward the Basin (ACE Basin Economic Forum 1996).

CHANGES ASSOCIATED WITH GLOBAL CLIMATE CHANGE

According to a 2010 assessment by the U.S. Global Change Research Program (USGCRP), the Southeast portion of the U.S. is already experiencing and will continue to see effects from climate change. The assessment recognized several important changes. Southeast annual average temperature has risen 2°F since 1970, with the greatest seasonal increase in the winter months. There has been a 30 percent increase in fall precipitation over most of the region but a

decrease in fall precipitation in South Florida. Summer precipitation has decreased over almost the entire region. The percentage of the Southeast in moderate to severe drought increased over the past three decades. At the same time, however, there has also been an increase in the occurrence of heavy downpours. The power of Atlantic hurricanes has increased since 1970, associated with an increase in sea surface temperature (USGCRP 2010).

The assessment further projected continued warming for the Southeast, with the greatest temperature increases in summer. The number of very hot days is projected to rise at a faster rate than average temperatures. Average annual temperatures by year 2100 are projected to rise 4.5°F under a lower emissions scenario and 9°F under a higher emissions scenario with a 10.5°F increase in summer and a much higher heat index. Sea level rise is projected to accelerate, increasing coastal inundation and shoreline retreat. The intensity of hurricanes is likely to increase, with higher wind speeds, rainfall intensity, and storm surge height and strength (USGCRP 2010).

The U.S. Fish and Wildlife Service (Service) climate change strategy, titled “Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change,” establishes a basic framework within which the Service and refuge will work as part of the larger conservation community to help ensure the sustainability of fish, wildlife, plants and habitats in the face of accelerating climate change (U.S. Fish and Wildlife Service 2010). This strategy will be implemented through a dynamic action plan that details specific steps the Service will take during the next five years to implement the Strategic Plan. The Service plan and subsequent refuge compliance will employ three key strategies defined and shown below to address climate change - Adaptation, Mitigation, and Engagement:

Adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. For the Service, adaptation is planned, science-based management actions that we take to help reduce the impacts of climate change on fish, wildlife, and their habitats. The refuge intends to be a cooperating partner in these actions now and as they develop over time.

For the present, the refuge can begin to plan and in some cases implement various forms of adaptation to existing programs that would benefit potential resources to be impacted. With the average annual temperatures projected to rise between 4.5°F to 9°F, future refuge environmental conditions in this coastal portion of South Carolina could well resemble those currently seen in Florida today, as well as some of the accompanying problems. This warming trend could increase the length of the burning season, resulting in a wider window of dryer prescribed burning conditions. Taking advantage of this condition could allow us to better emulate natural fire occurrences and to more effectively avoid conflict with seasonal breeding habits of some species.

Depending on how we approach them, more frequent extremes in length and severity of droughts and wet weather cycles can be beneficial as well as harmful. Wet conditions can produce greater densities of fuels to allow needed burning in areas otherwise too sparse to carry fire. Also, extended droughts can allow us to timely enter wetter areas where fire is desirable but reluctant to burn. The predicted overall warming effect, for example, may exacerbate issues such as the number and frequency of new invasive species that we will have to address.

The refuge can adapt by increased awareness, regular monitoring, and timely treatments of new invasive species of plants and animals and by selecting the most effective integrated pest management strategies from the very beginning of infestation to prevent initial establishment. Considering the fact that the projected warming trend represents average annual conditions, this increases the prospects that some of the refuge's temperate and Neotropical migratory birds, including summer migrant species such as the painted bunting, many of the warblers, tanagers, kites, and wood storks may lengthen their stay or in some cases could become permanent residents. Conversely, current local wintering species such as most waterfowl may exhibit an opposite effect and may tend to remain further north as warming occurs. However in the case of the summer migrant species above, the refuge can at minimum assist in the adaptation process of the displaced species by making timing adjustments in existing management actions. This could entail not only timing of management actions but also lengthening the duration of availability of habitat types such as forested, grass/shrub, natural marsh, and managed wetlands required by some species. These adjustments to the current management program would involve actions such as prescribed burning earlier or later in the season in order to avoid habitat disturbance to nesting birds or burning with less intensity to accommodate other needs of target displaced species. Other actions may include flooding or drawdown of managed wetland sites for a longer duration than customary, as well as earlier, later, and multiple flooding or drawdown events for species like the wood stork, waders, shorebirds, and marsh birds.

Sea level rise projections in our area vary among sources. The consensus currently appears to be that those relatively recent projections may be underestimates and that rates are actually in a process of acceleration. Two of the more prominent refuge programs that could be potentially impacted due to even small amounts of sea level rise, are the impounded freshwater moist-soil management and brackish management systems associated with local tidally influenced rivers. Those refuge managed wetland units that are currently managed for freshwater moist-soil plant food sources, primarily for waterfowl and secondarily for shorebirds and wading birds, may become increasingly susceptible to increased salinity, inundation, and dike erosion due to sea level rise. In this case, the refuge may consider adjusting management methods as they are needed in conjunction with eminent sea level rise. One potential method would be raising freshwater impoundment dike elevation and actually converting some of those affected tidal freshwater sites, to be managed under brackish conditions instead.

Currently, this station already manages three of its managed wetlands on the Jehossee Island portion of the refuge under more brackish type downriver conditions. Actually management of brackish water sites on the refuge tends to lend itself to even more opportunities to provide habitat for species diversity than do management of fresh water sites. These lower elevation brackish areas are logically first to become inundated and nonfunctional as sea level rise progresses. However, as new inland areas upriver are inundated with tidally influenced fresh water as sea level rises, they would in turn provide potential opportunities for creating new management locations to replace those downriver sites just recently converted to brackish management. This of course depends on future wetland policies or exemptions for new construction that might allow for climate change.

Mitigation is defined by the IPCC as human intervention to reduce the sources or enhance the sinks of greenhouse gases. Mitigation involves reducing our "carbon footprint" by using less energy, consuming fewer materials, and appropriately altering our land management practices. Mitigation is also achieved through biological carbon sequestration, the process in which CO₂ from the atmosphere is taken up by plants through photosynthesis and stored as carbon in tree trunks, branches and roots. Sequestering carbon in vegetation such as bottomland hardwood

forests or native grasses can often restore or improve habitat and directly benefit fish and wildlife.

In some small ways the refuge has already begun to reduce its carbon footprint. For energy use reduction, one full size refuge vehicle has been replaced with a smaller energy saving hybrid. Additionally three older refuge pickup trucks have recently been replaced with new flex-fuel models. Three higher efficiency heating and cooling compressors for the refuge office have replaced older less efficient units. Within the last three years, four small gasoline-powered utility vehicles were acquired and utilized as off-road work vehicles instead of more costly pickup truck use. In addition, one totally electric rechargeable utility vehicle was put to use at the Grove headquarters site where recharging was accessible and convenient.

Some land management practices have also been altered or replaced. Any site that requires mowing with a farm tractor has been scheduled for less frequent treatment to conserve fuel, equipment, time, and costs. This includes refuge open areas, grass/shrub sites, road shoulders, and rights-of-way that should only be mowed frequently enough, dependent on each site's plant growth response, to discourage woody plant encroachment and progression while providing year round habitat for grassland bird species.

Management of two areas, Goose Pond (GS7) and Alexander Pond (GS8) in the Grove South Compartment, has been altered in order to conserve energy and to contribute positively as a greenhouse gas sink. These two sites have been persistent in producing giant cutgrass regardless of energy expensive management methods to control the plant. In support of carbon sequestration, 300 cypress seedlings were planted in the two areas in 2005 while giant cutgrass was allowed to proliferate naturally as rail habitat, which actually created a dual CO₂ sink. This method reduced energy expended to control giant cutgrass, promoted a tree species tolerant to climate change and sea level rise, and provided a potential future cypress stand for wood stork nesting and wood duck use. One other small area of about two acres or less within a greentree reservoir (GN19) was planted with cypress seedlings to evaluate competition of cypress and other woody plants. This two acre area had suffered some hardwood loss due to extended flooding duration, similar to what would be expected to occur from sea level rise. This planting seems to be thriving so far.

A U.S. Forest Service October 2010 release of new estimates of the value of forests in sequestering carbon indicated that forests play a critical role in capturing and storing significant amounts of carbon that would otherwise pollute the atmosphere. The refuge is considering expanding planting utilizing cypress to mitigate any hardwood loss or other impact from inundation due to sea level rise. Another mitigation/sequestration possibility is that of planting longleaf pine in appropriate sites with acceptable elevation, hydrology, and soils. As a replacement for the faster growing but shorter lived loblolly, the more resistant longleaf can better withstand the intensity of wildfires, droughts, and storms predicted to increase with climate change.

Engagement involves reaching out to Service employees; local, national and international partners in the public and private sectors; key constituencies and stakeholders; and everyday citizens to join forces and seek solutions to the challenges to fish and wildlife conservation posed by climate change. By building knowledge and sharing information in a comprehensive and integrated way, the Service and its partners and stakeholders will increase our understanding of global climate change impacts on species and their habitats and use our combined expertise and creativity to help wildlife resources adapt in a climate-impacted world.

In January 2010 the refuge contributed to the engagement process and a better understanding of climate change impacts on species and their habitats by participating in a Climate Change Adaptation Planning Workshop for the South Atlantic Landscape Conservation Cooperative geographic area. For that workshop, one representative species from each of four ACE Basin NWR species groups were modeled for effects of climate change within South Carolina and the refuge. Representatives included one bird (endangered wood stork), one mammal (Eastern fox squirrel), one reptile (Eastern diamond-backed rattlesnake), and one amphibian (Southern dusky salamander). The NatureServe Climate Change Vulnerability Index model was utilized and results were generally as might be anticipated. Those results ranged from the highly mobile wood stork being only moderately vulnerable, to the dusky salamander being extremely vulnerable, while the fox squirrel and rattlesnake ranked between with a highly vulnerable rating. As a result of these modeling efforts, the refuge agreed to participate in a nationwide group effort involving a variety of species. Each participant agreed to complete two additional different models for a total of three models for at least one species or more for comparison of the three models. In our case we used the wood stork for comparison purposes. All three models were to be evaluated by the Service for possible use of one or more of them in the future.

One of the last two models was from the Environmental Protection Agency which scored the wood stork as “less vulnerable”. The last model was from the Rocky Mountain Research Station of the U.S. Forest Service, which scored the wood stork in four factors for an overall rating of “resilient”. All three models were therefore in agreement as to the general vulnerability status of the stork. Any of these models would be of value to the Service and refuge when it becomes necessary to prioritize species to receive management efforts to alleviate the impacts of climate change and secondly to assist in the identification of the critical factors for each specie’s vulnerability.

The refuge will continue outreach and engagement to coordinate with partners including SCDNR, Nemours Wildlife Foundation, the National System of Marine Protected Areas, the North American Amphibian Monitoring Program (NAAMP), and the South Atlantic Landscape Conservation Cooperative to address climate change and landscape level issues. For example the refuge currently assists SCDNR with maintenance of climate and water quality monitoring equipment located within a refuge tidal creek. Also the refuge plans to participate in monitoring quality of water discharged from our waterbird impoundments. This is important as the occurrence of heavier downpours and subsequent run-off predicted for the future could elevate fecal coliform bacteria levels in river water. The refuge has also already been involved for several years in coordination with Nemours Wildlife Foundation and others in providing locations and assistance for research on local species and habitats, as in recent secretive marsh bird and impoundment studies. Lastly, the refuge has been participating in and contributing data to amphibian monitoring through the NAAMP for the past six years. Any of the above refuge contributions are likely to aide and benefit the station and others by functioning as baseline markers in adjusting to future climate change.

CHAPTER III. RESOURCES OF CONCERN

Resources of concern can include species, species groups, and/or communities that support refuge purposes as well as FWS trust resource responsibilities including threatened and endangered species and migratory birds. The selection of resources of concern for this plan was in concert with those contained in the 2009 refuge CCP as well as with the South Carolina Comprehensive Wildlife Conservation Strategy (SCDNR 2005). Both of these plans take into account the conservation needs identified within international, national, regional, or ecosystem plans and goals; state fish and wildlife conservation plans; recovery plans for threatened and endangered species; and previously approved refuge resource management plans. National bird initiatives supported by the refuge include the North American Waterfowl Management Plan, Partners-in-Flight (PIF) North American Landbird Conservation Plan, North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan. Regional plans supported include the Southeastern Coastal Plains-Caribbean Shorebird Conservation Plan, South Atlantic Coastal Plain Partners in Flight Bird Conservation Plan, and the Southeastern United States Waterbird Conservation Plan. Additionally, the refuge will integrate the biological planning and conservation design provided by the South Atlantic Landscape Conservation Cooperative (SALCC) into our plan as the SALCC develops.

In this plan, habitat management will fully consider or closely parallel those recommendations presented by the 2006 Biological Review for the refuge. Additionally, the forest management activities to be implemented at the refuge to fulfill the habitat needs for refuge resources of concern are included in the ACE Basin NWR 2005 FHMP. That plan indicates that we will utilize native trees and promote wildlife species composition most suitable to specific sites. Emphasis, as well, will be placed upon development and maintenance of forest tree species diversity within the constraints of particular conditions in which species generally occur. Such diversity not only mimics natural forest diversity but also provides a wide range of habitats for the widest possible array of wildlife species. Also, according to the FHMP, the presence of internal stand structure both horizontal and vertical, along with spatial arrangement within the stand, is a critical habitat component for virtually all forest dependent priority species on the refuge.

ENDANGERED, THREATENED AND IMPERILED SPECIES

Wood Stork (Mycteria americana) Fed.; S.C. - End.

Wood storks are identified as a resource of concern as they are present on the refuge and are listed as an endangered species both federally and within the state of South Carolina (SC). The wood stork was classified as Tier 1 and Activity Code CR (Critical Recovery) in the BCR 27 priority list. The Partners-in-Flight priority score was 29 of 35 and was ranked within the Highest Priority in the South Atlantic Migratory Bird Initiative. Large numbers of wood storks, sometimes several hundred, are attracted to refuge impoundments, especially those on Jehossee Island. Storks take advantage of the sanctuary there and can be seen perching in the trees adjacent to those refuge impoundments. Wood stork nesting colonies occur within the ACE Basin Project Area, but not within the actual refuge acquisition boundary at this time. However, storks can be seen regularly during the summer months foraging and resting on refuge lands and ranging throughout the refuge acquisition boundary.

Habitat requirements for wood storks include feeding in shallow water portions of wetlands such as marshes, swamps, lagoons, ponds, flooded pastures, flooded ditches, and depressions in marshes. Foraging usually occurs in fresh water but brackish is also utilized. Foraging is primarily done in shallow water of about 15-50 cm deep or in flooded fields. They are attracted to areas with falling water level and hence concentrated food sources (Palmer 1962, Ogden et al. 1978). Their diet is mainly fish over 3.5 cm in length and also may include assorted other small animals. They are gregarious nesters and depend heavily on receding water levels with a concentration of adequate food sources being located nearby their nesting colonies. Wood stork nesting requires trees over standing water or islands surrounded by broad expanses of open water to discourage nest predation by snakes and raccoons.

The value and contribution of the refuge to wood storks presently is that of providing and protecting foraging habitat during the summer breeding season and attempting to encourage colonial nesting on the refuge. Storks migrate from the south to arrive in the refuge vicinity usually during early to mid-March and generally return south by November. Occasionally a very few, usually individual birds, may overwinter locally. In mid-March they settle into one of three or four rookeries in the larger ACE Basin Project area. None of these rookeries are located on the refuge. However, the refuge has attempted to encourage and provide nesting enticements such as artificial nest platforms in two locations including the employment of standing water during the summer months to discourage predation. At one of the sites, partial summer flooding of a greentree reservoir was conducted and decoys were utilized. So far, none of these techniques have been successful at attracting a nesting colony. The refuge does, however, contribute to other summer habitat requirements of wood storks. Wood storks depend on receding water levels that concentrate food sources primarily fish and other small aquatic animals. Total Southeast U.S. Waterbird Conservation Region population objective is between 10,000-50,000 storks. Our regional objective for BCR 27 is 20% of the Southeast total or 2,000-10,000.

Proper timing of a mid-summer partial drawdown of water levels in three refuge brackish managed wetlands on Jehossee Island have attracted and provided foraging habitat for 300 to 600 and occasionally more than 900 storks, almost half of the BCR objective total. The brackish managed wetlands at Jehossee Island also provide disturbance free open areas preferred by storks. Immediately adjacent to and partially surrounding these managed wetlands, is forested habitat available for loafing, perching, and roosting. Stork nesting chronology involves fledging young usually during July. Synchronizing drawdown for this time interval provides a highly available fishery resource important to adult storks who are training their recently fledged young to forage. There are approximately 2860 total acres of refuge managed wetland sites that could potentially provide foraging, in at least some brief stage, during drawdown for storks. Of these about 2,475 acres are freshwater moist-soil managed wetlands, 71 acres are greentree reservoirs, and 314 acres of the most valuable wood stork areas are brackish sites on Jehossee Island.

Due to available tidal salinity from the river, the 314 acres within the three managed wetland sites on Jehossee Island lend themselves to brackish water management, which has several advantages over refuge freshwater moist-soil areas. Brackish sites are managed by flushing with several drawdowns and refills annually. This maintains these areas in the more open water conditions preferred by storks. Frequent flushing also captures and supports a greater variety and quantity of forage fish available to storks. The vast majority of refuge managed wetland sites however, are freshwater moist-soil areas. In these freshwater sites, drawdown is started in March and April and lasts all summer to encourage the growth of waterfowl plant foods. Some wood stork foraging occurs in early summer as the water in these areas is leaving, especially if

wood stork rookeries are in close proximity to the sites. As these freshwater areas become completely drawn down, they are of less value to storks unless drawdown is delayed for some reason into the July fledging period.

Few management activities on the refuge benefitting wood storks would conflict with management of other resources of concern. Actions have been implemented, however, in order to resolve any potential conflict in management for other resources and those intended to benefit wood storks or improve their habitat. These management activities were designed, for example, to coordinate the management of refuge freshwater and brackish water sites during the entire annual cycle to benefit a diversity of water based species as well as storks. A multi-species management approach on the 314 acres of brackish managed wetlands on Jehossee Island encourages production of the submergent and emergent aquatic vegetation wigeon grass, dwarf spikerush, and saltmarsh bulrush for waterfowl use during the winter. Additional emphasis in that same habitat during the spring and fall, target drawdown to mudflat levels to promote the presence of invertebrates as a forage base for migrating shorebirds. Mid-summer and July water level drawdowns, again on these same sites, target foraging wood storks and other wading birds. There is the potential for conflict between providing foraging sites for storks and providing public use, especially summer sport fishing. Only in select areas that do not lend themselves well to management as stork foraging sites, will summer sport fishing be permitted.

Red-cockaded Woodpecker (Picoides borealis) Fed.; S.C. - End.

Red-cockaded woodpecker (RCW) was chosen as a refuge resource of concern as it is endangered at both the federal and SC state level. It was classified in the Highest Priority category in SAMBI and with a 32 of 35 possible total PIF priority score. There are no active RCW clusters located on refuge lands and they are not known to currently exist within the refuge acquisition boundary or the ACE Basin project area. However, as recently as the early 1970s, active clusters existed on the Cheeha–Combahee Plantation (Refuge Manager Mark Purcell personal correspondence with Lew Crouch, Manager, Cheeha–Combahee Plantation). This particular area is located between the refuge's main units on the Edisto River and those refuge units on the Combahee River.

Thousands of acres of potential RCW habitat exist throughout the surrounding 1.2 million acre ACE Basin Project Area as the result of private plantation quail management objectives. These plantations, the refuge, and other proximal pine sites may all be links in a habitat corridor of the near future. Many of the pinelands in these areas are likely approaching the age to contain the red heart condition necessary for nest cavity construction. Some of these private or corporate tracts are immediately adjacent to or in close proximity to the refuge. On the Edisto Unit there are about 1,611 acres of pine and pine/hardwood that could supplement future nesting or foraging habitat on these larger adjacent private tracts. A relatively new concept since 1998 has appeared at the state and local landscape level known as the Safe Harbor program. Efforts through the South Carolina Department of Natural Resources, ACE Basin Task Force, Charleston Ecological Services Office, private landowners in the ACE Basin Project Area, and the refuge are all coordinated to benefit the RCW. Private landowners in this program are given incentives and are encouraged to manage for the woodpecker's preferred habitat condition, instead of discouraging it, as is sometimes done by landowners to avoid having to accommodate endangered species regulations.

RCW nesting habitat requirements include large open park-like stands of mature pine maintained by fire and optimally with a dense ground cover of a variety of grasses, low shrubs,

and forbs. There must be very little or no midstory and few or no overstory hardwoods. Preferred cavity trees should be mature, usually infested with red heart disease that softens the heartwood, and of low basal area. The basal area of pine overstory is one of the more important habitat components within cavity clusters (NatureServe. 2009). The Red-cockaded Woodpecker Recovery Plan (U.S. Fish and Wildlife Service 2003) recommended that nesting cavity clusters in longleaf pine woodlands north of Florida should have an estimated average basal area ranging from 9.2 to 13.8 sq. m/ ha (40 to 60 sq. ft./ ac), while others have recommended as high as 18 sq. m/ ha (80 sq. ft./ acre). Cavities for roosting and nesting have been found in longleaf (*Pinus palustris*), loblolly (*Pinus taeda*), shortleaf (*Pinus echinata*), slash (*Pinus ellioti*), pond pine (*Pinus rigida*), and even bald cypress (*Taxodium distichus*). Longleaf pine is preferred even when mature stands of other pine species are available. Optimal foraging habitat on the other hand consists of a minimum of 120 acres of good quality habitat.

Foraging can occur in a diversity of forested habitat types that includes pines of various ages as well as some hardwood-dominated habitats (NatureServe. 2009). The recovery standard calls for open canopy pines with ≥ 14 in. dbh with minimum basal area 20 sq. ft./ acre or 10-14 in. dbh with basal area 0-40 sq. ft./acre or low densities < 10 in. dbh with minimum basal area 10 sq. ft./ acre or for all pines ≥ 10 in. dbh with at least 40 sq. ft./acre. Also little or no hardwood or pine midstory above 7 ft. in height, few or no overstory hardwoods less than 10% of canopy in longleaf stands and less than 30% in others, and greater than 40% of ground cover in herbaceous species and forbs (U.S. Fish and Wildlife Service 2003). In managing for the species only one thing is important: provide for all of its needs (Jackson 1994). The American Ornithological Union (AOU1991) concluded that this bird "...is a symbol of fire-maintained, old-growth pine savannas, once the dominant ecosystem in the Southeast."

Red-cockaded woodpeckers (RCW) were last documented in the larger ACE Basin Project area during the early 1970's. None have been known to specifically inhabit the refuge property in recent years which makes any recovery efforts on the refuge a challenge. Recovery Plan criteria is currently being measured in number of potential breeding groups. In this larger view the ultimate recovery goal across the landscape is variable, having been formulated using eleven recovery units delineated according to ecoregions, and requiring five recovery criteria to be met for delisting and six for downlisting (USFWS 2003).

Stepping the habitat goal down, according to the South Atlantic Coastal Plain Bird Conservation Plan, the objective would be to have a total of 650,000 acres in good condition by year 2025. Locally, the refuge contribution would be initially to provide at least 1500 acres of suitable foraging habitat to supplement future adjacent colonies on local private land by year 2020 and possibly a potential breeding group by 2025. Potential habitat for future nesting, but more likely foraging activity, may exist within approximately 2669 acres of pine and mixed pine-hardwood types on the refuge. This includes about 1106 acres of natural pine and loblolly plantations, and possibly 1563 acres of mixed pine-hardwood as marginal habitat. Some portion of the loblolly pine plantations, yet to be determined, may be harvested and planted in longleaf pine which in time would be advantageous to the woodpecker. Most of the areas above, except the pine plantations, have been burned by prescription on several occasions during the dormant season and some during the growing season since establishment of the refuge in 1990. All are subject to continued prescribed fire and future silviculture to manipulate forest composition and structure to potentially benefit the RCW.

Forest management activities planned for the refuge pine and mixed pine-hardwood types above that are being considered, would not conflict in providing breeding and foraging sites for RCW as well as for other priority species. Other species of concern that could potentially

benefit from conditions favorable for RCWs include the flatwoods salamander, pondberry, American chaffseed, eastern fox squirrel, eastern diamond-backed rattlesnake, Bachman's sparrow, brown-headed nuthatch, hooded warbler, and other landbirds. The above habitat conditions are to be established and maintained by the refuge through mechanical thinning, possible chemical application, and use of dormant and/or growing season fire to control plant composition, structure, and undesirable plant species. At least one short term conflict has been considered and resolved concerning fire during the growing season, but is usually out-weighted by maintaining the habitat for the long term. Some ground or low bird nests may be temporarily disturbed or impacted by fire during this period. This can be mitigated to some extent by burning as early as possible during the nesting season to allow re-nesting and burning with spatial patchiness intended. Also restrict burning of all blocks of similar refuge habitat during the same year therefore allowing alternate nesting areas to be available.

Flatwoods Salamander (Ambystoma cingulatum) Fed.-Thr.; S.C. - End.

In support of one of the CCP objectives, the flatwoods salamander was also selected as a refuge resource of concern in this plan. Little research and survey effort has been directed towards this federally threatened/state endangered species and accordingly limited information is known about flatwoods salamander populations in the southern coastal plain of South Carolina or the refuge. Flatwoods salamander presence on the refuge has not been confirmed. However, a few small isolated wetland sites of the type required for breeding can be found in and adjacent to pine forest habitat on the refuge. Over the last several years amphibians and reptiles have experienced worldwide population declines that have been related to numerous factors, including disease and pathogens, global climate change, invasive species, commercial trade, and interactions of multiple factors. Amphibians need both terrestrial and aquatic/wetland habitats within close proximity of each other to complete their life cycle. Thus, providing wetland/forest complexes at appropriate spatial scales is important for the conservation of these species (LMVJV 2007).

Habitat requirements for these salamanders involve open-canopied, pine forest subjected to growing season fires. The understory requirements consist of a diversity of herbaceous or graminaceous vegetation necessary as a prey base for the adult salamanders. They spend most of their lives underground when not breeding. Breeding occurs from late September to December when adults migrate from the uplands. They move to isolated, ephemeral ponds during this time to breed when the ponds flood due to rainy weather associated with cold fronts. It is most important to maintain these ephemeral, isolated wetlands in a somewhat herbaceous state as well to provide cover where the larvae mature in March and April before migrating as adults to the adjacent pine forest uplands. These breeding ponds can and often do burn during dry periods especially from wildfire occurrences. Burning assists in maintenance of the herbaceous understory. Of critical importance also is that the wetlands utilized by this species be isolated and ephemeral in nature to prohibit the existence of predatory fishes that forage upon larval and adult salamanders. Characteristics of breeding sites include a canopy of zero to sometimes nearly 100% with pond cypress (*Taxodium ascendens*), sweetgum, blackgum, pine (*Pinus spp.*), red maple, or redbay (*Persea borbonia*). Midstory at breeding sites can be dense but is usually open containing young of the canopy species or shrubs while the understory is dominated by graminaceous species (Palis, unpubl. data from NatureServe 2009). The number and specific locations of the type of wetlands needed for salamander breeding on the refuge are unknown and have not been surveyed for the presence of the salamander.

The refuge contains approximately 1106 acres of pine representing all pine types including longleaf, loblolly, pond pine in natural stands, and loblolly in plantations that could potentially

provide foraging and breeding habitat for the flatwoods salamander. Another 1563 acres of mixed pine-hardwoods could provide some marginal habitat adjacent to the pine types. Endemic to a small portion of the southeastern U.S. Coastal Plain, global abundance is somewhere between 2500 - 100,000 individuals (NatureServe 2010). Local and refuge abundance, if any, is unknown.

A station goal should be to locate any potential refuge habitat for the species and establish an acceptable level of monitoring of that habitat for the presence of the species. Continued burning and future thinning by the refuge will assist in maintaining conditions attractive to the flatwoods salamander. Burning and thinning will encourage the dense understory of grasses or herbaceous cover preferred by adults of the species in the flatwoods portion of the habitat utilized during the nonbreeding season. These same activities would enhance the grassy or herbaceous understory in isolated wetland portions of the habitat which is important as cover to allow salamander larvae to mature as part of their reproductive phase.

No current or anticipated conflict exists in refuge pine type related forest management practices relative to the flatwoods salamander. This includes thinning and growing season burning to encourage other potential refuge species as well as for the flatwoods salamander. Those additional species would include the red-cockaded woodpecker, pondberry, American chaffseed, American woodcock, red-headed woodpecker, and other landbirds of concern. Consideration was given to possible conflict with early dormant season prescribed fire for pine types before December and with the chance of salamander mortality while migrating during the period September to December to isolated ponds for the breeding season. Salamander migration and breeding are dependent on rain events during this period to fill the wetlands. Refuge burning would be highly unlikely to occur because of these wet conditions therefore would not be expected to cause conflict with salamander migration. Otherwise, plan dormant season fire activity for after December to completely avoid the salamander breeding season. For amphibians, varying the burn season to include growing season burning as well as dormant season burning has been suggested as one means of reducing the potential impact of fire (Schurbon and Fauth 2003). Fire employed during any season to improve habitat conditions for salamanders or other species should be designed to allow escape and to reduce species mortality. For example, this may include the use of low intensity and slow, backing type fire.

Canby's Dropwort (Oxypolis canbyi) Fed.; S.C. - End.

Canby's dropwort as a refuge resource of concern is endangered federally and in SC and was included as an objective in the refuge CCP. Although not known to occur in the refuge acquisition boundary, potential habitat for Canby's dropwort is present on the Grove and Barrelville Compartments and in other refuge pineland areas. South Carolina harbors some of the largest concentrations of this endangered plant species and it can be found nearby the refuge in Crosby Oxypolis Heritage preserve in Colleton County. Canby's dropwort occurs within the coastal plain of the southeastern United States primarily in depression wetlands.

Habitat requirements for Canby's dropwort include a variety of habitats, including pond cypress ponds, grass-sedge dominated Carolina bays, wet pine savannahs, shallow pineland ponds and cypress-pine swamps or sloughs. The largest and most vigorous populations reported occur in open bays or ponds which are flooded throughout most of the year and which have little or no canopy cover. Invariably, the sites are on a sandy loam or loam soil which is underlain by a clay layer, not unlike conditions found in many sections of the refuge. Based on county soil surveys, known soil types which support populations of Canby's dropwort are Rembert loam, Portsmouth loam, McColl loam, Grady loam, Coxville fine sandy loam, and Rains sandy loam. These soil

types are similar in that they have a medium to high organic content, high water table, and are deep, poorly drained, and acidic (NatureServe 2009).

Potential habitat for Canby's dropwort on the refuge is present in pineland sites on the Grove North, Grove South, Barrelville, and Jehossee East and West Compartments. Although it has not been confirmed on the refuge or within the refuge acquisition boundary, it has been found in adjacent Colleton County where a portion of the refuge is located. A station objective would be to survey the refuge for the plant by 2016 and if found, protect and monitor. This plant's shallow pond and pineland-type habitat would be similar to the ephemeral wetlands already described as breeding sites for the flatwoods salamander, except the potential dropwort sites would be flooded most of the year and would have little or no canopy cover. This potential type of habitat could occur at locations on approximately 1106 acres on the refuge that includes all pine types. Another 1563 acres of mixed pine-hardwood could also contain sporadic wetland sites of this type. Refuge surveys for Canby's dropwort have not been done nor have specific locations of wetland sites typical of the plant been identified.

There should be no conflict in managing for Canby's dropwort habitat and managing habitat for other species as no direct or specific management is anticipated for this plant. Habitats that support the largest populations of this plant elsewhere have no canopy to thin and are flooded too wet to burn throughout most of the year. Instead, indirect management including thinning and burning of pineland habitat surrounding these potential dropwort wetlands, would be applied. This would maintain the surrounding pineland type composition and structure in order to create a buffer, provide watershed benefits, and protect the integrity of the wetland habitat for the dropwort. Another form of indirect management for the plants wetland habitat is simple protection from drainage. This includes intentional drainage for other management purposes or unintentional drainage, for example, when fire lines are plowed or tied into wetland sites. Either activity would be a conflict and should be resolved in favor of protecting the plant and the hydrology of the wetland when possible.

Pondberry (Lindera melissifolia) Fed.;S.C. - End.

Pondberry as a refuge resource of concern is endangered federally and in SC and was also included as an objective in the refuge CCP. Although this endangered plant is not known to occur within the refuge acquisition boundary, potential pondberry habitat is present in and adjacent to pine forests on several sites on the refuge. In South Carolina it is known to occur in Beaufort County. Several of the refuge compartments are also located in Beaufort County. There is the potential that pondberry plant populations could be affected by the recent and progressive spread across the southeast coastal plain of laurel wilt caused by the fungus *Raffaelea lauricola*. Mortality from the wilt has greatly affected redbay (*Persea borbonia*) locally including on the refuge. Additionally, the wilt fungus has also been isolated from several other dead and dying plant species including pondberry (Mayfield and Thomas 2006). This fact may be all the more reason to include pondberry as a resource of concern.

Habitat requirements of pondberry within the coastal plain of the southeastern United States involves occurrence of the plant in depression wetlands of pine flatwoods, along the margins of pond cypress-gum swamp forests, within open bogs and in sandy sinks. In South Carolina, pondberry grows along the margins of limestone sinks and shallow depressions. The plant also inhabits pinelands and recently burned open areas. Radford and others (Radford et al. 1968) included Colleton County, where portions of the refuge are located, in the known distribution of pondberry. Pondberry can apparently occupy a variety of habitats as long as hydrological requirements are met. It occurs in seasonally flooded wetlands such as floodplain/bottomland

hardwood forests and forested swales, on the bottoms and edges of shallow seasonal ponds in old dune fields, along the margins of ponds and depressions in pinelands, around the edges of sinkholes in coastal areas with karst topography, and along the borders of sphagnum bogs. These conditions are usually shaded, but the plant can tolerate full sun (NatureServe. 2009).

Potential habitat on the refuge consists primarily of 1106 acres of all pine types and secondarily about 1563 acres of mixed pine-hardwood. Marginal habitat could exist in another 1524 acres of bottomland hardwood. No refuge surveys for pondberry or the specific location of wetland sites typical of the plant's habitat have been attempted. The refuge should plan to complete surveys for the plant by 2016 and if found begin monitoring and protection.

No conflicts are anticipated in management of habitat suitable for pondberry with management of habitat for other resources on the refuge. Encroachment of thinning and burning from adjacent areas into pondberry habitat would not be a conflict and may in fact benefit pondberry. As mentioned earlier, pondberry is known to inhabit recently burned open areas. Any type of wetland drainage activity however, could be a potential conflict the same as with Canby's dropwort. This includes intentional drainage for other management purposes or unintentional drainage for example when fire lines are plowed or tied into wetland sites that could be identified as potential pondberry habitat. Either activity would be a conflict and should be resolved in favor of this plant and protecting the hydrology of the wetland when possible.

American Chaffseed (Schwalbea americana) Fed.; S.C. - End.

This plant, as a refuge resource of concern in this plan, is also endangered federally and in SC and was included as an objective in the CCP. The endangered American chaffseed has not been confirmed within the refuge acquisition boundary, although potential habitat is present on several sites on the refuge in and adjacent to pine forests. American chaffseed primarily occurs within the southeastern coastal plain in pine flatwoods, ecotonal areas between peaty wetlands and xeric sandy soils and within open grassy areas.

American chaffseed is a highly fire dependent plant and likely responds well to growing season burns. In South Carolina, plants are found in flatwoods rather than pine savannahs, where it has only been observed once to have migrated into a savannah area from adjacent flatwoods. The fire regime at these sites, either prescribed or natural (or a combination of both), is a mixture of growing-season and non-growing-season burns; it is unknown what mix best favors chaffseed. Growing-season burns tend to maintain the grassy areas chaffseed depends upon for survival. In sites where grassy areas lie adjacent to woodlands, chaffseed is restricted to the grassy areas (NatureServe. 2009).

The American chaffseed plant, if present on the refuge, would most likely be found in those areas within or adjacent to refuge pine type habitats consisting of a combined total of about 1106 acres. Pine flatwood areas that are located within regularly burned pine type sites would be the preferred habitat of chaffseed. Another possible refuge habitat that could meet the life history requirements of chaffseed would be 1563 acres of refuge mixed pine-hardwood. Both of these forested types can be found on Jehossee Island and are subjected to and provide some or all conditions necessary to support chaffseed. This includes fire, ecotonal areas between peaty wetlands and xeric sandy soils, possibly flatwoods, and some fire dependent grassy areas that chaffseed depends upon for survival. Refuge pine types in general are on a 2-3 year burn regime, either dormant or growing season. Mixed pine-hardwood types on the Grove South Compartment have recently been subjected to their first low intensity dormant season burns in

2008 with a planned longer burn cycle of 3-5 years. Refuge plans should include surveys to ascertain presence of the plant by 2016 and if found, monitor and protect.

Management of refuge pine and mixed pine-hardwood types for conditions that would tend to favor chaffseed would not conflict with management of those same areas as habitat for other species of fauna and flora. Continued prescribed burning and future thinning as management to benefit chaffseed would improve habitat as well for other species including flatwoods salamander, red-cockaded woodpecker, brown-headed nuthatch, Bachman's sparrow, other landbirds, eastern fox squirrel, and the eastern diamond-backed rattlesnake. The fire regime of burning during the dormant season, growing season, or a combination of both to encourage the highly fire dependent chaffseed, should not preclude or conflict with management within the same general habitat type for other plants like pondberry for example. Although not as highly fire dependent as chaffseed, pondberry does inhabit recently burned open areas and the margins of various depression wetlands within pine flatwoods. Resolution and mitigation of any conflict with growing season burning and impacts to bird nesting within the pine and mixed pine-hardwood types that may apply to chaffseed, have already been addressed under 3.2.1.3 Red-cockaded woodpecker.

Bachman's Warbler (Vermivora bachmanii) Fed.; S.C. - End.

Bachman's warbler as a refuge resource of concern is endangered federally and in SC and was also included as an objective in the refuge CCP. Bachman's warbler is considered extinct by many, if not possibly the rarest North American songbird. In the SAMBI Implementation Plan it was included on the priority list in the highest priority species category. According to the Nature Conservancy's Global Ranking, it rates GH (of historical occurrence throughout its range, with possibility of rediscovery). In South Carolina it was last reported in Charleston County (Ion Swamp) and historically reported along Parkers Ferry Road near the refuge's Grove North and Grove South Compartments. Most authorities agree that if the Bachman's warbler still exists it is most likely to be found in the Francis Marion National Forest's I'On Swamp area which is nearby the refuge in Charleston and Berkeley Counties, South Carolina. In 1999, the Fish and Wildlife Service published a multi-species Recovery Plan for South Florida, in which it was recommended that surveys for the Bachman's warbler should continue (Beacham 2001).

Bachman's warbler habitat requirements include moist deciduous woodlands and swamps similar to the habitat of hooded warblers. See bottomland hardwood guidelines in Appendix E. It apparently is adapted to swampy canebreaks or bamboo thickets (Remson 1986). This species has been regarded as a bird of virgin bottomland forests and swamp forests, and as a second-growth species (Morse 1989). In general these areas were described as being forested with sweet gum, oaks, hickories, black gum, and other hardwoods; and where there was an opening in the forest canopy, the ground being covered with dense thickets of cane, palmetto, blackberry, gallberry, and other shrubs and vines (Beacham 2001).

Although possibly extinct, the last confirmed report of a sighting of the Bachman's warbler in South Carolina was in the early 1960's in the Ion Swamp portion of Charleston County (Hamel 1992). This is the county within which the refuge headquarters is located. Also historically it was reported within 3-4 miles of refuge headquarters near the Edisto Unit along Parkers Ferry Road. If this warbler does exist currently, it is likely to be associated with habitats similar to the past. That habitat could at least marginally remain on the refuge today. There are approximately 1524 acres of bottomland hardwood refuge areas containing deciduous hardwoods and swampy bottomlands that could be future habitat sites for the Bachman's warbler. Bachman's warbler prefers openings and internal edges in hardwood forests and with

blackberries or cane (Hamel 1992). To be attractive to Bachman's warbler, refuge plans should include thinning in the currently closed canopy and some group selection to create patch openings on at least 25% of the refuge's bottomland hardwoods by 2020.

Active management of refuge bottomland hardwood areas for a greater diversity in forest plant composition and structure was recommended by the 2006 Biological Review (USFWS 2006). Possible management within those bottomland hardwood areas that would provide for Bachman's warbler habitat, as well as a suite of other bird species, should not result in any type of conflict with management of other resources on the refuge. Recommendations of the review process suggested a light canopy thinning process favoring hard mast species for refuge bottomland hardwood areas that would emulate the results of natural weather events such as small openings created by windfalls within the forest canopy. If ever utilized within the context of a management action as was suggested, this process could also involve some group selection thinning in variable patches throughout the bottomland landscape. Whether natural or management induced, the desired effect would be to open these small areas to allow sunlight to develop a diverse and dense mid-story and understory structure attractive to several species of concern.

Refuge bottomland hardwoods currently are almost totally closed canopy with an open understory. The resulting change in density and diversity within the canopy, with thickets and cane brakes, would not only provide habitat for the Bachman's warbler but would benefit the yellow-throated warbler, hooded warbler, prothonotary warbler, Swainson's warbler, Cerulean warbler, black-throated green warbler, swallow-tailed kite, woodthrush, worm-eating warbler, Kentucky warbler, woodcock, rusty blackbird, and Rafinesque big-eared bat as well. If no active forest management to improve this habitat occurs in the short term, then we may have to plan for some possible long term actions. In the long term the Bachman's warbler, as well as the above suite of bird species, could at least indirectly benefit from our future actions, passive as they may be, to include new acquisition, conservation easements, and any future protection of the bottomland habitat from threats such as development, pollution, clearcuts, and agricultural use.

WINTERING WATERFOWL

The refuge is legally mandated by the Migratory Bird Conservation Act of 1929 "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds". A major part of this mandate includes migratory waterfowl. The refuge's managed wetlands or impoundments are heavily utilized by wintering ducks such as mallards, pintail, green-winged teal, blue-winged teal, wigeon, wood duck, black duck, mottled, shoveler, gadwall, whistling, ring necked ducks, lesser scaup, and other divers. Approximately 20 species are possible during winter. Wintering populations on the refuge for the 10 year period from 2002-2011 have averaged 14,500 total ducks at peak during January and February. Annual peak refuge population has been as high as 37,000 total ducks in the winter of January 1998-99. Essentially no goose use occurs on the refuge and very little in this portion of South Carolina.

The South Carolina coast has long been a key area for wintering ducks and has a rich waterfowl tradition. The average Atlantic Flyway dabbling and diving duck population figure for the 10 year period 2002-2011 during the mid-winter inventory was 1,255,087 birds. The average number of dabbling and diving ducks during the mid-winter inventory observed in the South Carolina portion of the flyway during the same 10 year period was 86,252 birds. This was down from an average of 238,990 birds that was established for a target for South Carolina based on the 10 year period 1970-1979. For the refuge the average dabbling and diving duck numbers

during the 10 year period 2002-2011 was 16,800 birds annually. This was down slightly from the average of 17,900 from the time period of 1996-2001, as the refuge at that time was new and had just begun surveys for waterfowl. These declines, especially for South Carolina, coupled with legal mandates for the refuge are adequate reasons to include waterfowl as a species of concern. While we try to understand the reasons behind the declines and until we can take the correct measures to reverse the trend, it is important that good and abundant winter waterfowl habitat is provided to maintain a waterfowl habitat base in South Carolina, especially in traditional wintering areas such as the ACE Basin NWR.

Migrating and wintering refuge waterfowl have a variety of habitat requirements to be met. Foraging areas are extremely important and usually come to mind first. Food must be available generally flooded between 0.2 and 1.3 ft. in depth and of sufficient quantity and nutritional quality to sustain waterfowl populations. A variety of food types are preferred. Grain foods will provide calories required in colder environments but may lack nutritional value and variety contained in other foods such as plants and seed materials of moist-soil plants or hardwood mast for example. Preferred moist-soil plants provide seeds and other plant parts (e.g., leaves, roots, and tubers) that generally have low deterioration rates after flooding and provide substantial energy and essential nutrients less available to wintering waterfowl in common agriculture grains (Strader and Stinson 2005).

Invertebrates are another extremely important food requirement for waterfowl. They provide an additional variety of nutrients and protein needed to prepare for migration, molting, egg production, and nesting. Although a single wetland site may not provide adequate food for all requirements, management areas with a variety of wetlands or flooding regimes usually have a mix of habitats that provide all nutritional requirements (Fredrickson and Reid 1988). Food availability alone however is not sufficient. Also required are other basic habitat needs such as sanctuary areas free from disturbance and hunting pressure. Additionally, requirements of refuge migrating and wintering waterfowl include presence of surface water, escape cover, areas for pairing, breeding, molting, loafing, and possibly thermal regulation during colder weather. Lastly and of equal value is the quantity and distribution of the above habitat across the refuge.

The refuge supports and contributes to the North American Waterfowl Management Plan, by protecting a variety of migratory birds, particularly waterfowl (primarily ducks) as a resource of concern, and other species associated with wetlands, and their respective habitats. These individually protected entities when combined, contribute to the continental protection of habitat and wildlife species focusing on waterfowl across the entire North American landscape. The continental goal of the 1998 North American Waterfowl Management Plan update was to maintain the current diversity of duck species throughout North America and to meet the 10 year breeding population average for the 1970-1979 time period as the basis for the year 2000 revisions of continental objectives. Utilizing figures from tables contained in the 2006 Biological Review, the year 2000 continental mid-winter goal set for dabbling ducks derived from that 10 year period was 17,839,706. Stepping down to the South Carolina state level from the same tables, the dabbling duck goal becomes 207,053. Objectives at the refuge level, again from figures provided in the 2006 Biological Review, indicate that the refuge should support wintering duck population numbers of 15,000 – 20,000 in the 1-5 year short term (2006 thru 2011) and 38,000 in the 6-20 year long term (2012 thru 2031).

Habitat needs of migratory waterfowl specifically on ACE Basin NWR are provided through efforts of the refuge staff to actively manage a diversity of wetland areas and sanctuary. These areas currently managed as wetland sites, were former natural marsh areas before conversion

to rice fields prior to the Civil War and then subsequently to managed wetlands for waterfowl of the present. Still other much smaller sites were forested wetlands that the refuge impounded in recent times as greentree reservoirs. All these sites are distributed throughout four major parts of the refuge and are referred to as managed wetlands in this plan. Currently there are approximately 26 individually managed wetland sites containing a total of about 2860 acres. These sites are impounded by dikes and are flooded, as needed, utilizing a combination of tidal river water and rainfall. Tidal hydrology is by gravity flow and is controlled by wooden rice field water control structures or trunks within the dike system of each managed wetland site. There are both fresh and brackish water sites that utilize the average tidal amplitude of 4-6 feet twice daily. These 2860 acres provide important waterfowl sanctuary where no public entry or disturbance is allowed. The refuge has wintered an annual average peak of waterfowl numbers since 1995 of about 14,500 birds with a one-time peak in 1999 of more than 37,000 birds.

Waterfowl hunting on the refuge is restricted to only 2400 acres of natural tidal marsh. That is only 20 % of the total refuge acreage and 55% of total natural marsh. The three distinct types of managed wetlands that provide for the habitat needs of waterfowl on the refuge are moist-soil sites, brackish sites, and greentree reservoirs. Seventeen individual moist-soil wetland sites managed specifically for freshwater conditions, totaling about 2269 acres, are located on the Grove, Bonny Hall, and Combahee Fields portions of the refuge. They are managed for moist-soil plant growing conditions at 0-5 parts per thousand salinity that favor growth of herbaceous plants generally from May through October. These emergent plants produce seedheads that are preferred and beneficial foods for wintering waterfowl. Dense plant growth is then prescribed burned as soon after October as feasible. This provides easier bird access and prepares the seed bed for next year's plant germination. As soon as each site is burned, gradual flooding begins to approximate depths of between 0.2 and 1.3 ft. for foraging waterfowl and generally lasts until late February. The preferred water depth for foraging ranges from ½ to 12 inches and food resources covered by more than 18 inches of water are out of the reach of dabbling ducks (Strader and Stinson 2005). In addition high protein nutritional needs for ducks are provided by invertebrates in moist-soil managed wetlands sites in mid to late February through partial drawdown to between 0.3 and 0.4 ft. or shallower in water level. This increases the availability of invertebrates found in the detritus from submerged plants for foraging ducks. Further gradual drawdown in March and April can provide for wading birds and shorebirds.

A second intensively managed wetland type on the refuge is the brackish water managed wetland site. There are only three brackish managed wetland sites on the refuge that total 314 acres in size and all are located on Jehossee Island. These sites are flooded with 5-15 parts per thousand salinity water to produce submerged aquatic plant foods for wintering waterfowl such as wigeon grass and dwarf spikerush and emergent plants like saltmarsh bulrush. Sites are flooded to depths of between 0.2 and 1.3 ft. except for those with submerged plants like wigeon grass that reaches or nearly reaches the surface and can be flooded somewhat deeper. This diversity of brackish submerged waterfowl food types compliments the nutritional value of waterfowl foods already provided by the refuge freshwater moist-soil managed wetlands. Although the focus on these sites is for wintering waterfowl, the open brackish habitat conditions are the most conducive on the refuge to a multiple species management approach for shorebirds, waterbirds, and wading birds including the endangered wood stork.

Finally, a third wetland type that is managed for waterfowl is the greentree reservoir. Currently three of these totaling 60 acres are located on the Grove North and Grove South portion of the refuge and one of 11 acres at Bonny Hall. Essentially they are bottomland hardwood or the mixed pine-hardwood sites that have been impounded and temporarily flooded usually by rainfall. Flooding is done only during the fall and winter to provide a high protein food source as

well as acorns and other mast for ducks. Invertebrates within the leaf litter provide a high protein food source as well. As many as 1500 or more wood ducks have been known to utilize these small refuge areas daily during the winter as daytime feeding and sanctuary sites.

No major conflicts are anticipated in managing for the present or future habitat needs of migratory waterfowl and the needs of other resources of concern. Any past conflicts on the refuge have been minor, short-termed, and resolved favorably. Future issues will be handled through appropriate mitigation or adaptive management as well. In the past it was recognized that some amount of conflict existed between timely drawdown for adequate moist-soil plant production in freshwater managed wetlands during early summer, and the conflicting desire to provide some prolonged shallow standing water for wood stork, wading bird, and shorebird foraging habitat. Fresh water sites generally are targeted for spring drawdown to bed level for plant germination in sites where drainage is adequate by the end of April or sooner. Storks usually arrive in the local area in mid-March and immediately begin nesting activity. Local wading birds are present and some shorebirds are moving through in April. As a result some sites that are drawn down first are only briefly available to the foraging needs of these species. Fortunately, those sites that may drain poorly and slowly actually provide a greater window of time available for water bird species to forage. However, these conflicts can be resolved or mitigated by the refuge through managing the hydrology of various summer flooding and drawdown of the three brackish managed wetlands on Jehossee Island during this time, specifically for wood storks and other waterbirds. On several occasions, over 900 adult and juvenile wood storks have been observed foraging within one or more of these sites.

Another management conflict with other species that can be favorably resolved is the issue of impacts of prescribed burning necessary for waterfowl habitat improvement. Burning of moist-soil managed wetlands is usually possible when fuels are cured from November through mid-April. Bald eagles are nesting within this time interval and frequently build their nests in dominant trees near or on the edge of moist-soil managed wetlands or on nearby tree islands. Several precautions can be taken to allow burning when eagle nests are nearby or present. Buffer areas can be established around nest trees when feasible, where fire is excluded to offer protection from smoke as well as heat. Head fires burning toward nest trees should also be avoided. Low flame intensity backing and flanking type fires can be utilized as they are less likely to impact nests. Impacts to some marsh and wading bird species of concern, especially the rail group, is also a consideration when burning moist-soil managed wetlands to improve waterfowl habitat. Those species of high priority that could be impacted within these sites include the king rail, yellow rail, sora rail, clapper rail, and possibly the black rail. Some rails, especially the black rail, are reluctant to fly or move from cover to avoid being overtaken by the fire. To lessen the chance of negatively impacting rails, prescribed fire should not be applied by completely surrounding the burn area with a continuous line or circle of fire. This gives rails and other species an escape route and direction to move in an attempt to avoid the flames. Use slow moving fire of low intensity that is backing into the wind, if fuel and burning conditions support that choice. This allows more time for species to move ahead of the fire and escape. Additionally, fires that are not complete in coverage and consumption of all fuels within these sites are not necessarily undesirable. Fires that leave unburned areas within the burn site are favorable to species that use those unburned areas to escape.

WOOD DUCKS (*AIX SPONSA*)

The Atlantic Flyway and Region 4 encourage and promote management activities to increase wood duck productivity on Service lands. The refuge 2006 Biological Review also recognized the importance of the wood duck as a resource of concern by including it in three of its

objectives. The first objective emphasized the management for healthy and productive greentree reservoirs (GTRs) as they are especially important for wood ducks. Secondly, in addition to providing wintering habitat, the refuge should maintain quality wood duck brood habitat and nesting conditions, including nest boxes. A third objective was to achieve the Atlantic Flyway and Region 4 banding goals for wood ducks assigned to the refuge. Studies have documented a lack of suitable natural cavities in the Southeast. This lack of natural cavities is the primary limiting factor to reproduction because of competition for cavity nesting sites from other species and loss of mature forested wetlands. Wood duck nest boxes can make a positive contribution to the well-being of this species, if they are properly constructed, located and erected, predator proofed, and maintained. A small number, 15 boxes, have been erected on the refuge and will not be increased until greater than fifty percent use is achieved. Wood ducks are common winter residents at ACE Basin NWR and essentially the only significant summer nesting duck. Winter night roost numbers of refuge wood ducks can be as high as 3000 to 4000 on managed wetland sites. Winter day use on one particular site, GN19 on the Grove North Compartment one of the four refuge GTRs, has peaked in recent years at around 1500 wood ducks.

Summer habitat includes generally fresh water near woodlands, such as wooded swamps, flooded forest, ponds, marshes, and along streams and rivers. Winter habitat can be on both freshwater and brackish marshes, ponds, streams, and estuaries (AOU 1983). Daytime winter habitat on the refuge consists primarily of greentree reservoirs and seasonally flooded forested wetlands as day loafing and foraging areas. Nighttime use in winter occurs mainly as roosting sites on refuge managed wetlands containing flooded moist-soil plants and emergent marsh grasses. Wood ducks nest in cavities of large trees with an entrance size of at least 9 cm and in wood duck nest boxes. These are located in forested wetlands usually within 0.5 km of water and near forest canopy openings (NatureServe 2009). After young leave the nest, females may lead them up to several km to suitable brood habitat with food and cover. Shallowly flooded habitat with good overhead cover within one to two feet of the surface of the water is important cover for broods (NatureServe 2009). A minimum of 1/3 cover to 2/3's open water is required but optimum habitat has 3/4's cover and 1/4 open water. Wood ducks typically use habitats with 50-75% overhanging woody vegetation and/or emergent vegetation for brood escape cover (Sousa and Farmer 1983)

The refuge will support continental goals of the North American Waterfowl Management Plan as well as step-down state goals. The basis for continental goals for all ducks originally set in the 1998 North American Waterfowl Management Plan was to meet the 10 year breeding population average for the 1970 -1979 period at 3,000,000. Since there are no breeding population figures at the state and refuge level, the mid-winter inventory will be utilized. At the state level, using harvest data assuming a 12% harvest rate, the 2006 Biological Review estimated an average wintering population of wood ducks for 1970-1979 for South Carolina to be 484,417. Stepping down to the refuge level, figures also provided in the 2006 Biological Review indicated that wood ducks represented 26.5 % of all waterfowl from ground counts on refuge. Therefore 26.5% of refuge total waterfowl objectives, means that the refuge should winter wood duck population numbers of 3,475 – 5,300 in the 1-5 year short term and 10,070 in the 6-20 year long term.

In support of this objective a variety of habitats is provided throughout the year on the refuge for wood ducks. The moist-soil managed wetlands of 2494 acres distributed widely over the refuge are utilized as winter feeding sites for wood ducks primarily during the early morning and late afternoon hours. More significantly, these same sites are used by wood ducks for winter night roosting. Three of these dispersed refuge managed wetland sites together have provided night

roosts for a range of from 250 to 3000 or more wood ducks daily during the earlier portion of the winter period. These occur usually within sites GS9A-B at Grove South, site CF2 at Combahee Fields, and site BH5 at Bonny Hall. Tidal creeks that meander through 4330 acres of refuge natural marsh also offer day feeding and loafing sites that smaller numbers of wood ducks favor both winter and summer. Three refuge greentree reservoirs totaling 60 acres at the Grove North and Grove South Compartments provide day feeding and loafing sites for as many as 1500 or more wood ducks during the fall and winter from November into January. There are 1524 acres of bottomland hardwoods suitable for wood ducks to locate at least minimum numbers of summer cavities for nesting and to find fall/winter foraging habitat when flooded. The refuge has started a wood duck nest box program very conservatively with a dozen boxes. Use for the first three years has been less than 50 percent and sporadic. Relocation of boxes will be considered before any additional ones will be added.

During the spring and summer months local wood ducks disperse to breed, nest, rear young, and molt. To contribute to these habitat needs, three smaller isolated managed wetland sites GS7, GS8, and GS26 in Grove South Compartment 3 of about 44 total acres that do not respond well to moist-soil management, are treated by partially flooding them during the summer and typically drawing them down the remainder of the year. Natural plant responses at these sites include giant cutgrass, sawgrass, needlerush, various marsh plants, and undesirable woody plants on the higher edges. A total of three hundred cypress seedlings were planted in two of these areas, GS7 and GS8, in 2005 to compete with undesirable Chinese tallow tree (*Sapium sebiferum*) presence there and to potentially become future stork nesting sites. In addition this combination, of both allowing dense natural marsh monocots to proliferate and planting of cypress seedlings, conserves otherwise intensive refuge maintenance/management efforts while contributing positively to carbon sequestration. Vegetative cover in these semi-permanently flooded sites, range from open water to dense marsh grass. These areas are attractive to wood ducks as brood rearing habitat and for molting. The dense marsh grass portions of these areas are also used by rails, bitterns, and other marsh birds. One of these areas, Perimeter Pond (GS26), is particularly valuable to the refuge banding program when maintained during the summer months in deeper water, up to two feet or more and at 80 percent open water. This is a wood duck banding site where we have been able to meet and exceed our annual banding quota for several years running.

Management for wood ducks does not conflict in any large measure with management for other waterfowl, marsh birds, and waterbirds that utilize the various habitats offered by 2860 acres of refuge managed wetlands as moist-soil, brackish, or greentree reservoir areas. Some moderate impacts to other animal and plant species, however, can occur in areas like the greentree reservoirs and others in both the short and long term. Within greentree reservoirs, seasonal inundation of bottomland or deciduous hardwoods inherently can displace some species of reptiles, amphibians, landbirds, and mammals for at least the duration of the winter months of November through February when flooded. The positive aspects of this situation are that the displacements are temporary, involve only relatively small areas of forested habitat, and actually occur naturally in bottomlands where hardwoods are subject to occasional and sometimes annual flooding. In greentree reservoirs the short term possibility of tree mortality from temporary flooding is usually avoided by adequately and early removal of water annually at the end of the winter season. Some long term stress and tree mortality has also been associated with dormant season flooding in greentree reservoirs, even when managed properly. Potential effects such as these to plant and animal species can at least be offset by emulating the natural local flood regimes or through timely flooding and drawdown, through variation in flood depths each year, and by not flooding at all in each greentree reservoir once out of every 3 or 4 years. Early flooding, annual flooding, and delayed spring drawdown can result in decreased acorn

production, increased tree mortality, and gradual replacement of seasonally flooded oak stands with species that are more water-tolerant but produce less food for waterfowl, so alternate year and variable flooding are recommended (LMVJV 2007).

Also, there is some conflict during part of the summer months with the necessary deep flooding of Perimeter Pond (GS26) for banding within the Grove South Compartment. Use as a wood duck banding site takes precedence, however. Deep flooding precludes mid-summer drawdown to benefit other species of concern including wood storks, other wading birds, and shorebirds. This is a relatively small site of about 25 acres or less depending on water depth and is more than offset by summer management for the same species of concern in the brackish managed wetlands at nearby Jehossee Island. Also, drawdowns at Perimeter Pond to benefit these bird species are usually possible before and after the wood duck banding period.

SHOREBIRDS

Shorebirds as a group were included as an objective in the refuge CCP and in the 2006 Biological Review. The Atlantic Coast Joint Venture (ACJV), under the framework of the NABCI, originated SAMBI and its planning area that corresponds to the eastern half of the Southeastern Coastal Plain Bird Conservation Region BCR 27, within which the refuge is located. In the SAMBI priority species list of migratory birds there is a total of 25 shorebird species listed and 19 of those have been observed on the refuge. Five of those 25 species are listed within a score of highest priority species and all five are present or have been observed at least once or twice on the refuge. The remaining twenty species are listed as of high priority and 14 of those are present or have been observed at least once or twice on the refuge. Approximately 30 species of shorebirds utilize managed wetland sites and some portions of natural marsh on the refuge. The greatest abundance and diversity occurs mostly in the warmer months during northbound and southbound migration. Use is generally concentrated around water drawdown of refuge brackish managed wetland sites as they provide more open flats for foraging, whereas the more abundant freshwater moist-soil managed wetlands and natural marsh areas are sometimes too densely vegetated for most shorebird use. The refuge does not contain sizable shorebird habitat in the form of lengthy ocean shoreline or expansive naturally open tidal flats that could attract more of the priority shorebird species of Table 3 below. Instead, emphasis and concern on the refuge is directed toward those species that readily use drawdowns of smaller brackish managed wetland sites.

Habitat requirements can vary widely depending on the range in size of shorebird species groups from sandpipers to plovers to avocets or skimmers. Generally in the refuge landscape, habitats consist of areas of open, shallow water or exposed mudflats and sites with short, sparse vegetation such as dwarf spikerush. Water depths preferred are usually those less than 0.3 ft. deep. Shorebirds feed primarily on insects, larvae, worms, mollusks, and other invertebrates. Manipulation of water levels within refuge managed wetlands is required to provide adequate foraging conditions. Refuge areas subject to the least disturbance are preferred for foraging and resting. Populations are more abundant during the spring and fall portions of the warmer months during migration and less during the mid-summer and winter, therefore timing of water level manipulations is important as well. Table 3 shows some of the more important shore, wading, and marsh bird species aggregated by habitat-species suites. They represent priority shore, wading, and marsh bird species for BCR 27. The three habitat types in Table 3 below are present on the refuge and so are some, but not all, of the priority species shown.

Table 5. Priority shore, wading, and marsh bird species and habitats for BCR 27

Habitat	Priority Species	Description
1) Managed and Palustrine Emergent Wetlands and Mudflats	King Rail, Yellow Rail, Black Rail, Least Bittern, American Bittern, Buff-bellied Sandpiper, Stilt Sandpiper, Whimbrel, Northern Pintail, American Black Duck, Ring-necked Duck, Wood Stork	Freshwater marshes and mudflats-freshwater emergent tidal marshes, managed impoundments, dredge spoil, exposed mudflats (managed and shallow water)
2) Maritime Communities: Estuarine emergent wetlands	Nelson's Sharp-tailed Sparrow, Salt Marsh Sharp-tailed Sparrow, Seaside Sparrow, Black Rail, Yellow Rail, Black Duck, Wood Stork, Blue-winged Teal	Estuaries - tidal flats, emergent wetlands, natural marsh and border maritime woodlands
3) Maritime Communities: Impounded estuarine wetlands	Red Knot, Piping Plover, Snowy Plover, Wilson's Plover, Least Tern, Royal Tern, Common Tern, Gull-billed Tern, Black Skimmer, American Oystercatcher, Reddish Egret	Brackish managed impoundments

As a partner in the U.S. Shorebird Conservation Plan and supporter of the S.C. Comprehensive Wildlife Conservation Strategy 2005-2010, the refuge integrates management actions designed to benefit shorebirds into the overall manipulation of managed wetlands throughout the refuge but more particularly during spring and fall in brackish impoundments. The most reliable habitats that provide for the needs of shorebirds on the refuge are the brackish managed sites on Jehossee Island. These three sites total about 314 acres and are managed with flooding and drawdown of tidal waters ranging in salinity from 5 to 15 parts per thousand. Management is for summer habitat for shorebirds, wading birds, and marsh birds and lasts from March through September. Shorebird species benefitted include black skimmer; least, royal, common, gull-billed, and sandwich terns; willet; black-necked stilt; semi-palmated plover; Wilson's plover; American avocet; greater and lesser yellow-legs; spotted, least, western, white-rumped, pectoral, and stilt sandpipers; dunlin; short and long-billed dowitchers; and wimbrel. Frequent flushing of water through these sites and the openness, occasionally up to 70 percent open water, are more attractive to shorebirds than the dense summer plant growth in managed freshwater sites or the natural marsh. In freshwater managed wetlands, this dense summer growth, including both desirable and undesirable plants, generally tends to inhibit some shorebird use as compared to brackish sites. Depending on the degree of openness, these freshwater moist-soil sites of about 2269 acres are at least available to provide some mudflats and shallow water for foraging shorebirds, at drawdown during March, April, and sometimes into May. They are usually not re-flooded as most brackish sites are later in the summer. In addition, 4330 acres of natural tidal marsh on the refuge, although dense in areas with a variety of marsh plant species, does offer openings, mudflats, and edges of tidal creeks and rivers for most if not all of the shorebirds listed above.

Management practices for shorebirds and the management for other refuge species or resources of concern are not anticipated to result in any unresolved conflicts. Resolution of

conflicts for shorebirds has already been included in Chapter 3 under wood storks and migratory waterfowl. Any conflicts were resolved through an adaptive management process where multiple species management was employed to accommodate several species over time and space. The prime example of this, also previously addressed, is the brackish managed wetlands on the Jehossee Island portion of the refuge. One extra precaution should be mentioned concerning the brackish sites. Several summer drawdown and re-floods on the brackish sites, whether for wading birds, marsh birds, or shorebirds, will require a conscious effort to maintain moisture to avoid detrimental impacts to soil, plants, and invertebrates. Drying of the soil substrate in these sites to the point where dried mud starts to form cracks can be detrimental to invertebrate populations as forage for shorebirds and to desirable plants intended for winter waterfowl foods. Drying of these soils with sulfates can cause an undesirable aerobic and acid forming condition unfavorable to short term management.

WADING BIRDS

Nearly a dozen wading birds species have been observed utilizing various wetland habitats on the refuge. Some of the primary groups are herons, egrets, ibises, storks, and allies. Long-legged wading birds in Table 3 as compared to shorebirds are capable of utilizing more of the available refuge wetland habitats considering various water depths and presence of vegetative cover. These include fresh and brackish managed wetland sites and some of the natural marsh sites that are not as attractive to shorebirds. Additional refuge wading bird priority species listed in SAMBI not shown in Table 3 include: little blue heron, tricolored heron, black-crowned night heron, yellow-crowned night heron, glossy ibis, white ibis, wood stork, and whooping crane. As of 2013, this was the sixth year for the refuge to winter at least one whooping crane from the eastern migratory experimental population. The last four of those years, a mated pair of whooping cranes spent the winter on the refuge. Each year crane use has occurred on one or more refuge moist-soil managed wetland sites in the Combahee Fields tract. Observations of these species, their numbers, use of impoundments, and the condition/management of these impoundments will provide valuable information for guiding future management decisions.

Habitat requirements for wading birds can be as diverse as the various species and groups represented. They range from fresh water ponds, lakes, streams, wetlands with emergent aquatic vegetation to brackish coastal marshes, riparian and wooded wetlands, bogs, and estuaries. All sites should be relatively free from disturbance. Water depth for foraging is also variable depending on the species but typically ranges from between 0.2 and 1.3 ft. Some species utilize deep water while perching on limbs or structure. These habitats must provide the presence of food resources that are both desirable and available. Available can mean foods of the correct type, size, concentration, and distribution. Concentrated food sources within shallow water drawdown situations provide optimum foraging habitat. For this group a broad spectrum of food resources generally includes fish of the small to medium size range, crustaceans, and other aquatic invertebrates, reptiles and amphibians, terrestrial invertebrates, some plant life, and even small birds and mammals. Dependent again on species, some waders prefer an interspersed of various types of aquatic systems, a mix of aquatic and non-aquatic, and some percentage of open water. The refuge 2006 Biological Review suggested a range of 30-60% open water compared to emergent cover in managed wetland sites on the refuge (USFWS 2006). Nesting requirements of the group include undisturbed habitat sites mostly at tree canopy level in woody vegetation for herons, egrets, ibises and wood storks. Some waders require colonies for nesting while others are solitary nesters but all require foraging areas to be in close proximity during the nesting period. At present there are no nesting colonies on the refuge. However, as development and disturbance continues to escalate in coastal South

Carolina, ACE Basin NWR and other public lands within the larger ACE Basin Project area will become increasingly important in providing secure nesting areas for these species.

Refuge contributions to the waterbird group and the Northern American Waterbird Conservation Plan include management of hydrology in impounded wetlands, protection from disturbance for the species utilizing the areas, and acquisition of additional wetland habitats. The foremost refuge contribution is brackish water management on 314 acres within three managed wetlands on Jehossee Island. This is during the summer months when wading birds require access to foraging areas with sufficient food resources provided and readily available to sustain them through the period of nesting, fledging, and rearing of young. Food resources in the form of forage size fish that have entered the wetland sites are concentrated and made available to wading birds by lowering water levels. The summer drawdown to accomplish this primarily for wading birds is in July. More than 900 wood storks at one time have been observed utilizing the drawdowns in these brackish managed wetlands.

Hundreds of other wading birds can be seen foraging including herons, egrets, ibis, and allies. In addition to this July primary drawdown there are two others, one in April and another in September. These two drawdowns are intended to focus on migrating shorebirds but provide some foraging periods for waders before reaching shorebird mudflat conditions. Although not as intensively utilized, all 2269 acres of freshwater moist-soil sites can provide some wading bird feeding opportunities during normal annual drawdown usually underway in March and sometimes lasting through April. Forage fish for wading birds in these areas are available in the lowest of elevations during drawdowns where water collects in residual pools or in shallow drainage ditches crossing the bed of these managed wetlands. Also three smaller isolated wetland sites GS7, GS8, and GS26 at Grove South of about 44 total acres that do not respond well to moist-soil management, are flooded and drawn down to various levels for wading birds as well as for rail and woodcock use. Some of the refuge wading bird priority species benefitted and listed in Bird Conservation Region 27 and in the S.C. Comprehensive Wildlife Conservation Strategy 2005-2010 include little blue heron, tricolored heron, black-crowned night heron, yellow-crowned night heron, glossy ibis, white ibis, wood stork, and the experimental population of whooping crane. Currently no wading bird rookeries exist on the refuge despite attempts to encourage them through summer flooding and placement of artificial nesting platforms in two different locations. However, isolating some abandoned remnant dikes on the refuge and converting to tree islands will be explored and considered as potential wading bird rookery sites.

Management activities intended to benefit wading birds on the refuge have been designed to have little or no conflict with management of other resources of concern. The multiple species management approach afforded by the brackish water managed wetlands represents the best example of compromise and adaptive management to avoid conflicts in habitat needs of resources of concern. This topic has been covered already in Chapter 3 under wood storks, migratory waterfowl, and shorebirds. The multiple species approach is possible and functional because of the relatively short plant germination and maturing time for waterfowl forage plants, tolerance of these plants for submerged or partially submerged plant growing conditions necessary for waterbirds, and relative openness of site conditions generally afforded by these particular brackish plants for waterfowl. Unlike the multiple species approach, spring and summer drawdown in freshwater moist-soil sites are not designed specifically with wading birds or shorebirds in mind. These drawdowns are intended to encourage desirable waterfowl food plants and discourage undesirable ones by timely removing water for germination and survival of the desired plants. This causes some conflict by shortening the window of time available for wading birds to forage but regardless it still provides a secondary benefit to them from drawdown. This secondary benefit to wading birds, however, can be increased whenever the

water level drawdown process is prolonged either intentionally or for some other reason including simply slow or poor drainage. However, drawdowns in freshwater moist-soil sites that prolong the flooding period into the summer and recur two consecutive years or more, usually begin to encourage undesirable plants such as giant cutgrass and to discourage desirable ones for waterfowl such as the panic grasses.

MARSH BIRDS

More than a dozen species of marsh birds utilize refuge natural marsh as well as some managed wetland sites for nesting, cover, and foraging habitat. These include the various groups such as the rails, bitterns, and marsh sparrows in Table 3. About half the acreage of the refuge or more than 7,000 acres is, in some form of mostly brackish marsh with some freshwater marsh and managed impoundments, available to marsh bird species. All of the priority marsh birds that are found at ACE Basin NWR require tall emergent vegetation as part of their habitat. All are breeding species, except American bittern and yellow rail. Of the marsh birds of priority interest, king, yellow and black rails are of highest concern, followed by least bitterns and American bitterns (Hunter and Noffsinger 2006). In addition several refuge priority songbird species utilize refuge natural marsh as well. These are resident seaside sparrows, wintering saltmarsh sparrows and Nelson's sharp-tailed sparrows. All of these species are listed in SAMBI as high or highest priority.

Marsh bird habitat requirements generally include the presence of tall emergent marsh vegetation for foraging, cover and nesting. Water depth requirements can vary from simple moist conditions to a foot or more deep. Large patches of habitat greater than 20 acres are more desirable for marsh bird species than smaller patches. On the larger patches of marsh, 40-70 percent should be in tall emergent vegetation, with the remaining 30-60 percent in open water, floating vegetation, and submerged aquatic vegetation. Small patches may suffer from elevated depredation pressure, so more emphasis should be given to maintaining suitable marshland in larger patches when possible. During the last several decades, overall loss of freshwater emergent wetlands has been underway as development pressures increase, especially away from immediate coastlines.

The king rail, in particular, is thought to have declined dramatically from inland areas and is now considered to be a species in potentially deep conservation trouble in areas away from the coast. The king rail, by being one of the high priority marsh birds in BCR 27, may serve as an umbrella species for the other priority marsh birds (Hunter et al. 2006). King rails may be the most habitat-specialized of the species nesting in tall emergent vegetation. Their nests are constructed near the soil, usually where standing water depths are about 0.8 ft. Higher water levels have the potential to flood out the species. Little or no standing water potentially exposes nests to greater depredation pressure from raccoons. Higher ground is utilized the rest of the year. These conditions should support nesting least bitterns as well, with nests usually placed higher in the vegetation making this species more tolerant of deeper flooding. The habitat requirements for the black rail are similar to the breeding habitat for king rails as far as needing to have some relatively high ground, except for black rail this is required throughout the year. The need to fully understand the effects of prescribed fire on black and yellow rails is of particular importance. This is because certain prescribed burning practices (complete encircling with fire and/or multiple aerial ignitions) are known to result in high mortality as these small rails are sometimes unable to escape flames and smoke.

Marsh birds that are benefitted by the refuge number more than a dozen species and are represented by groups such as the rails, bitterns, gallinules, and marsh sparrows. Refuge

contributions to the waterbird group and the Northern American Waterbird Conservation Plan include management of hydrology in impounded wetlands, protection from disturbance for the species utilizing the areas, and acquisition of additional wetland habitats. The refuge provides about 4330 total acres of natural marsh habitat available to marsh bird species. This includes a vast majority of brackish natural marsh and a small remaining percentage of scattered fresh water natural marsh. Most of the natural marsh is composed of tall emergent vegetation like the cordgrasses (*Spartina spp.*), narrow-leafed cattail, black needlerush, and bulrush that marsh birds utilize for nesting, cover, and foraging habitat. Active management of the natural marsh primarily takes place on Jehossee Island where over 3000 acres are subject to prescribed burning to maintain the current successional stage of tall marsh emergent plants without woody encroachment. This includes an area of 200 to 600 acres or more of high marsh on the island, depending on the amount of woody invasion that has occurred since the last burn cycle. The high marsh is important as breeding habitat for seaside sparrows and black rails.

In addition to burning in the natural marsh habitat to benefit marsh birds, the refuge intensively manages another 2860 acres of impounded managed wetlands. These include both the freshwater moist-soil and the brackish sites managed through the use of hydrology and fire mainly to produce waterfowl plant foods. These moist-soil and brackish sites all contain tall emergent vegetation, both desirable and undesirable, that is available for marsh bird nesting, cover, and foraging habitat. Some of the refuge marsh bird priority species that are benefitted and also listed in Bird Conservation Region 27 and the S.C. Comprehensive Wildlife Conservation Strategy 2005-2010 include king, yellow and black rails followed by least bitterns and American bitterns. Among songbirds, priority species are resident seaside sparrows and wintering saltmarsh and Nelson's sharp-tailed sparrows.

No major conflicts in managing for marsh birds and for those of other resources of concern are anticipated that cannot be resolved. Prescribed fire is the primary tool in the natural marsh, especially high marsh, to maintain the non-woody stage preferred by many marsh birds. Ironically however, if utilized incorrectly it can increase mortality in the very species that it was intended to aid. Some marsh birds especially black rails are reluctant to escape a flame front by flying or moving across an open area or burned area to safety. All fire techniques that afford escape opportunities to marsh species should be considered before ignition is started. Utilize slow backing or flanking type fires of low intensity when possible instead of high intensity fast moving head fires. Avoid burning all habitats at once by leaving some for another season or year, or burn several smaller areas at different times during the same season. Also do not encircle the burn area with a complete ring of fire and if acceptable, utilize spotty or incomplete coverage of the area to create escape zones.

The same fire techniques utilized to reduce bird mortality in the marsh also apply in the managed wetland sites. There can be conflict in managing water levels for wintering waterfowl verses marsh birds in managed wetland sites. Priorities in winter for waterfowl normally dictate that all sites in general will be maintained at refuge duck foraging depths between 0.2 and 1.3 ft. The deep end of this range precludes most marsh bird species use of these areas during winter months. A possible solution would be to leave one site in a cluster of sites each winter in moist to shallow water conditions of less than 0.5 ft. for marsh birds. This could be a site that is difficult to drain in the normal fashion in the spring, one that does not respond well to moist-soil management, or has undesirable plants due to prolonged retention of water during the growing season.

MIGRATORY LAND BIRDS

One of the establishing mandates of the refuge is “to conserve and protect migratory birds”. As of 2009, the refuge bird checklist included 291 total species of birds found with varying degrees of regularity. Fifty-five species of this total number are considered accidentals, meaning they have been reported only once or twice. A total of 96 species are known to nest on the refuge. Approximately 10 species of land birds are included in the highest priority category in the SAMBI priority list and nearly 30 are included in the high priority listing. Many of the migratory land birds, especially the Neotropical migrants are experiencing long-term declines as a result of widespread habitat loss and fragmentation. Bottomland hardwood forests and riparian woodlands have been identified as a top habitat conservation priority throughout the Southeast (Hunter and Noffsinger 2006).

Conservation and management of the critical bottomland forests as well as a diversity of other habitats on the refuge will enhance the breeding, wintering and transitional habitat requirements for many species of migratory and resident land birds. Migratory land birds on the refuge are those that are primarily associated with forested uplands, forested wetlands, scrub/shrub, openings, and grasslands. They encompass a wide range of species and groups including warblers, finches, sparrows, raptors, and numerous other perching or songbirds. A particularly important land bird species of management importance identified during the 2006 Biological Review is the painted bunting. Although the painted bunting is already a species of Continental Conservation Interest, the eastern subspecies (possibly a separate species) is among the highest ranking taxa in the Southeast in need of conservation attention (USFWS 2006). The eastern painted bunting is restricted to the Coastal Plain of extreme southeast North Carolina, South Carolina, Georgia, and northeast Florida, while most birds winter in south Florida (formerly more common, now decidedly uncommon), Cuba, and the Bahamas (Hunter et al. 2001). Although most large breeding populations are on sea islands or otherwise within 50 miles of the Atlantic coast, some sizeable populations do occur in the inner Coastal Plain to the fall line with the Piedmont, most of which are closely associated with major river systems, such as the Altamaha, Savannah, and ACE Basin–Cooper. This species is declining within the South Atlantic Coastal Plain, not unlike most other species associated with successional habitats (Hunter et al. 2001).

Habitat requirements can vary widely among this rather large assortment of species and groups. For example, many of the forest interior songbirds (e.g., Swainson’s warbler (*Limnothlypis swainsonii*), and cerulean warbler (*Dendroica cerulea*)) require complex vertical and horizontal structure for nesting and foraging (LMVJV 2007). Hamel (2000) suggested that for nest sites and foraging substrates, cerulean warblers need canopy gaps intermixed with dominant, shade-intolerant trees with expansive, long-limbed crowns that overtop large, individual, shade-tolerant trees (LMVJV 2007). Classifying some of these priority species and their habitat requirements may help to focus on those species and habitats that are of priority concern in the local bird conservation region, many of which currently inhabit and occur on parts of the refuge and surrounding landscape. Table 4 represents some of the priority land bird species and their habitats for the BCR 27 area within which the refuge is located. The table assembles landbirds according to habitat requirements and species associated with that habitat. All seven habitats, to some degree, are present on the refuge and so are many of the priority species shown.

Table 6. Priority land bird species and habitats for BCR 27

Habitat	Priority Species	Description
1) Grasslands and Associated Habitats	Henslow's Sparrow, Loggerhead Shrike, Northern Bobwhite Quail, Le Conte's Sparrow, Buff-breasted Sandpiper, Sandhill Crane	Grasslands within largely forest-dominated landscapes with pitcher plant bogs, prairies, sedgeland, savannas, barrens, glades, and sod farms
2) Early-Successional and Shrub-Scrub	Bachman's Sparrow, Henslow's Sparrow, Loggerhead Shrike, Prairie Warbler, Northern Bobwhite Quail, American Woodcock, Field Sparrow	"Old-field", hedgerows, fire maintained plant communities under mature pine forests, bogs, and remnant cedar (<i>Juniperus</i> spp.) glades
3) Forested Wetlands (Alluvial)	Swallow-tailed Kite, Prothonotary Warbler, Black-throated Green Warbler, Cerulean Warbler, Swainson's Warbler, Yellow-throated Warbler, Wood Duck, Mallard	Bottomland hardwood forests, alluvial forests, and swamp forests, alluvial floodplain, major forest types are cottonwood (<i>Populus</i> spp.), oak (<i>Quercus</i> spp., oak/hickory (<i>Carya</i> spp.), cypress (<i>Taxodium</i> spp.)/tupelo (<i>Nyssa</i> spp., and sweetbay (<i>Magnolia</i> spp./redbay (<i>Persea</i> spp.)
4) Forested Wetlands (Non-Alluvial): Pocosins, Carolina Bays, Other Non-Alluvial	Black-throated Green Warbler, Swainson's Warbler, Prothonotary Warbler, Worm-eating Warbler, Red-cockaded Woodpecker, Brown-headed Nuthatch, Red-headed Woodpecker, Chuck-will's-widow, Wood Duck, Yellow-throated Warbler, Northern Parula	Pocosins, Carolina Bays, and other non-alluvial wetlands, pond pine dominated pocosins, palmetto (<i>Sabal</i> spp.), laurel oak (<i>Quercus laurifolia</i>), loblolly pine (<i>Pinus taeda</i>)
5) Maritime Communities: Maritime Forest/ Shrub-Scrub	Painted Bunting, Prairie Warbler, Common Ground Dove, Northern Parula, Yellow-throated Warbler, Bicknell's Thrush, Kirtland's Warbler, Cape May Warbler, Black-throated Blue Warbler, Connecticut Warbler	Live oak (<i>Quercus virginianus</i>), palmetto (<i>Sabal palmetto</i>), loblolly pine (<i>Pinus taeda</i>), coastal hammocks with numerous under-story species, shrub-scrub thickets of wax myrtle (<i>Myrica cerifera</i>) and yaupon holly (<i>Ilex vomitoria</i>)
6) Mature Loblolly	Field Sparrow, Brown-headed Nuthatch, Prairie Warbler, Bachman's Sparrow, Northern Bobwhite Quail, Red-cockaded Woodpecker,	Mature loblolly, shortleaf (<i>Pinus echinata</i>), and slash pine (<i>Pinus elliottii</i>) forest; much of longleaf historic longleaf pine and shortleaf pine have been replaced with loblolly and slash pine stands
7) Riparian/ Mixed Mesic Hardwoods (Southern Mixed, Hammocks)	Swainson's Warbler, Kentucky Warbler, Acadian Flycatcher, Louisiana Waterthrush, Cerulean Warbler, Worm-eating Warbler, Wood Thrush, Hooded Warbler	Riparian-streamside areas, bottomlands and all palustrine wetlands on coastal plains and prairies, upland riparian areas; Hammocks-narrow bands of vegetation confined to slopes between upland sand/clayhill pinelands and bottomlands

The management of refuge habitats will consider, and whenever possible support, actions proposed to be implemented for the priority species of the S.C. Comprehensive Wildlife Conservation Strategy 2005-2010 and the Southeastern Coastal Plain (Bird Conservation Region 27) as part of the Partners-in-Flight Plan. The habitat needs of these priority migratory and resident land birds are met in various degrees on the refuge within several of the major habitat types. Planned management in these habitat types are intended to improve conditions for a diverse suite of species as well as some individual land birds. Refuge habitat types that are primarily associated with the land bird group include forested wetlands, forested uplands, scrub/shrub areas, various openings, and grasslands. These areas all total approximately 5,000 acres. This does not count the natural marsh of another 4,330 acres that has already been addressed for several species of sparrows under the marsh birds in Chapter 3. There are 3,087 acres of forested wetlands that are composed of 1,524 acres of bottomland hardwoods and 1563 acres of mixed pine-hardwoods available to migratory land birds. Refuge forested uplands of 1,110 acres will also provide habitat for land birds. These uplands consist of almost exclusively both natural and plantation pine type habitat with only a small amount of marginal scattered upland hardwoods.

There are no anticipated conflicts in management activities for the migratory land bird group and for the other plant and animal species of concern addressed for the refuge that have not been included and discussed already. Several diverse refuge habitat types are common to these land birds as well as to the other species of concern. They include the forested wetlands, forested uplands, early successional, and grassland areas. Although any major conflicts were resolved in the planning stage for managing these diverse areas for the land bird group, some of the necessary adjustments and compromises can be highlighted. For example, the use of growing season fire to favor potential red-cockaded woodpecker habitat was addressed, concerning possible nesting mortality of other landbirds. Potential harmful effects of growing season fire can be diminished in the forested upland pine and mixed pine-hardwood sites where proposed. This would be done through use of burns that are, early in the season before most birds begin to nest, of low fire intensity, backing type fire, of smaller acreages, and by not burning all similar habitat areas the same year.

Potential land bird short-term losses from fire are outweighed by the long-term benefits in the pine and pine/hardwood habitat types. One study found that declining birds that are associated with southern pinelands are heavily dependent on prescribed fire for their continued existence and few long-term consequences are likely to occur for nesting birds even when lightning-season (after April) burns are utilized (Cox and Widener 2008). Not only would both migratory land birds and potentially red-cockaded woodpeckers gain in the long-term from this short-term compromise, many other refuge resources of concern would benefit including plants and animals as listed in this plan in Chapter 3- Red-cockaded Woodpecker. All these particular species would be favored to some extent by habitat conditions with little or no understory, low basal area, open park-like stands, and conditions that are maintained by use of prescribed fire.

Another potential conflict that was resolved, dealt with the disturbances to land birds and other wildlife species that could result from poor timing of management techniques utilized to maintain the early successional and grassland habitat types. Activities including mechanical mowing, chipping, chopping, disking, planting, herbicide use, and burning are all potential techniques utilized to maintain these habitats in the long term for buntings, Neotropical migrants, and other land birds. Manipulations at critical times during the breeding and nesting periods from late April through July can be detrimental at least in the short term. Ideally for the least disturbance to species to be benefitted, treatment manipulations like mowing would be timed from mid-

February through early April after winter bird use of the standing thatch and before arrival of spring migrants for nesting. If the fuels exist and the treatment choice is burning, this may be the only season that fuels would be cured enough to carry fire. Otherwise any of these manipulations would be an option normally from August through early April in order to expedite the process outside bird nesting periods and to be the most effective.

Bald Eagle (Haliaeetus leucocephalus)

The bald eagle was officially de-listed from the endangered and threatened species list in June of 2007 but it will remain in a protected status under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Bald eagles are present year-round on the refuge with the majority of observations occurring during migration periods and winter. As of the year 2009 there were three active bald eagle nests on the refuge, one on the Grove South Compartment 3 and two on Jehossee East Compartment 4. Management activities for bald eagles on the refuge include occasional nest surveys from the ground and midwinter bald eagle surveys, in coordination with aerial nest surveys results from the SCDNR as they become available. As many as a dozen bald eagles have been observed on midwinter counts.

Breeding habitat requirements for eagles most commonly includes areas close to (within 4km) coastal areas, bays, rivers, lakes, or other bodies of water that reflect the general availability of primary food sources including fish, waterfowl, and seabirds (Andrew and Mosher 1982, Green 1985, Campbell et al. 1990). Wintering areas are commonly associated with open water though in some areas eagles use habitats with little or no open water if other food resources (e.g. rabbit or deer carrion) are readily available. In winter, eagles may associate with waterfowl concentrations or congregate in areas with abundant dead fish (Griffin et al. 1982). Eagles avoid areas where disturbance is a factor and usually chose nest trees in prominent locations within undisturbed sites.

There are at least 4,197 acres of forested habitat consisting of 1,110 acres of upland forests and 3,087 acres of wetland forest types on the refuge to provide available choices of eagle nest sites. Additionally, there are about 7,190 acres of open wetlands consisting of 4,330 acres of natural marsh and 2,860 acres of managed wetlands available as foraging sites. In the past the eagle nest sites have normally been located on the periphery of refuge forested areas usually on the natural marsh edge, tree islands, or bordering a managed wetland. Actively managing forest stands will help to create and preserve future potential eagle nest trees.

Most management activities designed to create or preserve potential nest trees or stands will not conflict with other habitat management practices. However, some activities nearby active nests such as prescribed burning to improve habitat for other species could be in conflict. Care would have to be exercised when dealing with fire intensity and smoke exposure to all nest sites. Nest tree sites could be either excluded from the burn or burned at low intensity to allow burn benefits for other potential species such as landbirds, amphibians, and endangered plants. Another alternative would be to burn during the eagle non-nesting season from March through October.

INVASIVE AND NUISANCE SPECIES

Invasive Plant Species

The occurrence and spread of exotic, invasive, and nuisance plant species were identified by Service staff and intergovernmental partners during the 2006 Biological Review as one of the priority management issues facing the ACE Basin National Wildlife Refuge (USFWS 2006). Invasive plant species have become intruders on all refuge wetland and upland habitats, as well as most disturbed sites to varying degrees. Chinese tallow tree and *Phragmites*, or common reed, are currently the two most problematic invaders on the refuge and are both listed in South Carolina's Nonnative Invasive Plant Species List of 2004 as severe threats. *Phragmites* is a tall, perennial grass that can be native or introduced and can grow to over 15 feet in height. Originally believed to have come from Europe, the introduced variety can quickly take over a marsh community. Chinese tallow tree is a small to medium sized deciduous tree that can reach a height of 15 meters at maturity. Chinese tallow tree is native to China and Japan. It was introduced into the United States in the 1700's through South Carolina.

Broad environmental requirements and persistent characteristics of these two invaders allow them to take advantage of a variety of refuge habitats. *Phragmites* is common in and near freshwater, brackish and alkaline wetlands in temperate zones around the world. It is widespread in the United States, typically growing in marshes, swamps, fens, and prairie potholes, usually inhabiting the marsh-upland interface where it may form continuous belts (Roman et al. 1984). *Phragmites* is especially common in alkaline and brackish (slightly saline) environments (Haslam 1972) and it can also thrive in highly acidic wetlands (Rawinski 1985). *Phragmites* does not necessarily prefer these habitats to freshwater areas. Its growth is greater, however, in fresh water but it may have competition in these freshwater areas by other species that cannot tolerate brackish, alkaline or acidic waters. Therefore, in freshwater it is often found in association with other wetland plants (NatureServe. 2009). This accounts for some of its detrimental effects by outcompeting native plants, changing marsh hydrology, altering wildlife habitat, and increasing fire potential. On the refuge, small colonies of *Phragmites* are appearing along river banks of the Edisto and Combahee Rivers and occasionally within two or three of the managed wetland sites adjacent to both rivers.

Chinese tallow on the other hand, is even more widespread on the refuge. It invades stream banks, riverbanks, and wet areas like ditches as well as upland sites and can thrive in both freshwater and saline soils. Tallow is also shade tolerant, flood tolerant, allelopathic, and is spread through seed dispersal by birds and water. Plant colonizing can be done by prolific surface root sprouting (Miller 2003). Seeds are produced annually and each tree has the potential of bearing thousands of seeds. Seedlings appear prolifically in almost any open or edge area of the refuge and within some forested areas. This plant grows rapidly and displaces some native trees. Refuge areas invaded include road rights of way, dike systems (tops, slopes, and berms), managed wetland sites, early successional areas, and grasslands.

Refuge contributions to benefit resources of concern, relative to invasive plant species encroachment, comes in the form of various treatments to prevent the spread or expansion of these invaders. Occasionally some small refuge areas of plant infestations of both Chinese tallow and *Phragmites* are controlled or reduced but eradication from the refuge is going to be a continuing process. Through integrated pest management techniques using mechanical, herbicidal, and hydrological control, we have at minimum prevented the expansion of invasive plants in areas like moist-soil sites where our most intensively managed habitats were at risk. As long as plant reproductive bodies like seeds, surface roots, rhizomes, and fragments persist

in the environment both on and adjacent to the refuge, new infestations will continue to appear. Refuge staff attempted ground control of *Phragmites* by utilizing a marsh all-terrain type vehicle within managed wetland sites where most equipment could not travel, as patches became noticeable during 2003. This method, which required utilizing the chemical glyphosate, was time and labor intensive, remained difficult to access, and produced limited benefits.

For the next several years the refuge received assistance on *Phragmites* ground and aerial control from the SC DNR Aquatic Nuisance Species Program. Areas were treated on and adjacent to the refuge on the Edisto and Combahee Rivers. These treatments were more successful, using aerial applications of the herbicide Habitat®. Since then, some limited aerial applications of Habitat® were done by helicopter. For the most part, *Phragmites* has responded well to treatment. However, patches were scattered and inconspicuous in the marsh areas adjacent to river banks and were sometimes missed during applications. *Phragmites* in one wetland site, BH1 at Bonny Hall, has become very sparse due to prior ground treatments that only achieved partial control. This can make spraying efforts in these circumstances ineffective and expensive until *Phragmites* stems and foliage develop more density, height, and surface area to absorb the herbicide. Marsh areas where *Phragmites* exists on the refuge are generally difficult to access for ground control with herbicides. Mowing and disking for integrated pest management purposes in those soft marshy areas is usually not possible. Fire has been incorporated in some control efforts in concert with hydrology both flooding and drying but these methods only temporarily reduced above ground stems and simply delayed sprouting until later.

Chinese tallow trees, unlike *Phragmites*, has been present on the refuge for years before the area became a refuge. These plants establish themselves usually on slightly elevated or well drained sites. Within managed wetland sites, they grow on the highest elevations of the bed, on spoil from drainage ditches, and profusely on the impoundment dike system and associated berms. On road shoulders, ditch banks, hedge rows, and fence lines without control, this plant can establish itself from seed and within 3 to 4 years will be beyond conventional tractor/bush-hog mowing size. Chinese tallow in general has at least been treated by mechanical mowing since the early 1990's when refuge tracts were purchased. This has served the purpose well enough to allow a farm tractor and mower to be driven on road shoulders, field edges, early successional, and grassland areas. In these areas and especially early successional/grassland sites where fire may not carry and mowing alone may be utilized, re-sprouting from the established rootstock that remains can become a significant problem. Re-sprouting can be a rapid process and will exceed bush hog capability if mowing is not done at least once each year to control Chinese tallow, sweetgum (*Liquidambar styraciflua*), and red maple until grasses establish sufficiently to carry a fire. On refuge dike slopes and in fields that had gotten to the tree stage, heavy mechanical mowing with a track hoe attachment or a chipping machine was required. Since around 1998 other techniques were integrated into the tallow control efforts. For example within managed wetland sites, hydrology or flooding was used with some degree of success. Aerial herbicides were required in other parts of managed wetlands such as the tallow selective herbicide Clearcast® (imazamox) or the broader spectrum forms of glyphosate. On many refuge dikes and dike slopes in recent years where tallow trees have been cut and resprouting is profuse, herbicides (such as 2, 4 D amine or glyphosate) are required in combination with additional mowing with tractor/side mower for integrated control.

Invasive species can have undesirable conflicts and negative impacts to natural plant diversity and to wildlife habitat on the refuge. Invasive plants like Chinese tallow and phragmites are introduced species that can thrive in areas beyond their natural range of dispersal and conflict with the management of refuge habitat intended for species of concern or native species. These invasive plants are characteristically adaptable, aggressive, and have a high reproductive

capacity. Their vigor combined with a lack of natural enemies or grazers often leads to outbreak populations. Invasive species can also have negative economic, public health, and safety impacts. In managing habitat for other species we are sometimes unintentionally providing optimum conditions for invasive plants to colonize and expand. Not all occurrence of Chinese tallow or *Phragmites* on the refuge can be dealt with in any one treatment year. Complete eradication is not always a short term possibility, but a goal should be to at least reduce conflicts between invasive species and habitats managed for other refuge resources of concern. Annual mechanical and chemical treatments are applied to invasive plants in those refuge locations where they have the most potential to expand or to negatively impact the habitat of desirable species. No comprehensive survey or mapping of exotic plants has been conducted on the refuge. Control efforts by the refuge have been limited by staff and funding. Most efforts are focused on reduction of invasive seed sources throughout the refuge. The refuge has received limited funding for invasive plant control for these type projects.

White-tailed Deer (Odocoileus virginianus)

The Refuge is home to many of the mammalian species common to South Carolina, including the white-tailed deer. Deer extensively utilize both upland and wetland habitats on the refuge, sometimes to the detriment of the habitat and other animals. Considering scattered refuge tracts, a total population estimate could range from 250 to 500 or more deer. They require areas to forage and browse across many habitat types sometimes to the point of depletion of their own food resources such as plant browse, hardwood mast, and assorted soft mast. This not only creates a potential food resource problem for the deer, it can alter the habitat conditions upon which a variety of other species depend. Problematic conditions such as these occur when existing natural habitat for deer and other competing species is limited in the quantity and quality of that desirable habitat. Conversely, these undesirable conditions can occur when an over population of the actual deer herd itself occurs, relative to the same given amount of habitat actually available. Obviously both situations can occur simultaneously with the same effect of multispecies competition for required resources in various forms including food, shelter, plant composition, physical presence and arrangement.

Habitat conditions and requirements for deer on the refuge will be managed through a balance of controlling herd numbers and secondly the quantity and quality of habitat available. Deer numbers are targeted to be maintained through recreational hunting at or below carrying capacity for the habitat as needed. Targets are recommended by results of abomasum parasite counts conducted every four to six years. For more than the last 10 years the total deer harvested on refuge hunts has averaged 40 deer during 14 days of hunting each year. Overall, the deer herd on the refuge appears to be in satisfactory condition. Herd health surveys were conducted in 1992, 1998 and 2004. Surveys indicated at times some need for increased harvest. Refuge either-sex deer hunts were begun when the refuge was established in 1992 and have helped. Quality deer management was begun in 1994 where bucks are not taken with less than three points on a side. The other half of the balance is the habitat. As quantity and quality of habitat conditions change and improve from planned activities such as burning, thinning, planting, and mowing; then herd numbers will likely change or increase accordingly. Deer harvest should be adjusted up or down as needed also. To increase hunter participation and harvest, the deer hunts should be scheduled, where possible, to avoid overlap with existing local archery and primitive weapons state hunts.

There is essentially no land habitat type on the refuge that white-tailed deer do not utilize at least to some extent for one purpose or another. At the present that amounts to well over

11,000 acres not all of which is normally considered as deer habitat. Even natural marsh areas provide cover, sanctuary, and some higher marsh elevations are preferred as bedding sites. Managed wetland sites are also utilized by deer attracted to dense summer and fall moist-soil plant growth as sanctuary, cover, and browse. As generalists in the various refuge habitats types utilized, deer are rivaled only by feral hogs in their mobility, numbers, and ability to over-exploit some habitats. One of the primary benefits to deer from refuge management activities comes indirectly from programs like prescribed fire by providing tender new growth within browsing reach of deer. Likewise, other planned habitat improvement activities such as forest thinning, openings, and early successional maintenance intended to improve habitat conditions primarily for migratory birds, will benefit deer also. Attention to oak composition is important to ensure adequate hard mast. Forest management where hard mast is involved should include efforts to insure that 30 to 60% of the canopy composition is in oaks or other hard mast-producing species. At the Grove Compartment about a dozen small food plots averaging an acre or less each are planted annually within some of the early successional and grassland areas. These are usually an annual grain or seed producing mixture of plants utilized by seed eating birds and as a supplemental green browse for deer.

As improvement in habitat conditions for other species of concern occurs that also benefits deer, it is highly likely that deer numbers will increase as well. If unchecked, the growing deer population through over browsing will eventually conflict with the improved habitat conditions intended for the other species of concern and herd health itself will also decline. Overall, the deer herd on the refuge appears to be in satisfactory condition. Herd health surveys were conducted in 1992, 1998 and 2004. Surveys indicate some need for increased harvest. The refuge's either-sex deer hunts were begun when the refuge was established in 1992. Quality deer management was begun in 1994 and bucks are not taken with less than three points on a side. As habitat conditions improve from planned understory improvement, herd numbers will increase. Deer harvest should be increased as needed. To increase hunter participation, the deer hunts should be scheduled, where possible, to avoid overlap with existing local archery and primitive weapons state hunts. The deer management program should continue to measure herd health conditions and density through abomasal parasite (AP) counts every four to six years. Special attention in this respect should be given to the deer herd on Jehossee Island where overpopulation could become a problem since public access is limited and no hunts have been conducted there. Control of the deer herd is necessary to make sure that the present and increased levels of understory vegetation are perpetuated.

Feral Hogs (Sus scrofa)

Feral hog populations conflict with refuge objectives for migratory birds and native wildlife species such as deer, wild turkey, and squirrels as well as causing considerable damage to roads, dikes, and other property. Feral hogs are swine of mixed breeding that have no owners and are not controlled or contained in any manner for livestock purposes. They have freedom to roam at large about the landscape and reproduction of the population is generally high. They are constant foragers and opportunistically consume a wide variety of both refuge plant and sometimes animal material. Feral hogs were first seen on and adjacent to the refuge about 1999. The source of the swine is believed to have been from a failed private big game hunting preserve a short distance up the Edisto River from the refuge. The most reliable story was that the hogs were simply released into the wild from large fenced enclosures when the private venture failed. Feral hogs now inhabit both sides of the Edisto River corridor from Jehossee Island upriver for several miles. There is also a hog population of unknown sources on the Yemassee South section of the refuge in Beaufort County.

Habitat requirements, except food and water, do not seem to be of particular concern to feral hog populations. Hogs tend to span all refuge habitat types at one time or another in search of any available food resources and freedom from disturbance. As a predator, feral swine eat salamanders, frogs, fish, crabs, snakes, turtles, rodents, muskrats, eggs and chicks of ground-nesting birds, white-tailed deer fawns, and livestock. In Florida, feral swine have contributed to the decline of at least 22 plant species and 4 species of amphibians listed as rare, threatened, endangered, or of special concern (USDA 2002). In the southern United States, feral swine predation may negatively affect bobwhite quail and wild turkey nest success also. They can be highly nomadic in search of assorted food resources and tend to prefer the more mesic sites on the refuge. Habitats in the local area along river corridors seem to be their favorite foraging areas. Currently most refuge tracts adjacent to the Edisto and Combahee Rivers either contain feral hogs already or have a high potential to be invaded. The least utilized refuge habitats are the high, dry pine ridges.

Feral hogs continue to conflict and tend to be problematic throughout the refuge and surrounding area. Hogs appeared in and immediately adjacent to the refuge around 1999 and continue to be destructive to refuge resources and compete with native species when hog numbers begin to build. During the warmer months, refuge hardwood bottoms, swamps, and wetter mixed pine-hardwood sites are preferred by hogs for foraging, rooting, and loafing. Cooler weather tends to bring hogs to dryer and sometimes more open sites. This includes the headquarters yard that receives rooting damage annually when hogs forage for fall live oak acorns, grubs, roots, and tubers. Significant damage can be done to the habitat of plant and animal resources in these areas. There are several characteristics of hogs that make them very difficult to control. Hogs can forage day and night in groups usually less than a dozen or as large as 15 to 30 individuals. A shift to primarily night activity and foraging will occur when hogs are disturbed or hunted excessively during the day. Hogs may breed year-round and gestation is 108-123 days. Litter size ranges up to 12 young with two litters per year and sexual maturity is usually in less than one year (NatureServe 2009). They have an excellent sense of smell, fair vision, and can be elusive when pursued. When unsuccessful attempts are made by hunters or staff to harvest or trap hogs, they become very evasive and difficult to engage.

The control of feral swine populations is critical to reconciling conflicts affecting the health of native species, bottomland hardwood forest habitats, and overall management objectives of the refuge. This species destroys native vegetation and competes heavily with numerous wildlife species. Swine also depredate the nests of ground-nesting birds as well as disturb and consume many species of reptiles, amphibians, young birds and even small mammals. In addition, they can cause considerable damage to dikes and roads. Currently refuge hunters are allowed to harvest as many hogs as they wish during the regularly scheduled deer hunts. Since around 2001 hog numbers removed from the refuge by all sources average between 150 and 200 annually. Total elimination of swine populations on a landscape basis, barring a disease epidemic, is virtually impossible. Management efforts must be focused on long-term intensive control utilizing multiple methods. In order of effectiveness of control, SCDNR suggests trapping, dog hunting, and still hunting. For the refuge this may include additional recreational harvest through hunting, continued staff incidental take and trapping; private contractor trapping or dog hunting; or any other non-conflicting and acceptable means of removal or control. To be successful, comprehensive control efforts must be in coordination with adjacent land owners to maintain swine control over large areas or landscapes to preclude re-infestation once under successful long-term management reduction.

CHAPTER IV. HABITAT GOALS AND OBJECTIVES

The goals, objectives, and strategies within this HMP reflect the Service's commitment to achieve the mandates of the National Wildlife Refuge System Improvement Act of 1997, the mission of the National Wildlife Refuge System, and the purposes and vision of ACE Basin National Wildlife Refuge. The Service intends to implement these goals, objectives, and strategies within the 15 year lifespan of an HMP, according to Service policy. These habitat management goals are broad, qualitative statements that are derived from the established purposes and vision for the refuge and essentially parallel and expand on those in the CCP. The goals and objectives listed below refer to the resources of concern identified in Chapter 3.

In support of regional population goals for migratory birds the refuge will strive to support the population and habitat goals and take guidance provided by the Atlantic Coast Joint Venture in the South Atlantic Migratory Bird Initiative (SAMBI) Implementation Plan. In the plan, those goals are presented in section 5.C. Regional Population and Habitat Goals. The goal stated in section C.1. Population Goals, is to "Maintain, stabilize, or increase populations of high priority breeding, transient, and wintering species." Goals of major groups of migratory birds are then divided into shorebirds, landbirds, waterbirds, and waterfowl. In the plan, each high priority group or individual species in a group are listed and the population goals of those are expressed in terms of either numbers of pairs and individuals or as a directional response such as to maintain, stabilize, increase, or double.

Strategic Habitat Conservation (SHC) as a new concept will be integrated into this plan as appropriate. SHC is a structured, science-driven approach for making efficient, transparent decisions about where and how to expend Service resources for species, or groups of species, that are limited by the amount or quality of habitat. It is an adaptive management framework integrating planning, design, delivery and evaluation using models, monitoring, and research.

FRESHWATER MOIST-SOIL HABITAT MANAGEMENT GOAL

Manage freshwater moist-soil wetlands year round to provide optimal habitat for wintering waterfowl and concurrently utilize a multiple species management approach to provide habitat for shorebirds, marsh birds, wading birds and threatened/endangered species.

Objective 4.1.1: Promote beneficial species of native freshwater wetland plants annually as a primary food base to support wintering waterfowl on 2,546 acres, within 18 moist-soil managed wetland sites, and that will support population numbers of 15,000 – 20,000 in the 1-5 year short term and 38,000 in the 6-20 year long term.

Management Sites: GS9A,B; BH1,2,5,5A,6,7,8A,8B,8C; CF1,2,3,4,5,6,7 (Appendix A and B)

Rationale: Supporting optimal habitat for wintering waterfowl includes providing freshwater wetland plants as a food base.

Resources of Concern: Wintering waterfowl; secondarily wading birds, whooping cranes, eagles, fall migrating song birds.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p>	<p>Probable Assessment Methods</p>
<ul style="list-style-type: none"> • Plant species composition, density and coverage • Hydrology timing, duration and depth • Use of prescribed fire and timing • Range of salinity 	<ul style="list-style-type: none"> • Conduct plant identification, vegetative surveys, ocular estimates and identify desirable/undesirable plant species • Monitor water level gage readings • Monitor fire effects, fuel moisture, and hydrology effects • Monitor salinity in ppt from meter or refractometer
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Dabbling and diving ducks use on refuge • Location of waterfowl utilization and feeding activity on refuge • Identification of plant foods consumed by waterfowl 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Winter waterfowl numbers from ground counts twice a month • Identify numbers of waterfowl utilizing within each wetland unit • Waterfowl forage observations or crop analysis sampling

Objective 4.1.2: Partially drawdown water levels during February in a minimum of one site in each of three cluster sites (Comp. 3,6,7) each year to promote supplemental invertebrate food sources to assist in the support of waterfowl population numbers in Objective 4.1.1.

Management Sites: GS9A,B; BH1,2,5,5A,6,7,8A,8B,8C; CF1,2,3,4,5,6,7 (Appendix A and B)

Rationale: Supporting winter waterfowl population numbers involves providing high protein invertebrate foods as needed by waterfowl just prior to and during migration.

Resources of Concern: Wintering waterfowl.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Invertebrate species composition, density and distribution • Detritus availability as food for invertebrates • Hydrology timing, duration and depth • Use of prescribed fire and timing • Range of salinity 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Invertebrate identification and sampling • Conduct plant identification, density, vegetative surveys and ocular estimates • Monitor water level gage readings • Identify desirable/undesirable plant species • Monitor fire effects and unconsumed plant biomass remaining • Monitor salinity in ppt from meter or refractometer
---	--

<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Dabbling and diving ducks use on refuge • Location of waterfowl utilization and feeding activity on refuge • Identification of invertebrates consumed by waterfowl 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Winter waterfowl numbers from ground counts twice a month • Identify amount of waterfowl use within each wetland unit • Waterfowl crop analysis sampling for invertebrates
---	---

Objective 4.1.3: Create extended shallow freshwater/mudflat conditions through drawdowns annually in managed wetlands as forage habitat to benefit wading birds, marsh birds, and shorebirds from early March through mid-May in a total of 21 sites in compartments 3, 6, 7. Continue moist-soil drawdown conditions until mid-May in 18 of the 21 sites to ADDITIONALLY provide tall emergent vegetation available to breeding marsh birds of concern and partially flood the remaining three freshwater sites (GS7, GS8, and GS26) for wood duck banding purposes or marsh bird foraging habitat ALL SUMMER.

Management Sites: GS9A,B; GS7, GS8, GS26; BH1,2,5,5A,6,7,8A,8B,8C; CF1,2,3,4,5,6,7 (Appendix A and B)

Rationale: Extended drawdowns in managed wetlands create forage and breeding habitat needed by wading birds, marsh birds, and shorebirds. Other sites accommodate wood duck banding efforts to meet annual quota.

Resources of Concern: Wading birds, shorebirds, marsh birds, wood ducks, whooping cranes.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Plant species composition, density and coverage • Hydrology timing, duration and depth • Use of prescribed fire and timing • Range of salinity 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Conduct plant id's, vegetative surveys and ocular estimates • Monitor water level gage readings • Monitor fire effects and unconsumed plant biomass remaining • Monitor salinity in ppt from meter or refractometer
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Monthly wading and shorebird numbers in each unit • Marsh bird presence in wetland units • Wood duck numbers at bait/banding sites 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Ground wading and shorebird counts once a month • Secretive marsh bird surveys • Wood duck counts and number of wood ducks banded for quotas at banding sites

BRACKISH WATER HABITAT MANAGEMENT GOAL

Manage brackish water wetlands year round on Jehossee Island to produce habitat for a diversity of avian species, with waterfowl serving as the management emphasis.

Objective 4.2.1: Promote Production of brackish water plant food sources in the three managed wetlands totaling 314 acres on Jehossee Island for the annual winter period October through February for peaks of at least 1,500 waterfowl each winter.

Management Sites: JE1,2; JW8 (Appendix A and B)

Rationale: Supporting optimal habitat for wintering waterfowl includes providing brackish water wetland plants as a food base.

Resources of Concern: Waterfowl; secondarily wading birds, marsh birds.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Plant species composition, density and coverage • Hydrology timing, duration and depth • Use of prescribed fire and timing • Range of salinity 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Conduct plant identification, vegetative surveys, ocular estimates and identify desirable/undesirable plant species • Monitor water level gage readings • Monitor fire effects, fuel moisture, and hydrology effects • Monitor salinity in ppt from meter or refractometer
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Dabbling and diving ducks use on refuge • Location of waterfowl utilization and feeding activity on refuge • Identification of plant foods consumed by waterfowl 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Winter waterfowl numbers from ground counts twice a month • Identify numbers of waterfowl utilizing within each wetland unit • Waterfowl forage observations or crop analysis sampling

Objective 4.2.2: Provide for the production of brackish water forage fish and invertebrate food sources in the three managed wetland sites of 314 acres on Jehossee Island, through at least one drawdown with emphasis on the annual summer period March through September to encourage a diversity of migratory shorebirds, marsh birds, wading birds, and the endangered wood stork.

Management Sites: JE1,2; JW8 (Appendix A and B)

Rationale: Summer water level drawdowns provide concentrations of food resources needed by a diversity of migratory birds.

Resources of Concern: Wood stork, shorebirds, wading birds, marsh birds.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Forage fish and invertebrate species composition, density and distribution • Detritus availability as food for invertebrates • Hydrology timing, duration and depth • Use of prescribed fire and timing • Range of salinity 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Conduct forage fish and invertebrate species surveys. • Monitor water level gage readings • Monitor fire effects, fuel moisture, and hydrology effects • Monitor salinity in ppt from meter or refractometer
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Dabbling and diving ducks use on refuge • Location of waterfowl utilization and feeding activity on refuge • Identification of plant foods consumed by waterfowl 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Winter waterfowl numbers from ground counts twice a month • Identify numbers of waterfowl utilizing within each wetland unit • Waterfowl forage observations or crop analysis sampling

GREENTREE RESERVOIR HABITAT MANAGEMENT GOAL

Provide greentree reservoir habitat for waterfowl and other migratory birds.

Objective 4.3.1: Manage hydrology by rotating water levels on 71 acres of GTR’s annually to provide foraging habitat including mast and invertebrates for at least 900 dabbling ducks and other migratory bird species.

Management Sites: GN19, GN3, GN1A; BH23 (Appendix A and B)

Rationale: Ducks utilize mast food sources for overwintering and require high protein invertebrate foods prior to and during migration. GTR’s provide these as well as invertebrates for other wintering migratory bird species.

Resources of Concern: Wintering waterfowl (wood ducks primarily), ibis, herons, egrets, snipe, wood cock.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Plant and invertebrate species composition, density and coverage • Tree mortality • Hydrology timing, duration and depth 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Conduct vegetative/mast surveys and ocular estimates • Invertebrate sampling • Inventory tree survival rates • Monitor water level gage readings • Identify desirable/undesirable plant species
--	--

<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Migratory bird utilization numbers on refuge GTR's • Location of migratory bird utilization and feeding activity on each GTR unit • Activity budget of migratory birds 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Waterfowl and other bird surveys • Invertebrate sampling, identification, and density counts • Activity surveys for migratory birds
---	--

NATURAL MARSH HABITAT MANAGEMENT GOAL

Maintain natural marsh in the present successional stage for avian species and as important fish nursery habitat while utilizing adaptive management to protect the marsh habitat from threats including sea level rise associated with climate change.

Objective 4.4.1: Manage 3,277 acres of refuge natural tidal marsh on Jehossee Island to maintain early successional emergent vegetation beneficial as nesting, foraging, and cover for secretive marsh birds, wading birds, and sparrows by prescribe burning a minimum of 150 acres of high marsh and 500 acres of low/mid-level marsh on the island at least once every 3-4 years.

Management Sites: JW1,5; JE23,24,25,26,27,28 (Appendix A and B)

Rationale: Early successional stage habitat required by tidal marsh birds can be maintained on Jehossee Island by prescribed burning to discourage woody growth encroachment.

Resources of Concern: Marsh birds (king, yellow, and black rails, bitterns, gallinules), wading birds, and sparrows (seaside, wintering saltmarsh, and Nelson's sharp-tailed).

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Marsh grass composition, density, and distribution • Woody invasive plant composition, density, and distribution • Use of prescribed fire and timing 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Marsh plant surveys • Woody invasive plant surveys in marsh • Monitor fire effects and woody plant control
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Monthly marsh birds, wading birds, and marsh sparrow utilization of habitat • Location of bird utilization • Activity of migratory marsh bird species 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Marsh bird species surveys • Identify amount of marsh bird use within each affected wetland unit • Foraging and nesting activity surveys for marsh bird species

Objective 4.4.2: Coordinate with a diverse group of partners to protect the habitat integrity of all 4,330 acres of refuge natural marsh for all marsh species including important fish habitat as spawning and nursery areas considering potential effects of climate change and sea level rise.

Management Sites: GS4,12,13,13A; JW1,5; JE23,24,25,26,27,28; CF8,9,10,11,12 (Appendix A and B)

Rationale: Changes in climatic conditions and water quality in the natural tidal marsh ecosystem affect all refuge partners.

Resources of Concern: Marsh birds and other marsh ecosystem related species, which could include shortnose sturgeon and all commercial and recreational fisheries.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Water quality • Sea level rise • Marsh plant species composition, density, and distribution • Woody invasive plant composition, density, and distribution 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Manual or automated water monitoring measurements over time • SET or other marsh/water level stations • Marsh plant surveys • Woody invasive plant surveys in marsh
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Fish species composition, density, and abundance • Marsh bird utilization of habitat • Shellfish resiliency 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • State DNR fishery sampling • Marsh bird species surveys • Shellfish monitoring and surveys

FORESTED UPLAND HABITAT MANAGEMENT GOAL

In refuge forested upland types of approximately 1,110 total acres designated in Appendix A and B as natural pine, pine plantations, and marginal upland hardwoods; provide forest habitat conditions conducive to supporting refuge resources of concern.

Objective 4.5.1: Manage natural pine (loblolly, longleaf, and pond pine) of approximately 424 acres of forested upland acres to create desired forest conditions for resources of concern.

Management Sites: All sites designated as NP (natural loblolly, longleaf, pond, and spruce pine) in Forest Compartments 1,2,3,4, and 7 as depicted in Appendix A and B.

Rationale: More desirable forest conditions from crown to herbaceous levels can be created by management actions such as thinning and prescribed burning.

Resources of Concern: Migratory landbirds, RCWs and T/E species

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Natural pine type age, density, crown closure, and ground cover • Use of prescribed fire and timing • Use of timber thinning 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Natural pine timber cruise and ground vegetative surveys • Monitor fire effects • Monitor understory response
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Landbird populations in natural pine sites • Amphibian and flatwoods salamander populations • RCW presence 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Point counts of landbirds • Salamander and amphibian surveys • RCW surveys

Objective 4.5.2: *Initiate conversion of the current refuge pine plantations of approximately 682 acres to either mixed pine-hardwood, through thinning, or to longleaf pine by planting, as determined on a site by site basis that will be more beneficial to migratory landbirds, RCWs and t/e plant resources of concern.*

Management Sites: All sites designated as PP (loblolly pine plantations) in Forest Compartments 1, 7, 8 as depicted in Appendix A and B.

Rationale: Conversion of unmanaged pine plantations to other forest types offer more diversity to landbirds, RCWS, and T/E plant resources.

Resources of Concern: Migratory landbirds, RCWs and T/E plants.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Planted pine density • Post thinning pine density • Ground, understory, and T/E plant species regeneration composition 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Timber cruise • Vegetative surveys
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Landbird population richness • Average age of stand for potential RCW use 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Point counts for landbirds • Increment borings

Objective 4.5.3: *Maintain or enhance any small marginal bands of upland hardwood, often found adjacent to pine-hardwood and bottomland hardwood sites, in at least the same or improved condition as they currently exist to benefit migratory landbird resources of concern.*

Management Sites: Any upland hardwoods as marginally encountered on adjacent up slopes from pine-hardwood and bottomland hardwood sites (these are small sites and are not shown on appendix maps except one site, YS14 in Compartment 8).

Rationale: Some migratory landbirds of concern prefer closed canopy upland hardwoods.

Resources of Concern: Migratory landbirds mostly warbler species

Adaptive Management Monitoring Elements:

Primary Habitat Response Variables <ul style="list-style-type: none"> • Hardwood density • Hardwood composition • Canopy closure 	Probable Assessment Methods <ul style="list-style-type: none"> • Timber cruise • Vegetative surveys
Primary Wildlife Response Variables <ul style="list-style-type: none"> • Landbird population richness • Natural cavity density 	Probable Assessment Methods <ul style="list-style-type: none"> • Point counts • Survey of natural cavities

FORESTED WETLAND HABITAT MANAGEMENT GOAL

In refuge forested wetland types of approximately 3087 total acres, designated in Appendix A and B as mixed pine-hardwood and bottomland hardwoods, provide forest habitat conditions conducive to supporting refuge priority resources of concern.

Objective 4.6.1: Conduct management action on 1,563 total acres of mixed pine-hardwoods to treat and move them toward either an open pine or an altered mixed pine-hardwood condition to improve forest structure for Migratory landbirds and T/E plants.

Management Sites: All sites designated as PH (mixed pine-hardwood) in Forest Compartments 1, 2, 3, 4, 5, 6, 7, 8, 9 as depicted in Appendix A and B.

Rationale: Treatment to convert present closed canopy mixed pine-hardwoods would enhance habitat for landbirds and T/E plants.

Resources of Concern: Migratory landbirds and T/E plants.

Adaptive Management Monitoring Elements:

Primary Habitat Response Variables <ul style="list-style-type: none"> • Tree density • Canopy closure • Understory/shrub density 	Probable Assessment Methods <ul style="list-style-type: none"> • Timber cruise • Vegetative surveys
Primary Wildlife Response Variables <ul style="list-style-type: none"> • Landbird population richness • Natural cavity density 	Probable Assessment Methods <ul style="list-style-type: none"> • Point counts • Survey of natural cavities

Objective 4.6.2: Conduct canopy thinning and group selection openings on at least 50% of 1,524 acres of the bottomland hardwood portion of total forested wetlands to increase sunlight penetration and improve forest structure and habitat diversity for Migratory landbirds and T/E plants.

Management Sites: All sites designated as BH (bottomland hardwood) in Forest Compartments 1,2,3,5,7,8,9 as depicted in Appendix A and B.

Rationale: Canopy thinning with group selection should enhance conditions for landbirds and plants of concern.

Resources of Concern: Migratory landbirds and pondberry.

Adaptive Management Monitoring Elements:

<p>Primary Habitat Response Variables</p> <ul style="list-style-type: none"> • Tree density • Canopy closure • Understory/shrub density 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Timber cruise • Vegetative surveys
<p>Primary Wildlife Response Variables</p> <ul style="list-style-type: none"> • Landbird population richness • Natural cavity density 	<p>Probable Assessment Methods</p> <ul style="list-style-type: none"> • Point counts • Survey of natural cavities

EARLY SUCCESSIONAL/GRASSLAND HABITAT MANAGEMENT GOAL

Provide early successional and grassland areas to benefit breeding and wintering landbirds.

Objective 4.7.1: Annually maintain at least one half of 189 refuge acres of early successional habitat with a mosaic of both native shrubby vegetation and grasses for migratory landbirds on the Grove South Compartment of the Edisto Unit.

Management Sites: GS2,2A,2B; GS5,GS6I,GS11; GS17,17A,17B,18,19,20,21,23,23A as depicted in Appendix A and B.

Rationale: Providing early successional and grassland areas on a continuing basis, creates a diverse habitat utilized by a variety of landbirds.

Resources of Concern: Migratory landbirds.

Adaptive Management Monitoring Elements:

Primary Habitat Response Variables <ul style="list-style-type: none"> • Grass/shrub cover ratio • Shrub distribution • Shrub height 	Probable Assessment Methods <ul style="list-style-type: none"> • Vegetative surveys
Primary Wildlife Response Variables <ul style="list-style-type: none"> • Landbird population richness • Landbird nest density 	Probable Assessment Methods <ul style="list-style-type: none"> • Point counts • Summer nest surveys

Objective 4.7.2: Maintain at least 30 acres primarily by annual mowing of a total of 51 grassland acres (identified in Appendix A and B) and approximately 75 additional grassland edge acres (not identified) dispersed across the refuge, with little or no shrub component while providing summer season forage conditions (seedheads and insects) and additionally providing winter habitat conditions (grassy thatch) for a diversity of migratory landbirds.

Management Sites: Any grass covered open or edge areas (old fields, pastures, refuge roadways, food plots, utility right of ways, and dike tops) dispersed across all refuge Compartments, with specific examples depicted in Appendix A and B only in Compartments 2,3,4,7.

Rationale: Maintaining grassland areas on a continuing basis will provide another diverse habitat utilized by a variety of landbirds.

Resources of Concern: Migratory landbirds.

Adaptive Management Monitoring Elements:

Primary Habitat Response Variables <ul style="list-style-type: none"> • Amount of grass cover or presence • Woody or invasive plant encroachment 	Probable Assessment Methods <ul style="list-style-type: none"> • Ocular estimates of plant cover
Primary Wildlife Response Variables <ul style="list-style-type: none"> • Landbird population richness 	Probable Assessment Methods <ul style="list-style-type: none"> • Point counts

CHAPTER V. HABITAT MANAGEMENT STRATEGIES

Established in 1990, the ACE Basin NWR provides resources for migratory birds, endangered species and compatible public uses. Through a motivated, experienced, and well-trained staff and volunteers and with active participation of partners, the refuge will strive to maintain its unique ecological landscape features and be an active partner to achieve the goals and objectives of the ACE Basin Project, a 1.2 million acre estuary/ecosystem conservation partnership between State, Federal, corporate, private land owners and non-governmental organizations. Through team development, the refuge will strive to be a model of excellence in natural resource management and celebrate our achievements with the public and our partners. The management of wildlife and habitat on the refuge will be an adaptive, science-based, comprehensive endeavor that links biological needs with resource management. The refuge will actively seek to expand partnerships to further conservation stewardship and protection of natural resources. We will actively seek research to support the informational needs of the refuge, being able to adapt and being responsive to change. We will seek and develop appropriate and compatible public use opportunities and enhance awareness and appreciation of the refuge and National Wildlife Refuge System. Through outreach and public participation, the neighboring communities within the ACE Basin Project area will share our values for the National Wildlife Refuge System and a fish and wildlife heritage for all Americans. The goals, objectives, and strategies presented in this plan are the Service's response to the issues, concerns, and needs expressed by the planning team, the refuge staff and partners, and the public. Strategies should be more specific and are potential methods to accomplish the selected habitat goals and objectives as step-downs from the CCP. These potential strategies are further broken down into prescriptions in the HMP that specify techniques or methods to accomplish the given strategies.

FRESHWATER MOIST-SOIL MANAGEMENT

Potential Management Strategy – Moist-Soil Plant Management

For meeting Objective 4.1.1, moist-soil management strategies will be utilized annually and will refer to all wetland management on the refuge where water levels from tidal river water are managed for freshwater production of moist-soil plants, primarily for waterfowl. Typically, this involves maintaining lower water levels to create a moist-soil type condition conducive to the production of beneficial seed producing plants throughout the spring germinating period and summer growing season. Preferred waterfowl food plants include panic grasses, smartweeds, flat sedges and wild millets in fresh-water moist-soil impoundments managed by spring and summer drawdowns. Undesirable invasive plants during the summer growing season include sesbania (*Sesbania exaltata*), especially on fire disturbed or dry sites, and southern wild rice or giant cutgrass (*Zizaniopsis miliacea*), if maintained with too much moisture or standing water during the growing season. The plant growth in this geographic area, both desirable and undesirable, is usually so dense that prescribed burning or sometimes mechanical manipulation is needed to encourage accessibility by waterfowl after the site has been flooded. Summer moist-soil and other plant growth is normally targeted for burning as soon as possible in the fall after drying or curing sufficiently to carry a flame. Ideally, burning would be done before mid-November but that is not always the case depending on many factors that tend to limit burning. Burning also scarifies the seedbed and encourages the next year's seed germination. Scarifying the seedbed by occasional disturbance or disking as is done in most moist-soil management, is not usually possible here because of wet conditions of the organic peat soils

that will not support equipment. After burning, each site is then flooded to make seeds or invertebrates available to foraging wildlife, usually waterfowl, during the fall and winter. Some of the smaller isolated moist-soil sites do not respond well in production of desirable freshwater moist soil plants for waterfowl. Therefore those sites are maintained wetter at various times throughout the year to provide a diversity of habitats for multiple uses such as wood stork foraging sites, wood duck banding, molting, brood sites, and thick emergent cover for rails, bitterns, and other marsh birds. The plants and invertebrates in moist-soil impoundments provide food resources necessary for wintering and migrating waterfowl to complete critical aspects of the annual cycle such as molt and reproduction (Strader and Stinson 2005). Depending on water levels, other bird species which may benefit secondarily include seed-eating Neotropical fall migrants, wintering sparrows, shorebirds, wading birds, rails, and raptors. Finally, the cycle will begin again with spring drawdown and moist-soil plant germination. Although moist-soil sites require less intensive typical agricultural management than flooded crop impoundments, they provide higher nutritional value forage to waterfowl. Preferred moist-soil plants provide seeds and other plant parts (e.g., leaves, roots, and tubers) that generally have low deterioration rates after flooding and provide substantial energy and essential nutrients less available to wintering waterfowl in common agriculture grains (Strader and Stinson 2005). The refuge contains approximately 2,494 acres of strictly freshwater moist-soil managed wetlands within approximately 17 manageable sites.

Management Strategy Prescription – Moist-Soil Hydrology

For meeting Objective 4.1.1 for the managed wetland sites and resources of concern previously listed in that section, the following freshwater moist-soil prescriptions will be utilized:

- Use moist-soil management techniques to adjust annual flood and drawdown hydrology to favor desirable plants like panic grasses, flatsedges, millets and smart weeds for waterfowl and other migratory birds and to discourage undesirable plants like giant cutgrass (*Zizaniopsis miliacea*) and sesbania (*Sesbania exaltata*)
- Monitor salinity during flooding to target near zero salinity conditions.
- Prescribe burn sites in the fall, preferably before mid-December, or as early as possible when fuels are cured to improve avian access and scarify seed beds for next spring germination of plants. Otherwise, conduct burns in late winter or early spring after waterfowl departure and before green up.
- Adjust winter water level depths, generally between 0.2 and 1.3 ft. deep, as necessary to accommodate feeding waterfowl.
- Conduct vegetation transects or at least visual estimates during the September through November period each year for moist-soil and other plant coverage in each managed wetland site. For transects, record dominant plant species and percent occurrence for each plant species in 1 m² plots.
- Evaluate the potential for the creation of additional impoundments to support wildlife and habitat diversity.
- Continue to provide important sanctuary for waterfowl, other migratory birds, and threatened/endangered species in the total 2,931 acres of all managed wetland sites on the refuge.
- Accommodate any wintering whooping cranes that use refuge moist-soil managed wetland sites by maintaining a consistent winter water level that cranes show preference for in at least one wetland site in a cluster of sites. A pair of cranes from the eastern experimental flock has utilized the refuge since 2008.
- Consider improving independent water drawdown and flooding of each site. This means a reliable water source and the ability to deliver water when required to each

impoundment, directly to the impoundment, without the need to lower or raise any other impoundment to allow this. For drawdown capabilities, this means the ability to draw each impoundment down, regardless of the water level being maintained in other impoundments and without having to affect or change the other impoundment's water level. This will require new structures, and new dikes to produce feeder canals to some of the impoundments.

- Evaluate and record the timing and effectiveness of managements activities (disking, mowing, burning) to determine which methods produce the desired outcome.
- Use adaptive management to determine timing for setting back succession and improving amounts and diversity of desirable wetland plants beneficial to waterfowl and other migratory birds.
- Develop maintenance plan and schedule to maintain approximately 28 managed wetland sites, 30 linear miles of dikes and approximately 40 water control structures and associated canals and ditches that provide water delivery for the managed wetlands.
- Prevent expansion of invasive plants, specifically Chinese tallow tree (*Sapium sebiferum*), on dikes and common reed (*Phragmites australis*) within managed wetlands. Use integrated pest management practices especially a combination of mowing and chemical use for Chinese tallow trees on accessible portions of dikes. Use only Service approved chemicals and applications.
- Discourage sesbania by early drawdown after February so that desired panicum grasses germinate early to be competitive with young sesbania. Also, try flooding recently germinated sesbania plants completely for several days until sesbania foliage yellows or dies, and then remove water from the site.
- Discourage giant cutgrass by eliminating any standing water from the bed of each site during the entire growing season.

Potential Management Strategy – Planned Late Winter Drawdowns in Managed Wetlands

For meeting Objective 4.1.2, a strategy in freshwater moist-soil managed wetlands will be utilized annually to provide invertebrates as forage for wintering waterfowl, and will take the form of a partial drawdown in water level. Invertebrates reproduce and thrive on submerged plant and organic material within wetland sites. Invertebrates provide a high protein food source needed by waterfowl during late winter just prior to migration. This contributes positively to nutritional reserves required later for successful activities such as egg-laying, molting, brooding, and rearing young.

Management Strategy Prescription – Timely Partial Drawdowns for Invertebrates

For meeting Objective 4.1.2 for the managed wetland sites and resources of concern previously listed in that section, the following freshwater moist-soil prescriptions will be utilized:

- Partially drawdown managed wetland sites to between 0.3 and 0.7 ft. water level depth to concentrate invertebrates and increase availability to waterfowl.
- Time partial drawdown of wetland sites providing invertebrates for waterfowl for the period of mid to late February prior to most migration until migration is complete.
- Continue to provide important sanctuary for waterfowl, other migratory birds, and threatened/endangered species in the total 2,931 acres of all 28 managed wetlands on the refuge.

Potential Management Strategy – Extended Drawdowns

For meeting Objective 4.1.3, a strategy involving extended shallow water conditions each year in moist-soil managed wetland sites will be required to provide forage fish for wading birds and to provide invertebrates for shorebirds. Typically about 2,546 acres of moist-soil habitat within approximately 18 sites occurs on the refuge each year. These sites are situated in three groups or clusters, with two sites in a cluster at the Grove, seven sites at Combahee Fields, and nine sites at Bonny Hall. They are managed for waterfowl during the winter. Some of these sites, if not all each year, are subject to a partial drawdown in February to provide invertebrates for waterfowl prior to migration. After that process the strategy in moist-soil sites is typically to drawdown for moist-soil plant production for the summer. That can be done in an extended drawdown manner that potentially provides benefits to wading birds, marsh birds, and shorebirds while timely removing water for plant germination. Gradual drawdown in some sites provide shallow water forage habitat for waders and marsh birds. Other areas will be mudflat conditions for shorebirds. Not all sites are always good candidates for extended drawdowns. This includes those that are, for various reasons, slow to drain and those that contain an unacceptable amount of dense undesirable vegetation like giant cutgrass. These conditions usually have been caused by residual flooding that has been extended for too long during the growing season already and should be corrected before intentional future extended drawdowns. A realistic goal should be to achieve at least 50% cover of “good” or “fair” plants (Strader and Stinson 2005). Migrating shorebirds tend to prefer the more open mudflat conditions where moist-soil plant growth is sparse, flattened, or nonexistent.

Management Strategy Prescription – Prolong Shallow Drawdowns for Foraging Conditions

For meeting Objective 4.1.3 for the managed wetland sites and resources of concern previously listed in that section, the following freshwater moist-soil prescriptions will be utilized:

- Manage drawdowns for shallow water and mudflat conditions that are conducive to foraging wood storks, herons, egrets, ibis, other waders and marsh birds. This provides benefits to some extent for shorebirds anywhere openings are present to allow foraging to occur.
- Preferably stagger drawdowns among sites so that drawdowns are not at the same time.
- Favor gradual drawdowns over rapid ones to maximize foraging opportunity at various depths and enhance water quality.
- These extended shallow water drawdown conditions are secondary to moist-soil management for waterfowl which should take precedence when considering issues of timing, plant germination, rainfall, slow drainage, and high river water levels that may prevent the desired and timely drainage.
- Continue to provide important sanctuary for waterfowl, other migratory birds, and threatened/endangered species in the total 2,931 acres of all managed wetland sites on the refuge.
- Maintain moist-soil conditions all summer conducive to tall emergent vegetation for breeding least bitterns, king rails, and black rails.
- When possible create colonial waterbird nesting habitat (mentioned in Table 5) in close proximity to shallow water drawdowns in moist-soil managed wetlands that are providing forage fish for wading birds. This can be done by establishing small isolated tree islands where practical and feasible or by planting cypress seedlings for future flooded nest sites. This also takes advantage of and adapts to future climate change and sea level rise.

BRACKISH WATER MANAGEMENT

Potential management Strategy – Manage for Brackish Plants as Food Source

For meeting Objective 4.2.1, the brackish water management strategies to be utilized annually to benefit wintering waterfowl will mainly involve adjustments in the hydrology of these brackish wetland sites to make beneficial plant foods available from October until March while waterfowl are present. Equally important during the summer plant growing season, the timing, depth, and duration of flooding and drawdown regimes will be critical to obtaining desired plant responses for winter flooding. Management of water salinity levels when possible is another important aspect to monitor to encourage plant success. Occasional prescribed burning can be an additional part of the strategy utilized to control vegetation.

All 314 acres of managed brackish marsh on the refuge occurs within three managed impoundments on Jehossee Island. These are the only managed wetland sites on the refuge that lend themselves to brackish water management. The target salinities for management are 5-15 ppt. The soils beneath the managed impoundments are mineral soils; loam, silty clay loam and loamy fine sand. These soils are suitable for both submerged and emergent aquatic vegetation. Vegetation management should be targeted for either, submerged aquatic vegetation, primarily wigeon grass (*Ruppia maritima*) and dwarf spike rush (*Eleocharis parvula*), or for emergent type vegetation, primarily saltmarsh bulrush (*Scirpus robustus*). The brackish water strategies for the winter waterfowl management period of the three Jehossee Island managed wetland sites can be described from a starting point beginning in October and ending in early March. Retain shallow flooding in site JE1 during October to maintain existing wigeon grass or dwarf spikerush. During this period, sites JE2 and JE8 will remain above bed level enough to sustain wigeon grass and to allow seedheads on saltmarsh bulrush to mature. Deeper flooding will begin in November in all three sites and will continue until March for wintering waterfowl. During this time, submergents like wigeon grass or dwarf spikerush and emergents like saltmarsh bulrush will be made available to wintering waterfowl through water level manipulation. From mid-February through March, consideration will be given to prescribed burning in all three sites if needed and practical.

A goal for all the above is a target of maintaining 40-70% beneficial emergent vegetative cover. When less than 30% open water occurs or undesirable vegetation begins to proliferate, one or possibly more corrective actions should be taken. These may include prescribed burning, early drawdown, extended total drawdown, late drawdown, deep flooding, mechanical disturbance, herbicide use, or some combination of these. Also, circulation of water through managed wetland sites is sometimes useful in discouraging algae formations and higher salinity water is usually more effective. Prescribed fire may be utilized every few years when needed. These burns are best done in the spring, depending on fuel density and degree of fuel curing, and may require unscheduled drawdowns.

Utilize adaptive management techniques for adjustments to brackish sites. Altering hydrology regimes during the winter months for waterfowl, as well as during the summer management period to enhance species diversity from March through late September, will vary depending on environmental conditions. Examples of these various environmental conditions include, but are not limited to, changes in hydrology such as water on or off to compensate for excess or lack of rainfall, high or low extremes in the salinity of river water required for timely flooding, algae production due to milder winter temperatures, and control of undesirable plant encroachment through drawdown or prolonged flooding.

Management Strategy Prescription – Manage Hydrology/Salinity for Plant Food Production and Availability

For meeting Objective 4.2.1 for the managed wetland sites and resources of concern previously listed in that section, the following brackish water prescriptions to benefit wintering waterfowl will be utilized:

- Flood sites to appropriate feeding depths between 0.2 and 1.3 ft. on existing plant species for waterfowl habitat and available forage foods from October until March.
- Target salinities for brackish water management at 5-15 ppt.
- Manage hydrology in the low elevations within these for submerged aquatic vegetation (SAV) production, primarily wigeon grass (*Ruppia maritima*) and dwarf spikerush (*Eleocharis parvula*).
- Manage hydrology at higher elevations for brackish emergent vegetation production, primarily saltmarsh bulrush (*Scirpus robustus*).
- Produce both submerged and emergent aquatic vegetation when possible within and among managed wetland sites when environmental conditions allow.
- Prescribe burn sites when needed, preferably in the fall as early as possible before mid-December if cured fuels allow, to discourage undesirables like giant cordgrass (*Spartina cynosuroides*). Otherwise, conduct prescribed burns after waterfowl departure and before green up.
- To further discourage giant cordgrass (*Spartina cynosuroides*) encroachment after fall or spring burning, deep flood into early summer to inhibit resprouting.
- Target from 30-60 % open water containing submerged aquatic vegetation (wigeon grass and dwarf spikerush) and the remainder in beneficial emergents (saltmarsh bulrush) not to exceed 70%.
- Continue to provide important sanctuary for waterfowl, other migratory birds, and threatened/endangered species in the total 2,931 acres of all managed wetland sites on the refuge.
- Prevent expansion of common reed to managed wetlands from natural marshes by aerial application of Service approved herbicides.
- Consider improving water management capabilities for wintering waterfowl as mentioned in Table 5.

Potential Management Strategy – Manage Brackish Water for Invertebrates/Fish as Food Sources

For meeting Objective 4.2.2, the brackish water management strategies utilized annually to benefit a diversity of migratory waterbirds other than waterfowl, will mainly involve adjustments in the summer hydrology of these managed brackish wetland sites from March through September. During March until mid-May management will be for northbound migrant shorebirds and breeding rails. This would be done by conducting two to three gradual drawdowns to shallow water depths with mudflat conditions and 0.2 ft. in JE1 while circulating some water from unit JE2 through it. During this time both JE2 and JW8 will be deep flooded to 2.0 ft. to discourage new spring growth of giant cordgrass especially after completing a prescribe burn on a unit. From mid-May until mid-August in JE1, flood and partially drawdown to between 0.2 and 1.3 ft. to concentrate forage fish for wading birds. The last of these partial drawdowns in JE1 should be timed to coincide with wood stork fledging usually in late July and then hold a partial

drawdown to a 0.4 ft. depth in JE1. During this same period, JE2 and JW8 can be partially drawn down from the 2.0 ft. deep water level at least once in June, for wading birds in general, through the range of 0.2 to 1.3 ft., then re-flooded and partially drawdown to 0.4 ft. to benefit wood storks in late July, similar to JE1. Afterward, continue gradual drawdown in JE2 and JW8 so that by mid-August there will be shallow water conditions of about 0.2 ft. and some exposed mudflats with invertebrate production for foraging southbound migrating shorebirds. These actions also encourages germination of wigeon grass, spike rush, or saltmarsh bulrush. From mid-August until late September, gradually drawdown further in JE1 from shallow water to exposed mudflats to focus on germination of dwarf spike rush and invertebrate production for southbound migrating shorebirds. During this period in JE2 and JW8, shallow flood to 0.4 ft. in the exposed portions of mudflat areas containing dwarf spike rush for blue-winged teal use and emergent/SAV plant survival.

A goal for all the above includes a target of maintaining 40-70% beneficial emergent vegetative cover. When less than 30% open water occurs or undesirable vegetation begins to proliferate, one or possibly more corrective management actions should be taken. These may include prescribed burning, early drawdowns, extended total drawdowns, late drawdowns, deep flooding, mechanical disturbance, herbicide use, or some combination of these. Also, circulation of water through wetland sites is sometimes useful in discouraging algae formations and higher salinity water is usually more effective. Prescribed fire may be utilized every few years when needed. Prescribed burns of this particular type to correct vegetative cover are best done in the spring, depending on fuel density and degree of fuel curing, and may require unplanned drawdowns to aid the curing process. Utilize adaptive management techniques for these types of adjustments to the brackish water sites. Altering hydrologic regimes during the winter months for waterfowl, as well as during the summer management period to enhance species diversity from March through late September, will vary depending on environmental conditions. Regimes can vary from the intended plan for many reasons and is acceptable in most cases to get the job done. Examples of these various environmental conditions include but are not limited to changes in hydrology such as water on or off to compensate for excess or lack of rainfall, high or low extremes in the salinity of river water required for timely flooding, algae production due to milder winter temperatures, and control of undesirable plant encroachment through drawdown or prolonged flooding.

Management Strategy Prescription – Brackish Water Drawdowns for Forage conditions for a Diversity of Migratory Waterbirds

For meeting Objective 4.2.2 for the managed wetland sites and resources of concern previously listed in that section, the following brackish water prescriptions to benefit a diversity of migratory waterbirds other than waterfowl, will be utilized:

- Manage primarily for waterfowl during the winter period designated in Objective 4.2.1 but then switch to manage for the summer period March through September instead for a diversity of migratory waterbirds in those same sites.
- From March through mid-May drawdown should be underway. Provide shallowly flooded areas, between mudflat conditions and 0.2 ft. in depth for foraging northbound shorebirds, some wading birds, and waterbirds. No less than 40% of each site should be managed for emergent vegetation.
- From mid-May through mid-August provide water conditions ranging between 0.2 and 1.3 ft. in depth through drawdowns, concentrate fish for wading birds especially wood storks, and encourage invertebrate production for southbound migrating shorebirds by early August. Some impoundment areas should be beginning to produce dwarf spike

rush (can initiate after July 15), and possibly late wigeon grass or saltmarsh bulrush (before or by July 15)

- Also from mid-May through mid-August target water level management to maintain 30-60 % shallow open water and 40-70 % emergent cover in each site. Avoid less than 30% open water. If less than 30% open water occurs, take management actions to correct like prescribed burning in combination with subsequent deep flooding early in the next growing season.
- From mid-August through late September focus on drawdown conditions to encourage germination of dwarf spikerush in JE1 (91 acres). Expose mudflats through drawdowns also for southbound migrating shorebirds. In JE2 (166 acres) and JW8 (57 acres) shallow flood existing dwarf spike rush to 0.4 ft. for blue-winged teal use.
- Continue to provide important sanctuary for waterfowl, other migratory birds, and threatened/endangered species in the total 2,931 acres of all managed wetland sites on the refuge.
- Consider additional shorebird surveys and improving water management capabilities for waterbirds as mentioned in Table 5.

GREENTREE RESERVOIR MANAGEMENT

Potential Management Strategy – Flood during dormant season and maintain in unflood conditions during the growing season

For meeting Objective 4.3.1, a greentree reservoir strategy for producing and providing mast and invertebrates annually for wintering waterfowl and other migratory bird species will be utilized every winter. Greentree reservoirs (GTR) are bottomland hardwood areas that have been impounded with levees and are temporarily flooded during the dormant season to provide food and habitat for wintering waterfowl (Rudolph and Hunter 1964). The refuge presently contains four GTRs. Two of them are in Compartment 2, one is in Compartment 3, and another is in Compartment 7 all totaling 71 acres.

Flooding is done only during the fall and winter season to provide food sources such as acorns, seeds, berries, and other mast for ducks and invertebrates for ducks and well as other migratory birds. This flooding period is normally November through February when foliage has dropped so that inundation of the hardwoods does not create significant flood damage to the trees. Water depths should vary from year to year to decrease chance of tree mortality and should remain completely de-watered at least once every 4 years.

Research has suggested that the continual (GTR) flooding practice can negatively impact bottomland hardwood stands, leading to decreases in mast production (Francis 1983), tree vigor and growth (King 1995), and regeneration (Young et al. 1995). There is also evidence that artificial flooding regimes applied to GTRs can shift tree species composition towards more flood tolerant species (Karr et al. 1990; King 1995). Problems associated with these sites can often be tied to annual flooding regimes and inundation that extends into the growing season (Wigley and Filer 1989), reducing soil aeration, killing less water-tolerant tree species, and increasing overstory mortality (King and Allen 1996). When managed properly, GTRs provide a valuable habitat, including feeding, resting, roosting, and loafing areas for wintering waterfowl.

Management Strategy Prescription – Shallowly Flood Hardwood Mast and Invertebrates for Winter Waterfowl and Other Migratory Birds

For meeting Objective 4.3.1 for the managed wetland sites and resources of concern previously listed in that section, the following (GTR) prescriptions for producing mast and invertebrates annually for wintering waterfowl and other migratory bird species will be utilized:

- Flood hardwoods only during the dormant winter season (usually November through February) and completely remove water prior to the growing season.
- Flood depths for wood ducks and other dabblers should remain shallow between 0.2 and 1.3 ft. while also including some intentional variation in depths or intentional unflooded conditions during some years.
- Emulate natural flooding patterns where possible.
- Flood and drawdown gradually to create a feather edge effect extending foraging opportunity for various hard and soft mast (acorns, nuts, berries, seeds and fruits) and invertebrates for ducks and other migratory birds.
- Gradual water level manipulation can incidentally produce feeding conditions in shallow water and saturated soil for other migratory birds including ibis, herons, egrets, snipe, and woodcock.
- Flood hardwood litter to create a submerged detrital effect which is a food base for various invertebrates that are then a food source for waterfowl and other migratory birds.
- In a multiple GTR situation, all GTRs should not have the same water level in a given year.
- Each GTR should be left dewatered at least once every 4 years.
- In multiple GTR situations vary water depths annually across all units.

Provide important sanctuary for waterfowl, other migratory birds, and threatened/endangered species in the total 2,931 acres of all wetland management sites on the refuge.

NATURAL MARSH MANAGEMENT

Potential Management Strategy – Control Woody Encroachment

For meeting Objective 4.4.1, a natural marsh management strategy will be utilized on Jehossee Island to maintain the current non-woody early successional marsh habitat through prescribed burning every three to four years to benefit marsh bird species. There is a total of about 4,330 acres identified as natural marsh on the refuge. Of that total, 3,277 of those acres are on Jehossee Island where essentially all of the refuge active marsh management occurs. That active management involves the use of prescribed fire as our primary direct management tool to maintain emergent marsh grasses, temporary openings, and general conditions as natural marsh habitat for avian species. Current prescribed burning to set back encroachment of woody marsh vegetation is planned for every three to four years and will continue to be done to benefit marsh bird species. This also includes an adapting or shifting process as needed to accommodate potential sea level rise. When marshlands move inland with sea level rise, so will our use of prescribed fire to continue to set back any existing woody growth.

All of the priority marsh birds that are found at the refuge require tall emergent vegetation as part of their habitat with little or no woody component. All are breeding species, except American bittern and yellow rail. Of the marsh birds of conservation interest, king, yellow and black rails are of highest concern, followed by least bittern and purple gallinule. Among songbirds, priority species are resident seaside sparrows, wintering saltmarsh sparrows, and Nelson's sharp-tailed sparrows. Therefore, periodic but infrequent fires (Gabrey et al. 2001),

possibly mimicking the historic fire regimes of these coastal habitats, are probably most likely to benefit sparrow and other passerine populations on the southeast coast. A breeding colony of seaside sparrows has existed on Jehossee Island probably since before the refuge was established.

Management Strategy Prescription – Prescribed Burn to Prevent Wood Encroachment

For meeting Objective 4.4.1 for the natural marsh sites and resources of concern previously listed in that section, the following natural marsh prescriptions for maintaining the current early successional natural marsh habitat through prescribed burning will be utilized:

- Maintain the vegetative structure of the brackish natural marsh on the refuge by prescribed burning during November through February every three to four years to keep shrub encroachment to a minimum.
- Burn high brackish marsh areas on Jehossee Island containing sand cordgrass (*Spartina bakerii*) and black needlerush (*Juncus roemerianus*), that are subject to woody shrub encroachment, in order to suppress hightide bush (*Baccharis halimifolia*) and wax myrtle (*Myrica cerifera*). These higher marsh elevations are more important to summer breeding and nesting species like seaside sparrows (*Ammodramus maritimus*) as potential tidal flooding of nests here is less likely than at the lower marsh elevations.
- Burn frequencies in high marsh can be three or more years or as triggered by woody encroachment to benefit breeding seaside sparrows and black rails (*Laterallus jamaicensis*). Recommendations (Gabrey and Afton 2000) are to manage high marsh by maintaining a mosaic of burned and unburned marshes and allowing vegetation to recover for seaside sparrows for at least two growing seasons before re-burning.
- Low to mid-level brackish marsh is subject to more frequent tides, has less encroachment of woody shrubs, and generally may not require burning as often; apply adaptive management. Monitoring of the effects of low to mid-level marsh burns in the long term may indicate value of prescribed burning at these lower sites. Lower and wetter marsh areas are likely more valuable for cover and foraging sites during the non-breeding season for seaside sparrows, as these birds typically move from summer high marsh to those lower marsh areas in winter.
- Maintain the small acreages of natural freshwater marsh that exist on the refuge as narrow fringes of the high brackish marsh and manage concurrently with the high marsh.
- Together fresh and brackish natural marsh provide tall emergent vegetation all year to meet the seasonal needs of species of concern. Summer breeding species include king and black rails, least bitterns, and seaside sparrows. Wintering species are yellow rails, American bitterns, seaside, saltmarsh, and Nelson's sharp-tailed sparrows. During the summer nearly 2,931 acres of managed wetland sites supplement the natural marshes for providing tall emergent vegetation for those summer breeding species also.
- Prescribed burning in natural marsh should be planned to facilitate survival and escape of rails and other species reluctant to escape, by encouraging slower, low intensity fire, some unburned patches, and smaller burn areas instead of entire burn block units.
- Consider establishing marsh bird surveys recommended in Table 5 to evaluate effectiveness of management actions.

Potential Management Strategy – Monitor and Protect Marsh

For meeting Objective 4.4.2, another natural marsh management strategy will involve overall monitoring and protection of 4,330 acres of marsh from potential threats on a continuing annual basis. This could be as simple as refuge staff alertness to any marsh ecosystem changes that

could indicate a need to be evaluated, as in significant changes in water salinity, temperature, depth, turbidity, or fishery or plant life. A more structured approach will also be utilized. That approach will be to coordinate with partners including SCDNR, National Estuarine Research Reserve, Nemours Wildlife Foundation, the National System of Marine Protected Areas, and the South Atlantic Landscape Conservation Cooperative to address landscape level issues affecting the natural marsh. Overall protection will include all marsh species and important fish habitat as spawning and nursery areas and also should consider the potential effects of climate change and sea level rise.

The larger ACE Basin Project marsh estuarine system, within which the refuge is located, is extremely valuable as habitat and as a spawning and nursery ground for most of the commercial and recreational fish species common to the South Atlantic coast, including sea trout (*Cynoscion nebulosus*), channel bass (*Sciaenops ocellatus*), flounder (*Paralichthys spp.*), drum (*Stellifer spp.*), bluefish (*Pomatomus saltatrix*), Spanish mackerel (*Scomberomorus maculatus*) and king whiting (*Sillaginodes punctatus*). Fish common in subtidal areas include mullet (*Mugil spp.*), menhaden (*Brevoortia tyrannus*), and bay anchovy (*Anchoa mitchilli*), as well as young-of-the-year star drum (*Stellifer lanceolatus*), Atlantic croaker (*Micropogonias undulates*), spot (*Leiostomus xanthurus*), silver perch (*Bidyanus bidyanus*), juvenile weakfish (*Cynoscion regalis*), flounder, hogchokers (*Trinectes maculatus*), tongue fish (*Cynoglossidae spp.*), catfish (*Ictalurus spp.*) and hake (*Merluccius spp.*). Six species of anadromous fish occur in the tri-river system associated with the Refuge as transients while passing from the marine environment to the riverine systems during spawning migrations. These fish are the American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), blueblack herring (*Alosa aestivalis*), striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus*), and the endangered shortnose sturgeon (*Acipenser brevirostrum*). Fresh water fish species include large-mouthed bass (*Micropterus salmoides*), catfish (*Ictalurus spp.*), gar (*Lepisosteus spp.*), bluegill (*Lepomis macrochirus*), crappie (*Pomoxis spp.*), and others. As an indicator of this region's estuary/forested wetland system productive capability, the commercial fishery harvest from this area is over 2.74 million pounds annually, or about 21 percent of the State's total volume of fish and shellfish. Dockside value of this harvest is nearly \$2,730,000 (ACE Basin NWR Planning Needs Assessment, date unknown). Recreational fishing in the ACE Basin Project area and on the refuge is a popular activity.

In 2009, portions of the refuge were included in the National System of Marine Protected Areas (MPA). In practice, MPAs are defined areas where natural and/or cultural resources are given greater protection than the surrounding waters. In the U.S., MPAs span a range of habitats including the open ocean, coastal areas, inter-tidal zones, estuaries, and the Great Lakes. They also vary widely in purpose, legal authorities, agencies, management approaches, level of protection, and restrictions on human uses. The official federal definition of an MPA is: "any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." -- Executive Order 13158 (May 2000). Two agencies are the primary managers of federal MPAs. The Department of Commerce/National Oceanic and Atmospheric Administration manages national marine sanctuaries, fishery management zones, and, in partnership with states, national estuarine research reserves. The Department of the Interior manages MPAs through national parks and national wildlife refuges (U.S. Department of Commerce and U.S. Department of Interior 2009).

Management Strategy Prescription – Coordinate with Conservation Partners for Protection

For meeting Objective 4.4.2 for the natural marsh sites and resources of concern previously listed in that section, the following prescriptions for annually protecting the integrity of the natural marsh will be utilized:

- Apply Strategic Habitat Conservation principals with Landscape Conservation Cooperative partners to address marsh issues at the landscape scale.
- Continue to cooperate as a member of the National System of Marine Protected Areas.
- Coordinate with SCDNR fisheries program at annual meetings to remain current on fishery issues that could involve management of refuge natural marsh and assist when appropriate.
- Continue partnership with the Nemours Wildlife Foundation and others to encourage research comparing species distribution and abundance within natural marsh areas as well as managed wetland sites.
- Maintain awareness of marsh conditions and any potential threats to the marsh ecosystem or fish nursery resources.
- Acquire additional lands that would protect more of the watershed which in turn helps to maintain water quality and integrity in the natural marsh to help abate climate change and sea level rise.
- Remain alert of any changes or reports of potential pollution sources.
- Enforce any protective marine regulations through the law enforcement program.

FORESTED UPLANDS MANAGEMENT

Potential Management Strategy – Favor Longleaf in Mixed Pine Thinnings

For meeting Objective 4.5.1, management strategies for the natural pine (loblolly, longleaf, and pond pine) component of forested uplands will include thinning by 2016 of mostly loblolly or pond pine as needed to favor longleaf, some possible replanting in longleaf, and generally more frequent and intense prescribed burning beginning in 2013 on a one to three year cycle in the natural pine type totaling 424 acres. These strategies benefit flatwoods salamander, foraging red-cockaded woodpecker, Bachman's sparrow, brown-headed nuthatch, wintering Henslow's sparrow (in wetter sites), and other songbird species associated with open pine canopies. A station goal should be to locate any potential refuge habitat for the flatwoods salamander and establish an acceptable level of monitoring of that habitat for the presence of the species. Continued burning and future thinning by the refuge will assist in maintaining conditions attractive to the flatwoods salamander. Burning and thinning will encourage the dense understory of grasses or herbaceous cover preferred by adults of the species in the flatwoods portion of the habitat utilized during the nonbreeding season. These same activities would enhance the grassy or herbaceous understory in isolated wetland portions of the habitat which is important as cover to allow salamander larvae to mature as part of their reproductive phase.

Locally, the refuge contribution to RCW would be initially to provide at least 1500 acres of suitable foraging habitat to supplement future adjacent colonies on local private land by year 2020 and possibly a potential breeding group by 2025. This natural pine type occurs on somewhat poorly drained soils of broad, flat, low areas and knolls. Dominant canopy species is loblolly pine, with longleaf pine being dominant in one stand (Grove North). The natural pine type occurs on old field sites that have been left to succeed into pine forests and have been

maintained by the regular influence of fire. On well drained sites, a mixture of loblolly and longleaf pines occur. On wetter sites, pond pine integrates within the stand. Smaller tracts of longleaf pine, also maintained by a regular fire regime, are found on dry flatwoods. The midstory is dominated by sweetgum with mockernut hickory, swamp red oak, laurel oak and switch cane also occurring. Shrub species include: wax myrtle, sparkleberry and persimmon. Yellow jessamine, greenbriar and blackberry are the principal vines.

Refuge pine forests and mixed pine-hardwood forests should be more intensively managed for RCW by means of growing season prescribed fires, mechanical forest thinning and possible chemical application to remove undesirable plant species. Low intensity backing fire would be preferred over intense head fire situations. One study found that declining birds that are associated with southern pinelands are heavily dependent on prescribed fire for their continued existence and few long-term consequences are likely to occur for nesting birds even when lightning-season (after April) burns are utilized (Cox and Widener 2008). The refuge natural pine (combined longleaf and loblolly/longleaf mixed stands) of 122 acres on the Grove North Compartment of the Edisto Unit, although small in acreage, can augment hundreds of acres of private pine habitat immediately adjacent to the refuge much of which is longleaf. These private acres are burned, thinned to park like conditions, managed essentially for quail hunting, and are approaching the age class and condition to be desirable to the RCW. The refuge can also work in conjunction with and assist the Charleston Ecological Services Field Station to encourage the larger ACE Basin Project area landowners on more of a landscape basis to enroll in the "Safe Harbor" program for RCW.

Management Strategy Prescription – Frequent and Intense Prescribed Burning; Converting to Longleaf Pine Plant Communities

For meeting Objective 4.5.1 for the natural pine sites and resources of concern previously listed in that section, the following prescriptions to manage natural pine type for refuge resources of concern will be utilized:

- Either dormant or growing-season burns should be applied to natural pine stands on cycles from one to three years dependent on overall site conditions such as percent hardwood sprouting, native grass/forb coverage, fuel loads, or other parameters. Frequency of burns is more important than season of burn.
- For longleaf and appropriate loblolly pine dominated habitat at the Grove North Compartment of the refuge, basal area should be 40-70 sq. ft. per acre. Thinning as needed may be used in this case to reduce canopy closure and create desired habitat conditions (Hunter et al. 2001). Habitat conditions for resources of concern are open canopy pinewoods with grassy/herbaceous ground cover.
- Uneven aged management of longleaf stands is the long-term goal. Intermediate treatments including thinning to favor existing longleaf, group selections and under-planting with longleaf seedlings may be incorporated to restore the desirable pine communities.
- More frequent and hot prescribed burning while maintaining burns resulting in open canopy is necessary to promote a grassy/herbaceous dominated ground cover. This habitat condition supports Bachman's sparrow, brown-headed nuthatch, foraging red-cockaded woodpecker, flatwoods salamander, and in the wetter areas, wintering Henslow's sparrow (Hunter et al. 2001).
- Consider bird, reptile and amphibian surveys in natural pine and other habitats (Table 5) to evaluate management actions.

Potential Management Strategy – Convert Pine Plantations to native habitat communities

For meeting Objective 4.5.2, management strategies may vary for converting present pine plantations totaling 682 acres to either mixed pine-hardwood or longleaf pine by 2018, on a site by site basis, to create habitat more beneficial to refuge bird and plant resources. One of the potential strategies to consider will be the conversion to longleaf pine involving total plantation loblolly removal and replanting in longleaf on some of the dryer sites. The other potential strategy for the lower sites will be to convert to mixed pine-hardwood through thinning of loblolly allowing regeneration of and favoring more hardwoods. The forest manager's choice of strategy for each site will depend on site factors such as soil types, elevation, and hydrology and the site's potential for these factors to support that particular forest type.

These pine plantations are located on transition zones between forest wetlands and upland pine. The pine plantations were established prior to refuge acquisition by previous owners. Dense loblolly is the single tree species with limited benefits to most refuge avian or plant species of concern. Past logging and agricultural practices combined with present day forestry management in the local landscape has resulted in monotype loblolly pine plantations being established on a widespread basis locally. Stands of varying ages are scattered across the Barrelville, Bonny Hall, and Yemassee South tracts of the refuge. Until a refuge forest habitat management plan was written and subsequently approved in late 2005, no treatments could be done except prescribed burning. Burning has not been accomplished because of hazardous fuel accumulations in recent years, close proximity of wildland/urban sites, and plans to thin or convert forest types in the near future.

Management Strategy Prescription – Converting Plantations to Mixed Pine-Hardwood or Longleaf Pine Plant Communities

For meeting Objective 4.5.2 for the pine plantation sites and resources of concern previously listed in that section, the following prescriptions will be considered to convert pine plantations to more beneficial types for refuge resources of concern:

- Within five years, complete evaluation of 349 loblolly pine plantations acres on Barrelville and 333 acres on Bonny Hall and Yemassee South to determine appropriate habitat communities and objectives for ROC's.
- Conversion to mixed pine-hardwood will occur on wetter sites, depending on soil types, elevation, and hydrology. Remove up to 80% of the pine to favor future hardwood regeneration (Robinson 2005) using operator select to 20-30 basal area (Hunter and Noffsinger 2006). Habitat conditions for resources of concern are partially open canopy with a dense understory layer. These areas will be protected from frequent fire to allow natural hardwood regeneration to occur. Planting of hardwoods may be considered if needed to create desired forest community. The following species would potentially benefit from the above actions: wood thrush, worm-eating warbler, Kentucky warbler, Swainson's warbler, woodcock, and rusty blackbird.
- Dryer sites will be converted to longleaf pine depending on soil types, elevation, and hydrology. On these higher, well drained sites, if deemed practical, harvest loblolly pine and replant in longleaf. This may occur in a single treatment harvest or could include multiple group selections over time, followed by longleaf planting.
- Maintain these longleaf pine communities with frequent burning and thinning to desired conditions with open canopy, little if any mid-story, grassy/herbaceous ground cover,

and basal area of 40-70 sq. ft. per acre. This habitat condition would potentially support Bachman's sparrow, brown-headed nuthatch, foraging red-cockaded woodpecker, and in the wetter of these areas, wintering Henslow's sparrow.

- Consider fire effects monitoring and hiring of a forester type position as listed in Table 5.

Potential Management Strategy – Minimum Disturbance to Upland Hardwoods

For meeting Objective 4.5.3, the annual management strategy for refuge upland hardwoods will continue to be primarily protection with very little if any active management. Refuge acreage of upland hardwoods is quite small comprising less than 1% of total forested acreage. This type probably could have been included in the forested wetlands type as well, as it occurs in small bands adjacent to pine-hardwood and bottomland hardwood sites on slopes with moderately poorly drained soils. Dominant tree species include: water oak, white oak, post oak, Southern red oak, sweetgum, American beech and Southern magnolia. Wax myrtle is the principal shrub.

Management Strategy Prescription – Maintain Current Forest Conditions Through Minimal Silviculture Practices

For meeting Objective 4.5.3 for the upland hardwoods sites and resources of concern previously listed in that section, the following prescriptions will be utilized to manage and protect upland hardwoods for refuge bird resources of concern:

- Light thinning to release desirable trees and encourage a moderately dense deciduous understory if needed, protect from extreme fire and otherwise maintain hardwoods essentially as they currently exist.
- If fire is to be applied to maintain existing conditions of moderate understory density in hardwoods, greater emphasis should be placed on growing season burns (creeping into hardwoods during wet soil conditions) on a longer return cycle of 5 years or more if consistent with fuel type and climatic conditions. Landbird species of concern to potentially benefit would include woodthrush, Kentucky warbler, Cerulean warbler, black-throated green warbler, black-throated blue warbler, hooded warbler, oven bird, worm-eating warbler, and nuthatch species.

FORESTED WETLANDS MANAGEMENT

Potential Management Strategy – In Mixed Pine-Hardwood Thin/Burn or Both

For meeting Objective 4.6.1, management strategies for refuge mixed pine-hardwood acres, as recommended by the 2006 Biological Review, will involve the conversion of those acres on a site by site basis to one of two types to improve habitat and benefit refuge resources of concern. The refuge contains forested wetlands of about 3,087 acres that occur primarily on old natural levees, floodplain terraces and flats. Mixed pine-hardwood (1,563 acres) and bottomland hardwood (1,524 acres) are the principal forested wetland types represented. Management actions for the mixed pine-hardwood type being considered here include a varied combination of thinning or burning or both. For 1,563 acres of mixed pine-hardwoods, future management will involve the beginning of conversion by 2018 of those acres on a site by site basis to one of two types to improve habitat and benefit refuge resources of concern. If a mixed pine-hardwood route is chosen, then we will favor hardwoods with light thinning, patch openings, and longer fire

intervals of 5-8 years. Potential species to benefit include woodthrush, Swainson's warbler, worm-eating warbler, Kentucky warbler, rusty blackbird, woodcock, and possibly red-cockaded woodpecker, flatwoods salamander, Canby's dropwort, pondberry, and American chaffseed.

The other choice would be to move the mixed pine-hardwood situation eventually toward a longleaf condition by opening the canopy, burning on a 3-5 year cycle, and minimizing loblolly pine. Species supported by this choice would include Bachman's sparrow, brown-headed nuthatch, red-cockaded woodpecker, and in the wetter sites possibly flatwoods salamander, Canby's dropwort, pondberry and American chaffseed.

The present mixed pine-hardwood type, including Live Oak-Maritime, occurs on higher flats and is composed of tree species that tolerate limited periods of moderately high soil saturation and flooding (Wharton et.al. 1982). Dominant tree species include: loblolly and longleaf pine, swamp chestnut oak, cherrybark oak, laurel oak and swamp red oak. Codominant species are represented by live oak, willow oak, water oak, white oak, overcup oak, sweetgum, blackgum and pignut hickory. A diverse shrub layer is composed of horse sugar, wax myrtle, switch cane, sweet pepperbush, American holly, fetterbush, persimmon, dwarf palmetto, gallberry and blueberry. Vines include greenbriar, catbrier, cross vine and Virginia creeper. The ground layer is comprised of cinnamon fern, royal fern, marsh fern, nut rush sedge, partridge berry, panic grasses and rushes interspersed throughout the forest.

Management Strategy Prescription – Converting and/or Maintaining Mixed Pine-Hardwood Stands Based on Site Condition

For meeting Objective 4.6.1 for the mixed pine-hardwood sites and resources of concern previously listed in that section, the following prescriptions will be considered when possibly converting refuge mixed pine-hardwood to a more beneficial type for refuge plant and animal species of concern:

- For the 1,563 acres of refuge mixed pine-hardwood stands a decision will be made to convert some of these stands, on a site condition basis, toward open mature longleaf pine stands on the dryer sites or toward a mixed pine-hardwood situation on the wetter sites while favoring hardwoods. Appropriate combinations of thinning and burning will begin to be applied to convert to desired forest habitat type by 2018.
- Most of the 1,563 acres is better suited to be converted to mixed pine-hardwood, but some higher and dryer sites should be converted to longleaf. Need elevation, hydrology, and soil work site-by-site through further development and implementation of silviculture practices.
- For converting to longleaf pine, frequent and intense burning and thinning, will be required. Removal of hardwoods to create an open pine canopy and reducing the remaining basal area by 50% while prescribe burning on a 2-3 year cycle will favor longleaf (Hunter and Noffsinger 2006).
- For converting to mixed pine-hardwood, selective thinning will be used, if needed, for release of favorable mast producing hardwoods. The small clumps or stands of pines will be thinned leaving a basal area of 20-40 square feet. The understory vegetation layer could be increased by opening up the forest canopy to about 60%. Once established, the denser patches of understory vegetation could be increased through group selection size openings (Robinson 2005). The fire return interval can be longer in this type, possibly every 3-5 years (Hunter and Noffsinger 2006).

Potential Management Strategy – In Bottomland Hardwood Thin/Group Select

For meeting Objective 4.6.2 the potential management strategies for the 1,524 refuge bottomland hardwood acres, as recommended by the 2006 Biological Review, will include at least some thinning in the closed canopy stands and some group selection to create patch openings by 2020. Guidelines that are proposed in the 2007 Lower Mississippi Valley Joint Venture (LMVJV) recommendations include reduction in canopy cover, retention of snags and den trees and increase in understory vegetation as shown in Appendix E. The 2006 Biological Review also recommended that vertical structure be maintained or improved, species composition generally maintained while insuring that a reasonable portion of the stand remains in hard mast producing species (1/3 to 2/3 of the stand) and that canopy dominated tree species and crown size be increased. Under these recommendations (Robinson 2005), the following general rules can be applied:

- 1) periodic disturbance (thinning) will maintain vertical structure;
- 2) light thinning will favor shade tolerant species;
- 3) group selection will favor shade intolerant species (many of the hard mast species);
and
- 4) reduction of competition through light thinning will allow residual trees to grow faster thereby reaching larger size with fuller crowns for a larger portion of their life span.

Periodic disturbance will be in the form of light to moderate thinning, if feasible through commercial operations, with some group selection areas. Consider variable retention harvest where thinning within the area varies from light to heavy so that long-term, some shade tolerant and shade intolerant species will be favored within the same stand. Also, the resulting variable “openness” provides different levels of understory and mid-story development. Thinning will allow sunlight to penetrate the forest canopy and maintain vertical structure of the stand and reduce competition. Larger old growth trees with large canopies will be retained while competing and less desirable trees around them are removed. Group selection areas will create openings large enough to encourage regeneration of or release of hard mast (shade intolerant species). If hard mast species compose 1/3 to 2/3 of the stand prior to thinning, no group selection areas may be needed. It appears that few hardwood bottom stands on the refuge are deficient in hard mast. All cavity trees and potential cavity trees will be left for cavity nesting species (Robinson 2005).

In bottomland hardwood forests, individual tree selection and group selection harvests benefit most avian species. Improvements in the bottomland hardwoods through canopy thinning and group selection openings should benefit species like Swainson’s warbler, Cerulean warbler, hooded warbler, yellow-throated warbler, black-throated green warbler, prothonotary warbler, swallow-tailed kite, woodthrush, worm-eating warbler, Kentucky warbler, woodcock, rusty blackbird, Rafinque’s big-eared bat, and even potential habitat for the Bachman’s warbler. The pondberry plant could possibly benefit if present on the refuge in bottomland hardwood swales.

Additionally to benefit bald eagles the refuge can continue to protect, maintain, and monitor all nesting pairs. Staff can conduct annual nest surveys to track and preserve active and potential nesting sites. Protecting active and inactive nest sites during prescribed fire activities is another means of contributing to the habitat needs of the bald eagle. Additionally, a need the refuge can provide is nest site protection in general from any disturbance such as maintenance activities, traffic, public use, and recreational activity. The refuge can emphasize forest management practices where appropriate to improve eagle nesting habitat to support an increase in the bald eagle population. This may include selective thinning for potential nest trees, preserving tree

islands and protecting dominant trees especially on forested edges near the natural marsh or wetland. Management measures to improve nest sites that inadvertently could cause disturbance, should be accomplished outside the nesting season. All managed wetland sites on the refuge can provide foraging sites for eagles. These wetland areas concentrate waterfowl, fish, and carrion that are potential winter food sources for eagles.

While including a number of species found in the mixed pine-hardwood type, the bottomland hardwood forests occur on lower flats and are dominated by species tolerant of slightly longer periods of soil saturation and flooding (Wharton et al. 1982). Dominant tree species include: overcup oak, swamp chestnut oak, water oak and red maple. Although loblolly pine is present, spruce pine is the principal co-dominant pine species found on these wetter sites. Other codominants are: water hickory, pignut hickory, American hornbeam and green ash. Shrubs and vines include: switch cane, wax myrtle, fetterbush, dwarf palmetto, catbrier, sawbrier, poison ivy and Virginia creeper. The ground layer is less dense than that of the mixed pine-hardwood type and consists of a variety of herbs, grasses and sedges including netted chain fern, partridge berry, nut rush sedge, beak rush, sedges, plume grass and panic grass. The Bald Cypress-Water Tupelo Swamp community occurs in the wettest parts of floodplains that have standing water for most of the year. As a result, few herbs occur. Along with bald cypress, water tupelo dominates in the canopy. The Bald Cypress-Water Tupelo Swamp community is commonly found along the Combahee River. No active management is planned within the cypress/gum swamps for the near term. These areas are well suited for “protection” and over time should promote cavity development suitable for bats and other species.

Management Strategy Prescription – Silvicultural Treatments will Open Canopy, Create a More Dense Understory, and Improve Forest Structure

For meeting Objective 4.6.2 for the bottomland hardwood sites and resources of concern previously listed in that section, the following prescriptions will be considered if planning involves thinning and creating openings in refuge bottomland hardwood areas to improve habitat diversity and structure for resources of concern:

- Conduct light thinning and group selection openings, with very rare incidence of fire (Hunter and Noffsinger 2006). If fire is to be applied in hardwoods greater emphasis should be placed on growing season burns (creeping into hardwoods and moister soil conditions) on a longer return cycle if consistent with fuel type and climatic conditions (Hunter and Noffsinger 2006).
- Thin canopy to about 60% cover allowing sunlight to increase in understory vegetation layer and then through half acre or larger group-selection sized openings, increase denser patches of understory vegetation (Hunter and Noffsinger 2006).
- Supporting canebrake conditions would be part of this management and should provide important habitat conditions for the species listed above in the potential management strategies (Hunter and Noffsinger 2006).
- Follow 2007 LMVJV guidelines to establish general management triggers and future desired conditions as shown in Appendix E.
- Consider conducting bat surveys as mentioned in Table 5.

EARLY SUCCESSIONAL/GRASSLAND MANAGEMENT

Potential Management Strategy – Mow, Burn, or Herbicide for Early Succession

For meeting Objective 4.7.1, management strategies for maintaining refuge early successional habitat, the majority of which is located on the Grove South Compartment, for priority landbirds, will involve annual utilization of various combinations of methods as needed to maintain this type of habitat in a mosaic condition of grasses and shrubs. These methods can consist of a variety of mechanical, chemical, and prescribed fire treatments or combinations of these that are found to be effective for given site conditions. The preferred results of these actions are summer production of seed and insect foods within the grassy sections, and nesting/cover habitat within the shrub areas for landbirds. Grasses are usually left standing to provide winter habitat and cover for other bird species like wrens and sparrows. Original plans were to reforest the 189 total refuge acres of former agricultural fields and pasture sites, but the refuge recognized the importance of these sites for painted buntings and Henslow's sparrows, among other grass/shrub mosaic or early successional bird species.

The breeding landbird requiring the most management attention at the refuge is the painted bunting (Hunter et al. 2001). The painted bunting is already a species of Continental Conservation Interest, the eastern subspecies (possibly a separate species) is among the highest ranking taxa in the Southeast in need of conservation attention and the refuge may represent an important location for supporting Eastern painted buntings in the outer Coastal Plain habitat. Painted buntings seem to be most closely associated with woodland edges and shrub-scrub with access to grassy areas. Grassy areas are especially important for young buntings that require high protein food sources from insects associated with the grasses. Adult buntings typically bring juveniles to these areas to forage. The refuge should be able to contribute to reversing population trends with increasing habitat being made available and supporting high annual reproductive success. Regarding the latter, painted bunting, like many edge species, may be particularly vulnerable to high nest depredation and parasitism associated with areas with substantial open land, but also like many edge-associated species may be able to persist despite these problems. For a reference point, high reproductive success can be measured as the average of four young per successful nest as suggested in the South Atlantic Coastal Plain Bird Conservation Plan.

Management Strategy Prescription – Manage Breeding and Wintering Habitat

For meeting Objective 4.7.1 for the early successional sites and resources of concern previously listed in that section, the following prescriptions will be utilized to provide for early successional habitat, mostly on the Grove South Compartment, consisting of a mosaic of both native shrubby vegetation and grasses for priority landbirds:

- Maintain refuge old field/pasture areas, dispersed on the Grove South Compartment in 12 areas totaling 151 acres, in early successional growth with a mosaic of both native shrubby vegetation and grassland containing either native or commercial grasses (see EPABU 2003 Workshop below).
- Maintain a 50-75% component of grassy forage conditions with Dallis grass (*Paspalum dilatatum*) and/or bahia grass (*Paspalum notatum*) during summer months, that will produce preferred seeds as well as insect foods for juvenile and adult painted buntings, indigo buntings, blue grosbeak, bobolink, and other birds.

- Maintain when possible a 25-50% shrubby component of waxmyrtle, hightide bush, other broadleaf saplings, or blackberry to provide potential summer bird nesting habitat and cover within these same sites in addition to the grasses.
- Leave all grassy areas unmowed or untreated as standing thatch for the winter season to provide potential wintering habitat and cover for temperate migrants like short-billed marsh wrens or sparrows like the Henslow's sparrow.
- Treat areas in a timely fashion as required and needed to maintain the desired mosaic condition on each site utilizing any combination of techniques that are effective including mechanical (mowing, cutting, shredding, chipping, chopping), burning, disking, planting, and herbicide treatment.
- Rotate setback or treatment of individual areas from year to year as needed to assure that desired early successional habitat conditions remain in at least some areas each year.
- Ideally for the least disturbance to species to be benefitted, treatment manipulations like mowing would be timed to be conducted from mid-February through March 15 after winter bird use of the standing thatch and before arrival of spring migrants for nesting. This may be the only season that fire, as a choice of treatment, would carry.
- Otherwise any of the other manipulations would be an option normally from September 15 through mid-March to expedite the process outside bird nesting periods and to be the most effective. An example would be mowing in late August or September to stress and discourage woody plant growth by removing nutrient reserves above ground before the plant root system can store them for the winter.
- Forest edges surrounding these early successional areas can be feathered or thinned to less than 50% canopy cover by cutting into the existing woods 50-100 feet to maximize potential use by painted buntings, and other shrub-scrub species like the American woodcock (nesting and diurnal foraging habitat), prairie warbler, northern bobwhite, field sparrow, eastern towhee, and common ground-dove.
- If it becomes feasible, have a painted bunting habitat use study conducted on the refuge (Table 5). Research would address unanswered questions about its preferred territorial boundary establishment, nesting habitat and climate change relative to its long term welfare.
- Consider recommended management techniques presented specifically for the Eastern painted bunting at the EPABU 2003 Workshop at the SCDNR Web Center in South Carolina as follows:
 1. Grass >50%, mow in early March, preferably, or hold off till end of September-early October.
 2. Consider prescribed burning when wax myrtle or shrub-scrub is 2-3 meters in height. The desired condition should be 25-50% shrub-scrub coverage in a mosaic with 50-75% in grassy condition. Emphasis on regular dormant season burning (3-6 years) or growing season (3-6 years) mixed with bush-hogging and preferably disking (3-6 year disturbance intervals).
 3. Open the adjacent pine or hardwood forest with <50 percent canopy cover and opening-tree falls. Old growth maritime forest is excellent PABU habitat (low densities but probably very high nest success based on other shrub-scrub nesting birds). No need to manage this habitat, since tree falls provide shrub-scrub habitat for PABUs.

4. Wetlands edge - freshwater and salt marsh edge utilized if in close proximity.

Potential Management Strategy – Mow, Burn, Disk, or Herbicide for Grasslands

For meeting Objective 4.7.2, a management strategy for providing assorted small edge areas refuge-wide as open grassland habitat for landbirds will involve mechanical or other treatments at least once or more annually to maintain the grassland open condition. An approximate total that may vary annually between 125-150 acres of these dispersed edge type habitats are maintained throughout the refuge but only 51 of these acres are sufficiently consolidated to be shown on the maps in Appendix A and B. These areas contain desirable naturally occurring grasses and weeds. These habitats include assorted open areas, old fields, edges, pastures, refuge roadways, utility right of ways, and dike tops. This strategy is designed to encourage native and other grasses and weeds that provide preferred forage conditions containing seedheads and high protein insects for summer breeding migratory and resident songbird species as well as provide potential wintering habitat for other avian species. Local native species like wild turkey, bobwhite quail, and white-tailed deer utilize these grassy sites as well. While maintaining the grassy successional stage, any encroaching native woody plant growth is also controlled by the treatments. Currently these refuge sites are mowed, burned, or mechanically/herbicide treated not only to encourage grasslands, but to aid in the control of invasive exotic plants (primarily Chinese tallow in this case) through integrated pest management. The primary grasses available and preferred by landbirds currently at the refuge are voluntary Dallis grass (*Paspalum dilatatum*) and remnant agricultural stands of bahia grass (*Paspalum notatum*).

Management Strategy Prescription – Manage Summer Forage and Winter Cover

For meeting Objective 4.7.2 for the open grassland sites and resources of concern previously listed in that section, the following prescriptions will be utilized to provide for open grassland habitat refuge wide for landbirds:

- Retain assorted open and edge areas in grassland habitat containing naturally occurring grasses dispersed refuge wide with very little or no shrub component.
- Maintain grassy forage conditions specifically during summer months that produce preferred seeds of Dallis grass or bahia grass, as well as insects, for food for juvenile and adult painted buntings, indigo buntings, blue grosbeak, bobolink, field sparrow, common ground-dove, and other birds.
- Maintain grassy thatch by leaving a dense standing winter grassy condition as unmowed/untreated to provide potential wintering habitat and cover for some of the temperate migrant species like short-billed marsh wren or sparrows like the Henslow's sparrow and spring habitat for woodcock (nesting and diurnal foraging habitat).
- Treatment of areas is primarily by mowing but burning, disking, and herbicide treatment can be utilized to advantage.

CHAPTER VI. MANAGEMENT STRATEGY DOCUMENTS

NECESSARY RESOURCES

The successful implementation and accomplishment of refuge HMP goals, objectives, and their recommended strategies over the next 15 years, for the most part, will be dependent upon future availability of resources. These necessary resources include adequate refuge funding, presence of experienced refuge staff and/or other service personnel, specialized refuge equipment, research assistance, and services/contracts provided through private sector vendors or resource professionals. Accomplishment of many management projects can be absorbed through existing budgets and current staff levels over time by concentrating on priority programs. However, this method alone likely will not allow full accomplishment of goals and objectives during the lifespan of the HMP without supplemental assistance with many projects.

Specialized construction equipment is necessary to continue to maintain approximately 30 miles of refuge impoundment dikes, 40 water control structures, and 28 managed wetland sites where water levels are managed to improve habitat conditions for resources of concern. Additionally, refuge as well as private equipment operators are required that are experienced in this type of construction operation and ground conditions. When funding is available, private sector vendors instead of refuge personnel may be contracted to complete maintenance type construction/rehabilitation in some managed wetland sites or to conduct invasive plant control when aerial application is desirable or required.

Coastal management systems, as we have on the refuge, can at times require immediate emergency repairs. In tidal coastal environments timely repairs to prevent further rapid deterioration to infrastructure, such as dikes and water control structures, is sometimes required within managed wetland sites not only to protect from normal daily tidal situations but even more importantly from events such as storms, hurricanes, floods, erosion, and extreme tidal events.

Some of the refuge managed wetland sites are located in remote locations such as on Jehossee Island, a coastal island situation requiring barging of construction equipment by private sources. Of course, this is dependent also on availability of barging contractors and being able to secure them in a timely manner before deteriorating conditions worsen. Contracted projects in many of these cases are necessary as they relieve competition for refuge equipment, operators, and resources potentially being used concurrently for other time sensitive refuge projects. In other instances we are dependent on service personnel when available from adjacent refuges to advise or assist in habitat related issues. Assistance from a forester from another refuge has been utilized on occasion when available as there has never been a forester assigned to this station. This station's first Forest Habitat Management Plan was completed in 2006 through contract with a retired forester from an adjacent refuge. Another example involves both engineering and construction assistance to expedite managed wetland site rehabilitation. This is occasionally accomplished through one of our cooperative partners, Ducks Unlimited, who oversees contracts to complete some wetland site habitat improvement projects.

Listed below in Table 5 are proposed project summaries and their associated costs as outlined from the ACE Basin NWR CCP for fish and wildlife population management and habitat management over the next 15 years. This proposed project list reflects the priority needs identified by the public, planning team, and refuge staff based upon available information. These projects were generated for the purpose of achieving the refuge's habitat goals, objectives, and strategies.

Table 7. Proposed Habitat and Wildlife Population Management Projects

PROJECT NUMBER	PROJECT TITLE	FIRST YEAR COST (Dollars)	RECURRING ANNUAL COST (Dollars)	STAFF (FTE'S)
Project #1	Painted Bunting Habitat Use Study	10,000	5,000	
Project #2	Perform reptile, amphibian, bats, shorebirds and marshbird surveys	30,000	20,000	
Project #3	Hire Full-time Forester	60,000	60,000	1 Forester
Project #4	Improve water management capabilities for wintering waterfowl habitat, shorebirds migration habitat, wading bird habitat, and wood storks	785,000	50,000	
Project #5	Create Colonial Waterbird nest habitat	30,000	5,000	
Project #6	Fire Effects Monitoring (especially long term)	25,000	10,000	
Project #7	Prescribed burn/marshbird impacts	10,000	3,000	

DOCUMENTATION OF COMPLIANCE

Some habitat management activities described in this plan may require appropriate state or federal permits to proceed. When required, those permits will be obtained prior to the occurrence of any activity. As an example any ground or site disturbance that potentially may affect a refuge historical or cultural resource will be submitted to the attention of the regional archaeologist for review. If necessary at that point the archaeologist will contact the S. C. State Historic Preservation Office to determine if permits are required. In other incidents, permits may or may not be required when projects involve manipulation of managed wetland dikes, water control structure replacements, or similar construction issues that may potentially be construed as wetland fill. Some of these activities may be exempted from permits. If not exempted, then applications for permits will be submitted through the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act.

DOCUMENTATION OF SPECIAL USE – COMMERCIAL SALE OF TIMBER

Execution of Timber Harvest

Timber harvest or sale on the refuge will be scheduled for individual stands within compartments on an as needed basis as opposed to assigned time periods of entry and re-entry for each compartment. Most refuge timber stands within compartments are relatively small in acreage and often scattered. Silvicultural activities will be done in priority order of highest to lowest according to the needs of any particular stand and the alternative risk of no action. Examples might include timber harvest for hazardous fuel reduction to reduce risk of wildfire, tree disease prevention or control, salvage operations, invasive species management issues, storm damage, climate change effects, and for wildlife habitat diversity or improvement. The following methods of refuge harvest or sale of timber are subject to change as conditions, markets, methodology of operations, and refuge experience broadens.

A timber cruise or inventory will be conducted for each silvicultural action. The inventory may be conducted using fixed plot or point sampling techniques. Volume tables for each compartment will be expressed in 2-inch diameter classes for both sawtimber and pulpwood. Volume tables will be used for both pine and hardwood volumes for both sawtimber and pulpwood products. The following data may be collected during each compartment cruise:

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

A timber harvest prescription will be written for each proposed harvest activity or sale. 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. Treatment prescriptions could contain the following information:

- Compartment map;
- Stand map designating various timber stands within the compartment;
- Description of compartment including vegetation profile, soil types, hydrology, and other physiological features;
- Timber data including tree species composition, sawtimber, and pulpwood volumes, stocking, age, condition, and basal area.
- Wildlife habitat parameters including plant composition of overstory and understory; number of cavity and den trees; presence of vines, Spanish moss, and switchcane; number of dead snags; presence of woody debris; and evidence of wildlife activity (e.g. bird nests, browsing of plants, and wildlife tracks).

- Composition of woody plant regeneration;
- Description of silvicultural treatment to be conducted in the compartment;
- Description of desired results;
- Map of treatment area; and
- Timber data for the treatment area showing what is to be removed during treatment.

To determine which trees are designated for removal, the forester will follow sound silvicultural procedures prescribed in the compartment prescription. Marking trees to be removed or to be retained with paint will allow the contractor to determine which trees are designated for removal during timber harvest and help the forester identify the stumps of marked trees during administration of the logging contract. In many situations an alternative to tree marking, the operator select method of harvest, can be utilized in order to meet habitat objectives. In an operator select operation the stand boundary will be marked with paint.

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 stand, 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 harvest or sale 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. The refuge forester will be responsible for staying informed as to the details of the local markets surrounding the refuge in order to satisfy these conditions.

Timber harvest operations can occur anytime of the year but should be timed to cause the least detrimental effect to associated natural resources. Seasonal restrictions of harvest activities can prevent disturbance to sensitive wildlife and plant species such as bird nesting/breeding or undesirable plant damage during the growing season. Logging will also be restricted to dry periods of the year to keep soil disturbance and damage to residual vegetation at a minimum.

Logging Operations

Refuge roads for commercial timber harvest operations may be limited to existing roads only. This will help reduce fragmentation of the habitat and limit disturbance to soil and plants throughout the refuge. Logging operators will be allowed to use skidders, crawler tractors, and wheeled tractors to skid logs to loading areas where they can be loaded onto trucks. Tree-length skidding will be allowed, but the trees must have tops and all limbs removed before skidding when applicable. Removal of tops and limbs will reduce chances of damage to residual trees. Other special conditions and/or restrictions, as determined by refuge staff, may be stated in the Timber Sale Bid Invitation (Exhibit 3) or a special use permit awarded to the successful bidder.

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 harvests is 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 hazards, times when harvesting may interfere with essential refuge operations or public use, 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 potentially damage existing cultural resources. 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 any remaining amount returned.

Archaeological and Cultural Resources

Archaeological and cultural resource sites have been located in several areas of the refuge. In fact the refuge headquarters is housed in an 1828 colonial mansion that is on the National Register of Historic Places. This administrative office is in turn located on "The Grove Plantation", an antebellum plantation once active in the rice growing culture. No significant Native American sites have been found as yet on the refuge as a result of past archaeological surveys. When a compartment or stand comes under consideration for treatment, known archaeological sites and cultural resources that are identified in or near the treatment area will be brought to the attention of the Service's regional archaeologist. Review of the sites and resources will be performed by this person and clearance obtained from the State Historic Preservation Office if required. Upon completion of all clearances, treatment will be implemented with an appropriate buffer established around the perimeter of the site. It is possible that forest management activities on the refuge could inadvertently disturb archaeological sites. In the event this happens, the logging operation will cease and the regional Archaeologist will be contacted.

Aesthetics

Aesthetics are important concerns for forest habitat managers. Thousands of visitors use the refuge every year for hunting, fishing, wildlife observation, or other compatible wildlife-dependent recreation. In application of all forest habitat treatments, consideration must be given to the fact that these habitats are to be managed for the benefit of present and future generations of Americans. While the intentions of this management plan are to fulfill this obligation, it must be realized that some silvicultural treatments may not readily appeal to some visitors. Therefore, buffer strips may be established along watercourses and some major roadways. Silvicultural applications will be minimized in these areas to provide an aesthetically pleasing forest to visitors. Buffer strips along roads may even be implemented during conversion of pine plantations.

Insects, Diseases and Timber Salvage Harvests

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 overall health of the forest. The presence of tree diseases and insects is a normal occurrence in the forest. 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 local, state, and federal authorities for advice on how to effectively control the problem. In the event of extensive disease or insect infestation, the refuge manager or forester 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.

Salvaging damaged timber, dead, or down trees following natural events, such as ice storms, tornadoes, disease/insect outbreaks, windstorms, wildfires, etc., is a common practice in forest management. Forest management on ACE Basin NWR will 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.

Conditions Applicable to Timber Harvesting Permits

The following conditions apply to permits for timber harvesting (Exhibit 1)

- Except where specifically authorized by a special use permit, all regulations governing activities on national wildlife refuges in general and specific public use regulations for ACE Basin NWR (including littering, possession and use of firearms, and protection of wildlife) apply.
- All logging will be within the boundaries specified (see attached map) and coordinated with the refuge forester or his designee.
- Trees larger than or equal to 16 inches in diameter (dbh) shall be cut so as to leave a stump not more than 6 inches above the root collar. Trees less than 16 inches in diameter (dbh) shall be cut so as to leave a stump not more than 6 inches in height on the side adjacent to the highest ground. Stump heights will be measured on the side adjacent to the highest ground. Trees are painted at eye level and at stump; ground level paint spot must be visible after tree has been cut. All marked trees must be cut. In

the event any marked trees are not cut by permittee, refuge personnel will have the trees cut and will withhold from the permittee's performance guarantee a sufficient amount to cover the cost incurred.

- Logging will not be permitted when the ground is wet and subject to rutting or severe soil compaction. The permittee and his employees will do all in their power to prevent rutting and erosion. Permittee will be required to fill any ruts made as a result of his operation.
- Only marked or designated trees shall be cut, unless otherwise agreed on by both parties. Utmost care shall be exercised to protect all other trees and vegetation from damage. Additional trees marked by refuge personnel for roads or loading sites will be paid for at bid price. Unmarked trees which are cut or injured through carelessness shall be paid for at double the market value stumpage price. Additional damages may be assessed or merchandising methods adjusted based on the severity of the damage.
- Trees will be de-limbed and topped at the point of felling, unless special conditions are permitted.
- If excessive skidding damage occurs, skidding lengths can be shortened by refuge forester.
- No loading sites will be permitted within 300 feet of public roads or near ATV trails open to the public. A refuge forester must approve the location of all loading sites and temporary roads.
- Trees and tops cut shall not be left hanging or supported by any other living or dead tree or brush. Any tree that becomes lodged when cut shall be immediately rendered unlodged and felled flush to the ground. All tree tops and other logging debris will be removed from roads, roadside ditches, trails, firebreaks, fields, streams, and drainages immediately after felling.
- When timber sale is adjacent to private land, all logging debris will be pulled back onto the refuge to avoid damage to private property.
- Vehicles and other equipment will be operated in a safe manner at all times. Both refuge personnel and the visiting public use the refuge roads. The speed limit on refuge roads is 35 miles per hour unless posted otherwise.
- Each bidder will submit with his bid, or have on file in the refuge office, a current statement demonstrating his financial ability and the ownership or control of necessary equipment to carry out the operation on the basis herein specified. To properly construct and/or maintain roads will require the use of a crawler tractor and road grader.
- The permittee and his/her employees will be reasonably prudent in preventing and suppressing forest fires. Permittee shall be liable for all fire suppression costs resulting from his operations.
- The permittee shall protect all known (identified on the ground) archaeological sites against disturbance, destruction, or damage during harvesting operations. If, during the course of the harvest activity, the permittee notices illegal excavation or archaeological

resources removal activities, this information shall be immediately provided to the refuge manager.

- All known archaeological sites will be identified on the ground by refuge personnel, by placing a wooden stake at the center and flagging the perimeter with pink or pink/black ribbon. If previously unrecorded cultural resources or human remains be discovered on Service land, thinning activities at that site will be immediately halted. There can only be minimal soil disturbance within these areas.
- If, during the course of the harvest activity, the permittee deliberately damages a recorded site, the permittee will be responsible for the resultant site damage assessment and mitigation.
- The operating season or period of all harvest activity will be specified. Any operations outside the specified season must be approved in advance by the refuge. For safety reasons and to minimize conflict, the permittee will cease logging operations during refuge deer hunts.
- A pre-entry conference between the refuge forester (or designee) and the successful bidder representative will be required before beginning logging operations to ensure understanding of the permit conditions and thus avoid serious conflicts.
- The refuge manager or his/her designee (e.g., administrative forester) shall have the authority to stop timber harvesting operations anytime justifiable reasons develop.
- Loggers are required to implement South Carolina's Forestry Best Management Practice guidelines.
- Clean-up of oil, hydraulic fluid, and other contaminants as a result of the logging operation is the responsibility of the permittee.
- The permittee will remove plugs, dams, and bridges constructed by the permittee upon completion of the contract.
- The U.S. Government accepts no responsibility to provide right-of-way over private lands for transfer of harvested materials.
- Maintenance of all roads on ACE Basin NWR used in the logging operation will be the responsibility of the permittee. These roads must be maintained to pre-harvest condition or to the standards described under these permit conditions.

Control Records

The following process will be adhered to before application of any silvicultural treatments. First, stands will be inventoried in a uniform manner to evaluate habitat conditions as they apply to the objectives of the refuge. Next, inventory data will be evaluated and a determination made as to the best course of action to accomplish the overall habitat objectives. Finally, a Regional Office timber prescription approval will be necessary before any treatment is applied to the stand. All original documents pertaining to the stand treatments (i.e., inventory data, prescriptions, approvals, volumes removed, and contracts) will be kept in the refuge office files.

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 invitations, 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 management unit folder for each individual management unit or within a general timber harvest folder, thus keeping all information pertaining to timber harvests within a single file.

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 ACE Basin NWR CCP, ACE Basin NWR HMP, and management unit 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 high 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 3). Bid invitations will contain the following information:

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

Bids and Performance Deposits

For all bid sales, a bid opening date and time will be set to occur at the refuge headquarters. All bids (Exhibit 2) 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 \$500 bid guarantee must accompany all bids received through the formal bid process. 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 Federal Government. When the successful bidder is named, all unsuccessful bidders' deposits will be immediately returned. The successful bidder's deposit will be returned when a performance guarantee is submitted. The performance guarantee is a deposit of \$10,000 and must be received before any activities proceed. Depending on the size of the sale or potential for damage, more than 10 percent of the appraised value may be justified as a deposit; the amount of the deposit will be stipulated in the bid invitation. The performance guarantee will be retained by the Federal Government in a holding account to cover any damages caused by the successful bidder, their agents, employees, or their producers. The balance of the deposit will be refunded to the successful bidder when the sale is completed.

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

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 Service's Regional Director signs the special use permit.

Payment for Forest Products and Administration of Receipts

In the case of lump sum sales, the successful bidder (hereafter referred to as the permittee) will have 10 days after receipt of the harvesting permit to make total payment, or in the event of a consumer scale sale (pay as cut), the performance guarantee will be considered as prepayment for the first operating period and after each subsequent operating period, payment will be made to the Federal Government in the amount indicated by actual scale tickets for that period. In no case will harvesting operations begin prior to payment. The purpose of an advance payment is to encourage the permittee to begin harvesting operations as quickly as possible and is Department policy. All payments will be in the form of a check payable to U.S. Fish and Wildlife Service.

In some cases, such as salvage sales, where speed is essential and volumes are difficult to determine, timber products may be sold by mill scale. That is, the products will be sold according to the volume of products delivered to a mill, as scaled by that mill. In mill scale sales, payment will be made according to the units scaled at a negotiated price per unit. Payments will be made on a time schedule specified on the special use permit. All payments will be accompanied by mill scale tickets or other documentation confirming the volume of forest products removed from the refuge.

Refuges are authorized to enter into Timber for Land Exchanges. In this process, land within the approved 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 Division of Realty will be responsible for land appraisals, accomplishment of a level one Environmental Assessment, 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. The refuge manager identifies areas within the approved acquisition boundary for acquisition.
2. The 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 (Area Supervisor and Division of Realty).
4. The 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 sale bid forms 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. The Division of Realty advises the landowner that the third party will intercede to acquire the subject property on the Service's behalf.
10. The Division of Realty obtains an exchange agreement with the third party. The agreement identifies and states the price of the subject property and stipulates the volume and value of timber involved in the refuge's timber sale. The third party acquires the subject property at the appraised value.
11. 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.
12. The third party completes logging operation within the specified time frame, as detailed in the special use permit.

CHAPTER VII. LITERATURE CITATIONS

ACE Basin Economic Forum. 1996. ACE basin economic forum: Health economy, healthy environment: An action agenda for compatible economic development. Walterboro, SC.

Andrew, J.M. and J.A. Mosher. 1982. Bald eagle nest site selection and nesting habitat in Maryland. *J. Wildlife Management* 46:382-390.

American Ornithologists' Union (AOU). 1983. Check-list of North American Birds, 6th edition. Allen Press, Inc., Lawrence, Kansas. 877 pp.

American Ornithologists' Union (AOU) Committee for the Conservation of the Red-cockaded Woodpecker. 1991. The conservation crisis. The red-cockaded woodpecker: on the road to oblivion? *Auk* 108:200-213.

Beacham's Guide to Endangered Species. Beacham's Guide to the Endangered Species of North America. © 2001 Gale Group (gale.com). All rights reserved. Read more: <http://www.answers.com/topic/bachman-s-warbler#ixzz1I7zXBbIK>

Colleton County Land Use Planning Task Force. 1997. Draft Colleton County land use plan. Colleton County Land Use Planning Task Force, Walterboro, SC.

Cox, J. A. and B. Widener. 2008. Lightning-season burning: Friend or foe of breeding birds? Miscellaneous Publication No. 17. Tall Timbers Research Station, Tallahassee, FL.

DeVoe, M. R. and D.S. Baughman (Eds.). 1986. South Carolina Coastal Wetland Inpoundments: Ecological Characterization, Management, Status, and Use. Vol. II: Technical Synthesis. Publication No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, S.C.

Francis, J. K. 1983. Acorn production and tree growth of Nuttall oak in a green-tree reservoir. U. S. Forest Service, Southern Forest Experiment Station, New Orleans, LA, USA. Research Note SO-289.

Fredrickson, L.H. and L.A Reid. 1988. Nutritional Values of Waterfowl Foods. USFWS Fish & Wildlife Leaflet 13.

Gabrey, S.W., A.D. Afton, AND B.C. Wilson. 2001. Effects of structural marsh management and winter burning on plant and bird communities during summer in the Gulf Coast Chenier Plain. *Wildlife Society Bulletin* 29:218–231.

Gabrey, S.W., and Afton, A. D. 2000. Effects of winter marsh burning on abundance and nest activity of Louisiana seaside sparrows in Gulf Coast Chenier Plain. *The Wilson Bulletin*. 112(3):365-372.

Griffin, C. R., T. S. Baskett, and R. D. Sparrowe. 1982. Ecology of bald eagles wintering near a waterfowl concentration. U.S. Fish and Wildlife Service Special Science Report - Wildlife No. 247:1-12.

- Hamel, Paul B. 1992. *The Land Manager's Guide to the Birds of the South*. The Nature Conservancy, Southeastern Region, Chapel Hill, NC. 437 p.
- Haslam, S. M. 1972. *Phragmites communis* Trin. biological flora of the British Isles. *Journal of Ecology*, 60: 585-610.
- Hunter, W.C., L. Peoples and J. Collazo. 2001. *Partners in Flight Bird Conservation Plan for the South Atlantic Coastal Plan*. American Bird Conservancy. 166 pp.
- Hunter, W.C., W. Golder, S. Melvin, and J. Wheeler. 2006. *Southeastern United States Regional Waterbird Conservation Plan*. United States Fish and Wildlife Service. Atlanta, GA. 134 p.
- Hunter, William C. and Noffsinger, Bob. 2006. *ACE Basin National Wildlife Refuge Final Biological Review*. U. S. Fish and Wildlife Service. Unpubl.
- Jackson, Jerome A. 1994. Red-cockaded Woodpecker (*Picoides borealis*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/species/085> ;doi:10.2173/bna.85
- King, S. L. 1995. Effects of flooding regimes on two impounded bottomland hardwood stands. *Wetlands* 15;272-284.
- King, S. L., and J. A. Allen. 1996. Plant succession and greentree reservoir management: Implications for management and restoration of bottomland hardwood wetlands. *Wetlands* 16:503-511.
- LMVJV Forest Resource Conservation Working Group. 2007. *Restoration, management, and monitoring of forest resources in the Mississippi Alluvial Valley: recommendations for enhancing wildlife habitat*. Edited by R. Wilson, K. Ribbeck, S. King, and D. Twedt, 88 pp.
- Mayfield, A.E. III, and M.C. Thomas. 2006. The redbay ambrosia beetle, *Xyleborus glabratus* Eichhoff (Scolytinae: Curculionidae). Florida Department of Agriculture and Consumer Services, Division of Plant Industry Pest Alert.
- Miller, James H. 2003. *Nonnative invasive plants of southern forests: a field guide for identification and control*. Gen. Tech. Rep. SRS-62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 93 p.
- Morse, D. H. 1989. *American warblers: an ecological and behavioral perspective*. Harvard University Press. 384 pp.
- NatureServe. 2009. *NatureServe Explorer: An online encyclopedia of life* [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: December 30, 2009).
- Ogden, J. C., J. A. Kushlan, and J. T. Tilmant. 1978. The food habits and nesting success of wood storks in Everglades National Park 1974. U.S.D.I. National Park Service, National Research Reprint No. 16. 25 pp.

Palmer, R. S. (editor). 1962. Handbook of North American birds. Vol. 1. Loons through flamingos. Yale University Press, New Haven. 567 pp.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. The University of North Carolina Press, Chapel Hill, NC.

Rawinski, T. 1985. Common reed (*Phragmites australis*) in a select group of New York/New England natural areas, an overview. Eastern Heritage Task Force, The Nature Conservancy. 6 pp.

Remson, J. V., Jr. 1986. Was Bachman's warbler a bamboo specialist? *Auk* 103:216-9.

Robinson, David H. 2005. Forest Habitat Management Plan. Ernest F. Hollings ACE Basin National Wildlife Refuge. U. S. Fish and Wildlife Service. Unpubl.

Roman, C.T., W.A. Niering, and R.S. Warren. 1984. Salt marsh vegetation change in response to tidal restriction. *Environmental Management*, 8: 141-150.

Rudolph, R. R. and C. G. Hunter. 1964. Greentrees and greenheads. p. 611-618. In J.P. Linduska (ed) *Waterfowl Tomorrow*. U. S. Department of Interior, Washington, DC, USA.

Sousa, P., and A. Farmer. 1983. Habitat suitability index models: wood duck. U.S. Fish and Wildlife Service, FWS/OBS82/10.43.

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

S.C. Department of Natural Resources. 2005. Comprehensive Wildlife Conservation Strategy. S.C. Department of Natural Resources, Columbia, SC.

Strader, R.W., and P.H. Stinson. 2005. Moist-Soil Guidelines for the U.S. Fish and Wildlife Service, Southeast Region. Division of Migratory Birds, U.S. Fish and Wildlife Service. Jackson, MS. 17 pp plus appendices.

[USCB] U.S. Census Bureau. 1990. 1990 Census summary tape files lookup. <http://venus/census.gov.cdrom/lookup>. Access date March 1999.

USDA. 2002. Environmental assessment: Management of predation losses to state and federally endangered, threatened, and species of special concern; and feral hog management to protect other state and federally endangered, threatened, and species of special concern, and candidate species of fauna and flora in the state of Florida. United States Department of Agriculture, Animal Plant and Health Inspection Service, Wildlife Services, Gainesville, FL, USA.

U.S. Department of Commerce and U.S. Department of Interior. 2009. Marine Protected Areas of the United States website. www.mpa.gov (accessed March 2010)

U.S. Department of Commerce. 1998. The regional economic information system [CD-ROM]. U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economics Measurement Division, Washington, DC.

U.S. Fish and Wildlife Service. 1992. Environmental Assessment for Prescribed Burning on the ACE Basin NWR. U.S. Fish and Wildlife Service, Hollywood, SC 19 pp.

U.S. Department of the Interior. 1992. Planning Needs Assessment for the ACE Basin NWR. U.S. Fish and Wildlife Service, Hollywood, SC 24 pp.

U.S. Department of the Interior. 2009. Ernest F. Hollings ACE Basin National Wildlife Refuge Comprehensive Plan. U.S. Fish and Wildlife Service, Southeast Region, 183 pp.

U.S. Fish and Wildlife Service. 2003. Recovery plan for the red-cockaded woodpecker (*Picoides borealis*): second revision. U.S. Fish and Wildlife Service, Atlanta, GA. 296 pp.

U.S. Fish and Wildlife Service. 2006. ACE Basin National Wildlife Refuge Final Biological Review. U.S. Fish and Wildlife Service. Atlanta, GA 84 pp.

U. S. Fish and Wildlife Service. 2009. ACE Basin National Wildlife Refuge Comprehensive Conservation Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 191 pp.

U.S. Fish and Wildlife Service. 2010. "Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change," website.
[HTTP://INSIDE.FWS.GOV/GO/POST/CLIMATE-CHANGE-STRATEGIC-PLAN](http://inside.fws.gov/go/post/climate-change-strategic-plan) accessed October 2010.

U.S. Global Change Research Program. 2010. "Global Climate Change Impacts in the U.S." From website <http://globalchange.gov/publications/reports/scientific-assessments> accessed October 2010.

Wharton, C.H., W.M. Kitchens and T. W. Sipe. 1982. The ecology of bottomland hardwood swamps of the Southeast: a community profile. U.S. Fish and Wildlife Service. Biol. Serv. Prog. Washington, D.C. FWS/OBS-81/37. 133 pp.

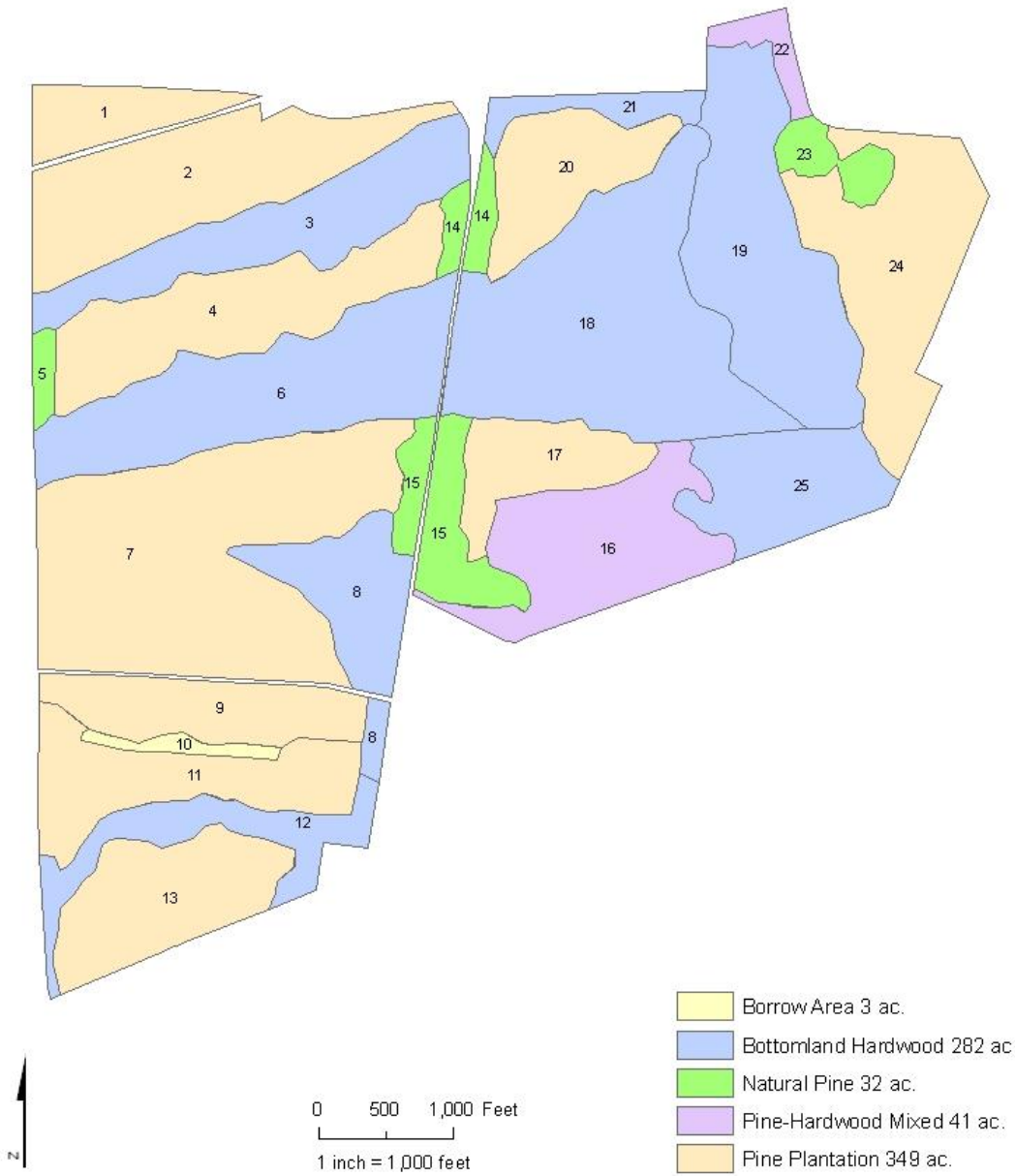
Wigley, T. B. and T. H. Filer, Jr. 1989. Characteristics of greentree reservoirs: a survey of managers. Wildlife Society Bulletin 17:136-142.

Young, G. L., B. L. Karr, B. D. Leopold, and J. D. Hodges. 1995. Effects of greentree reservoir management on Mississippi bottomland hardwoods. Wildlife Society Bulletin 23:525-531.

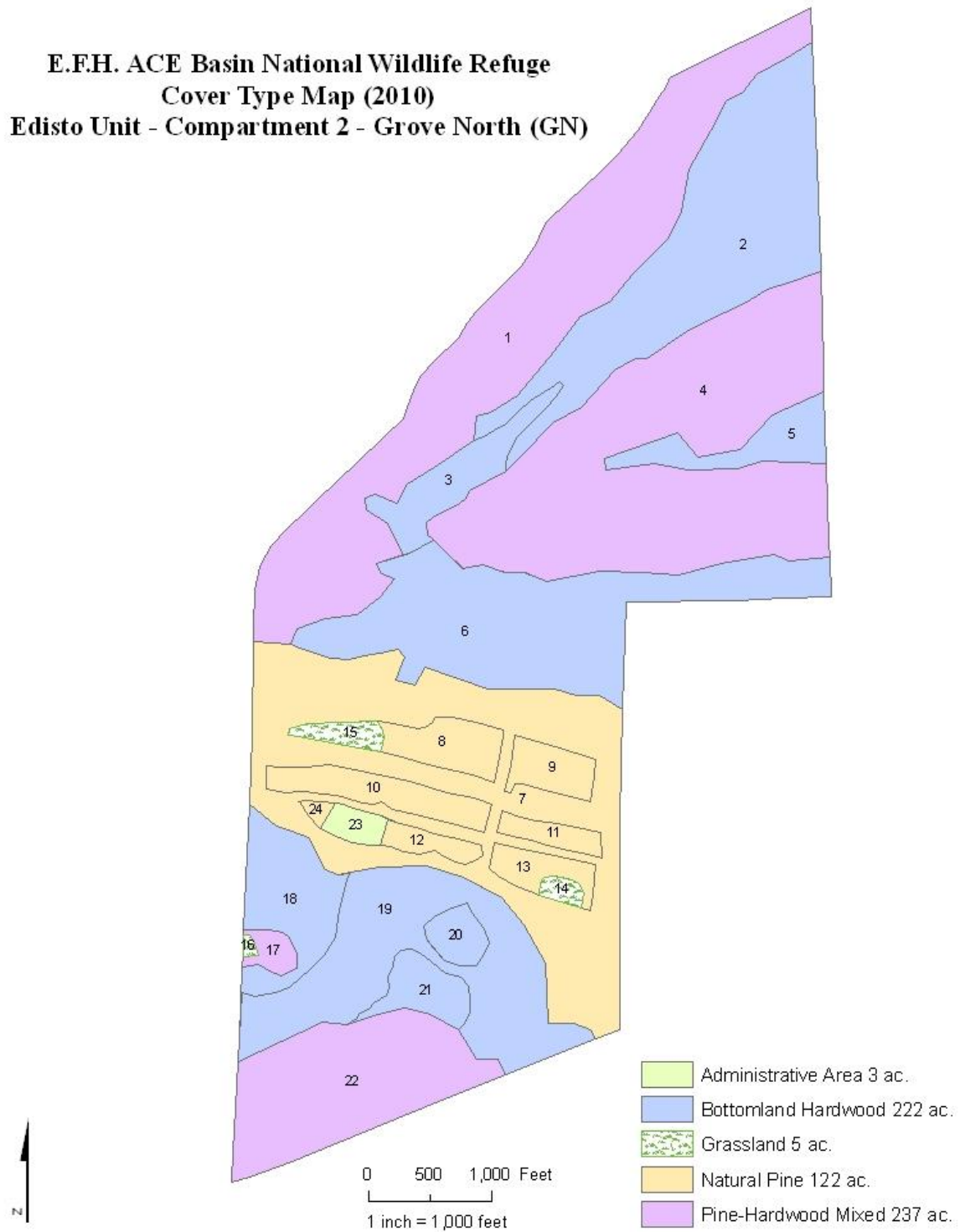
APPENDICES

**APPENDIX A. ACE BASIN NWR COVER TYPE MAPS:
COMPARTMENTS 1-9**

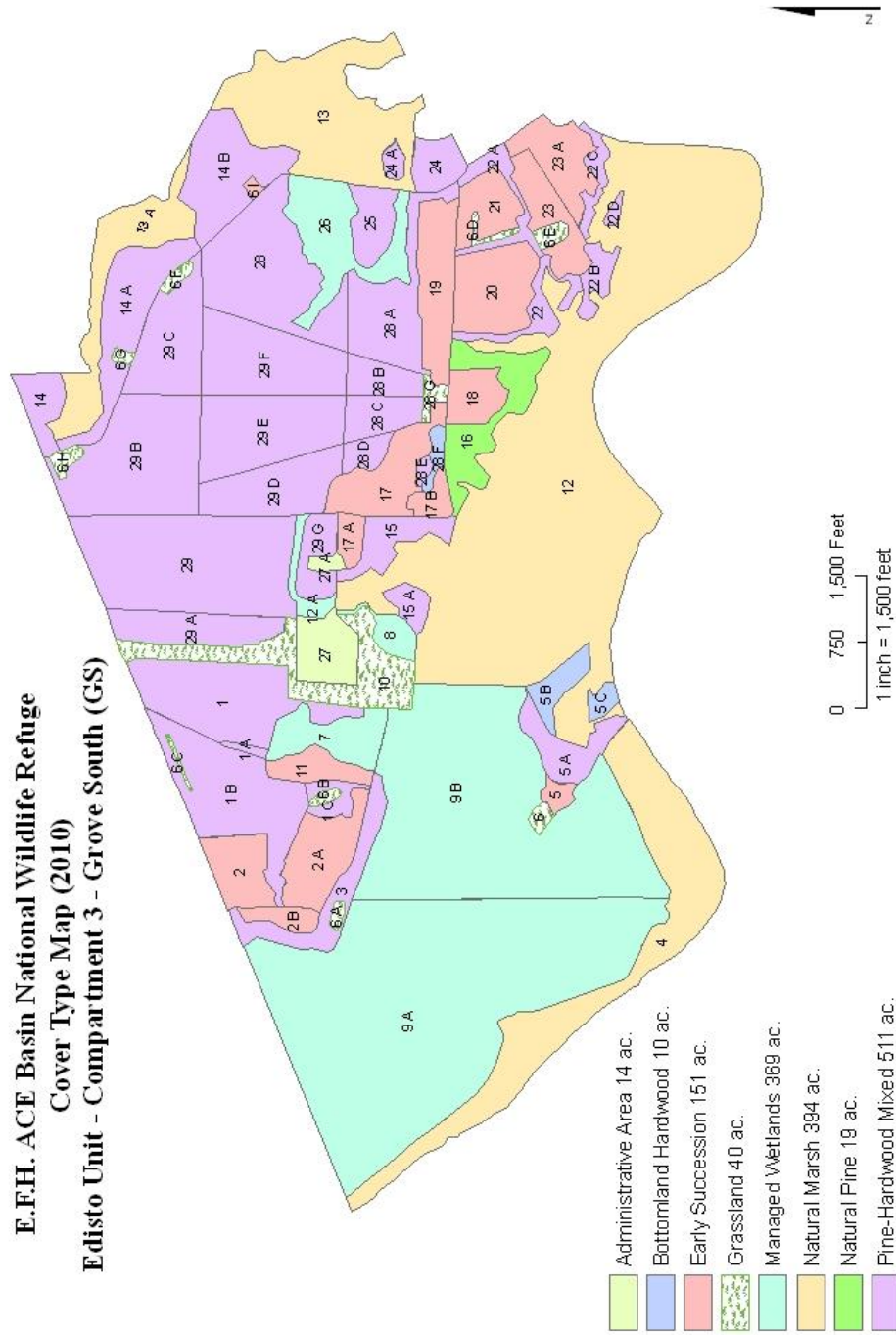
**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Edisto Unit - Compartment 1 - Barrelville (BV)**



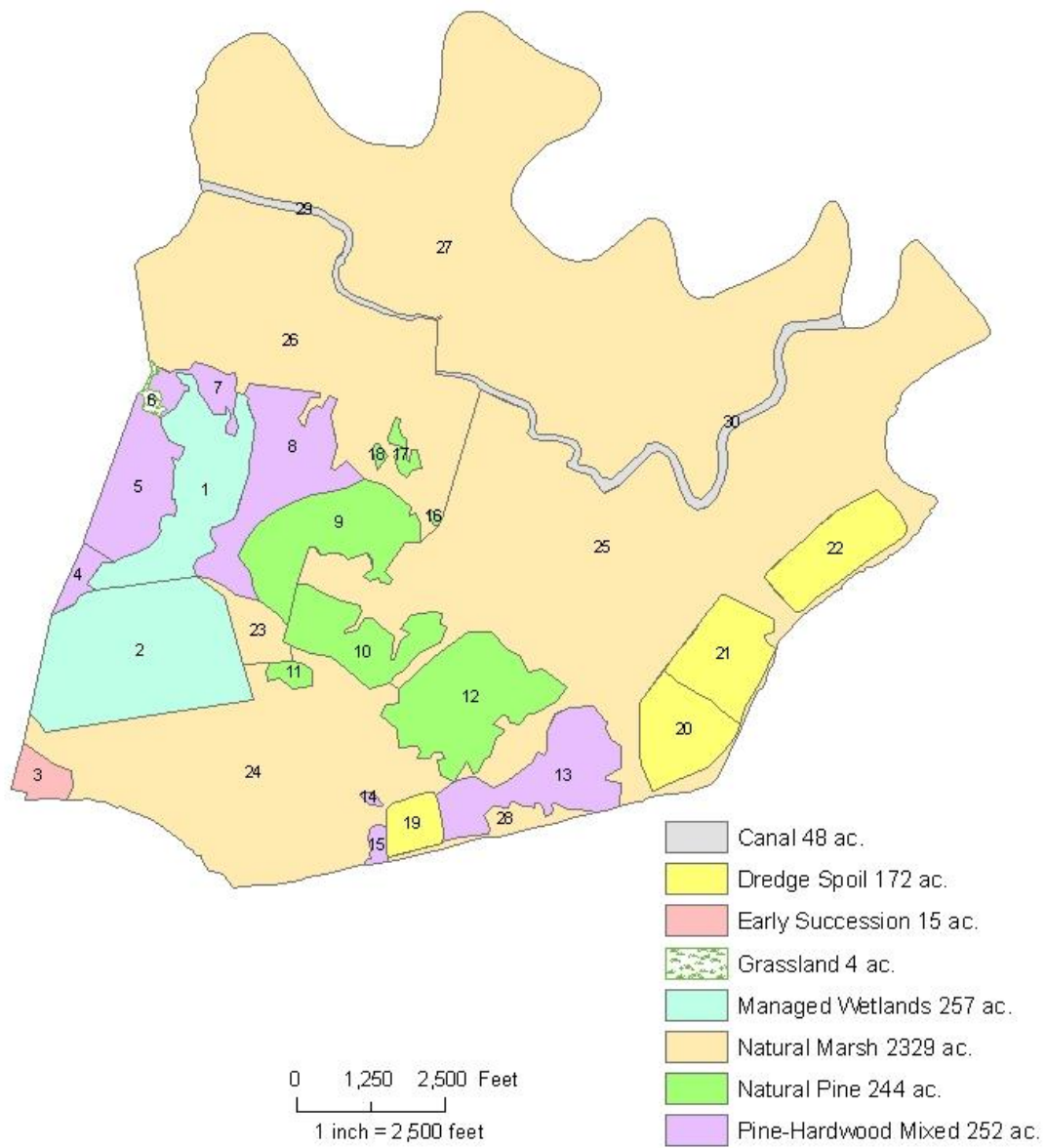
**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Edisto Unit - Compartment 2 - Grove North (GN)**



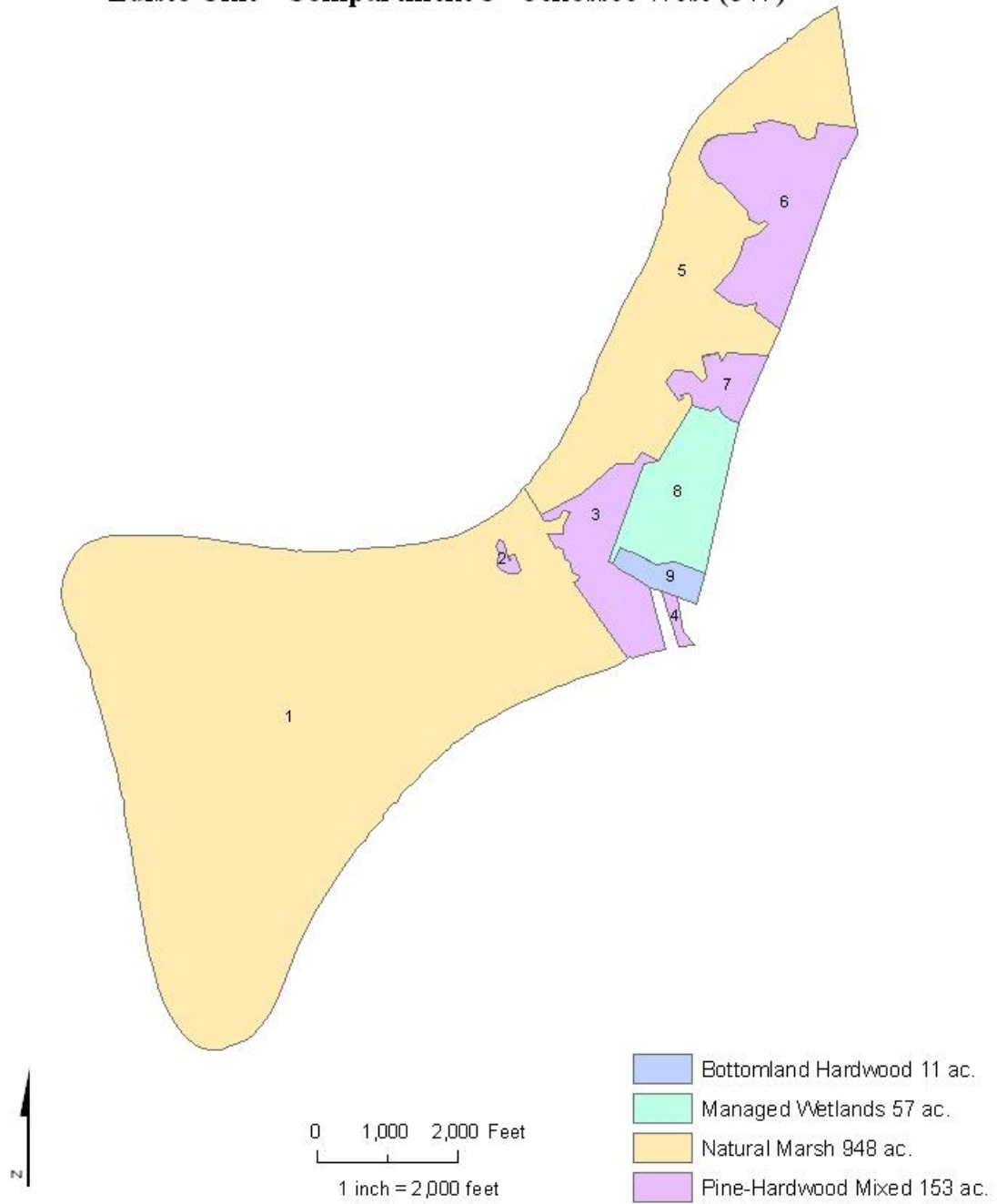
**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Edisto Unit - Compartment 3 - Grove South (GS)**



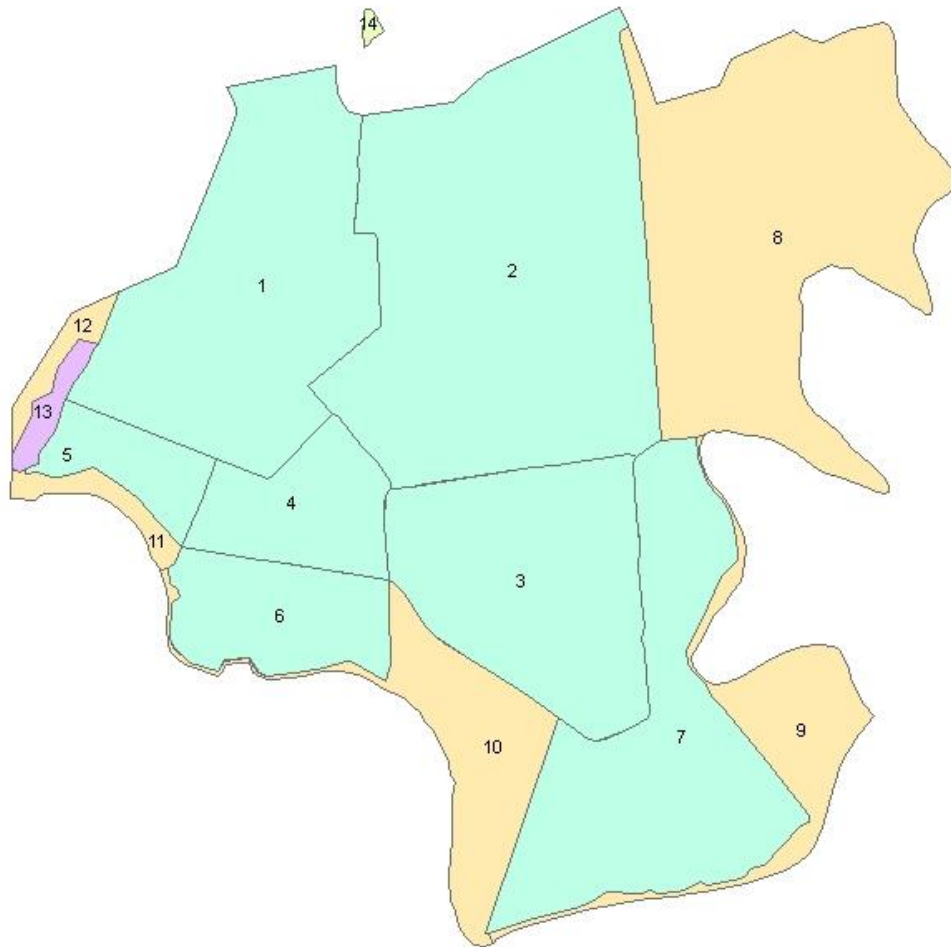
**E.F.H ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Edisto Unit - Compartment 4 - Jehossee East (JE)**



**E.F.H ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Edisto Unit - Compartment 5 - Jehossee West (JW)**



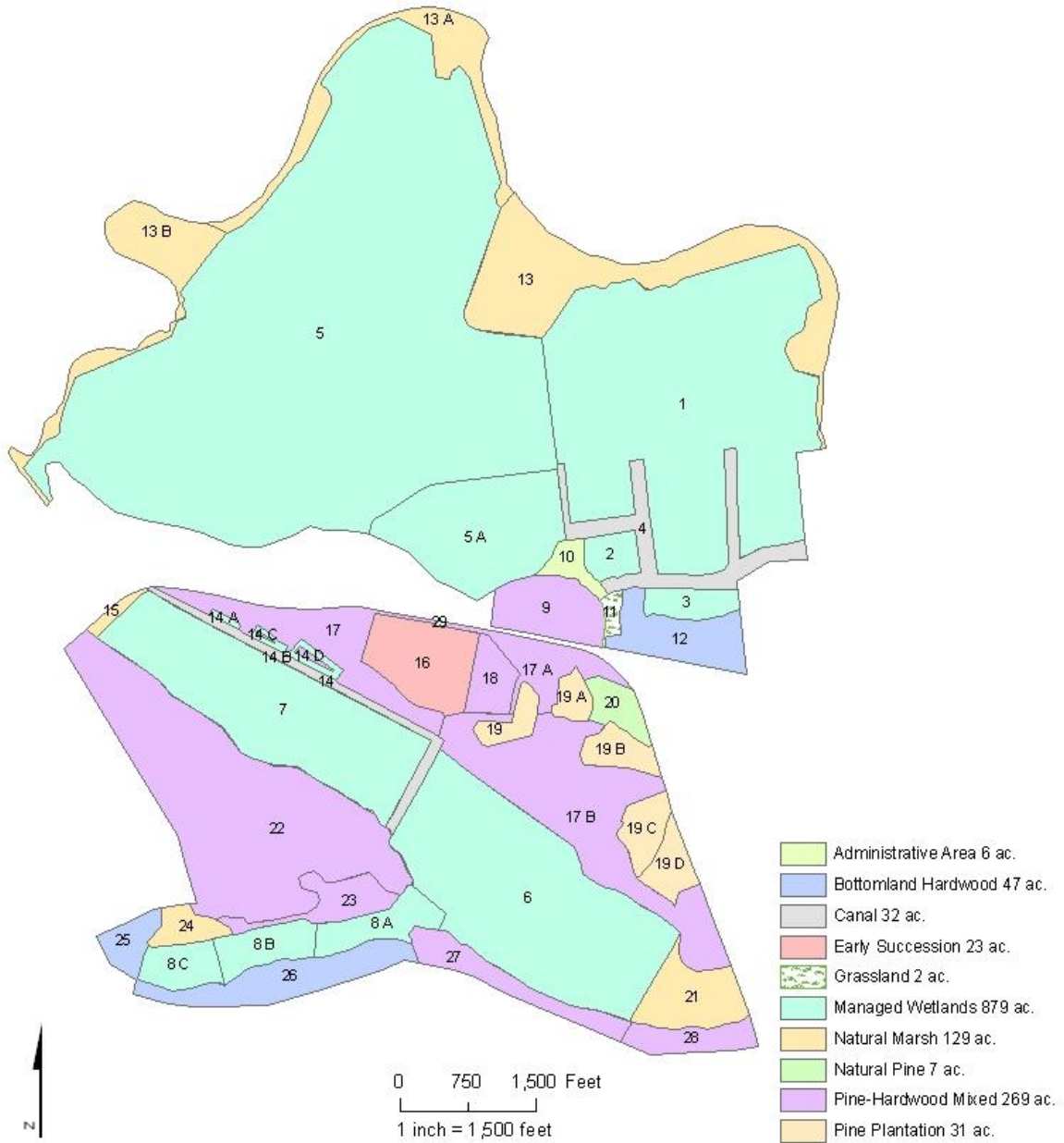
**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Combahee Unit - Compartment 6 - Combahee Fields (CF)**



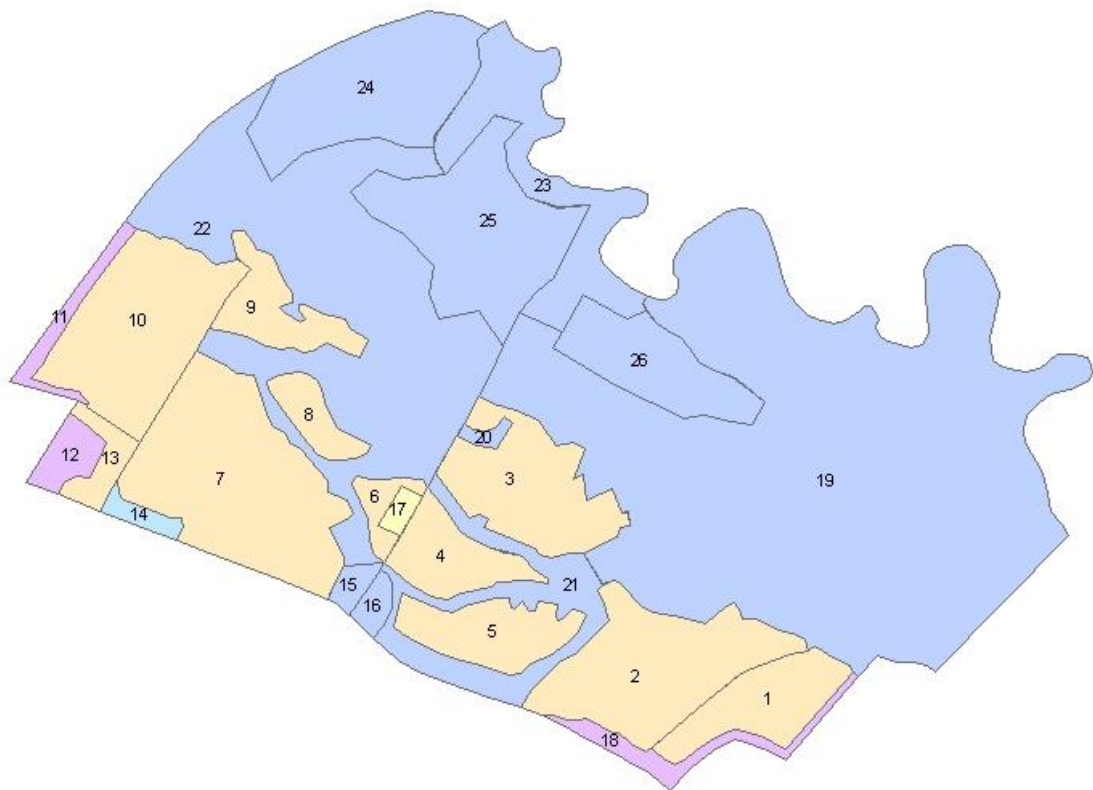
0 1,000 2,000 Feet
1 inch = 2,000 feet

- Administrative Area 2 ac.
- Managed Wetlands 1298 ac.
- Natural Marsh 530 ac.
- Pine-Hardwood Mixed 12 ac.

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Combahee Unit - Compartment 7 - Bonny Hall (BH)**



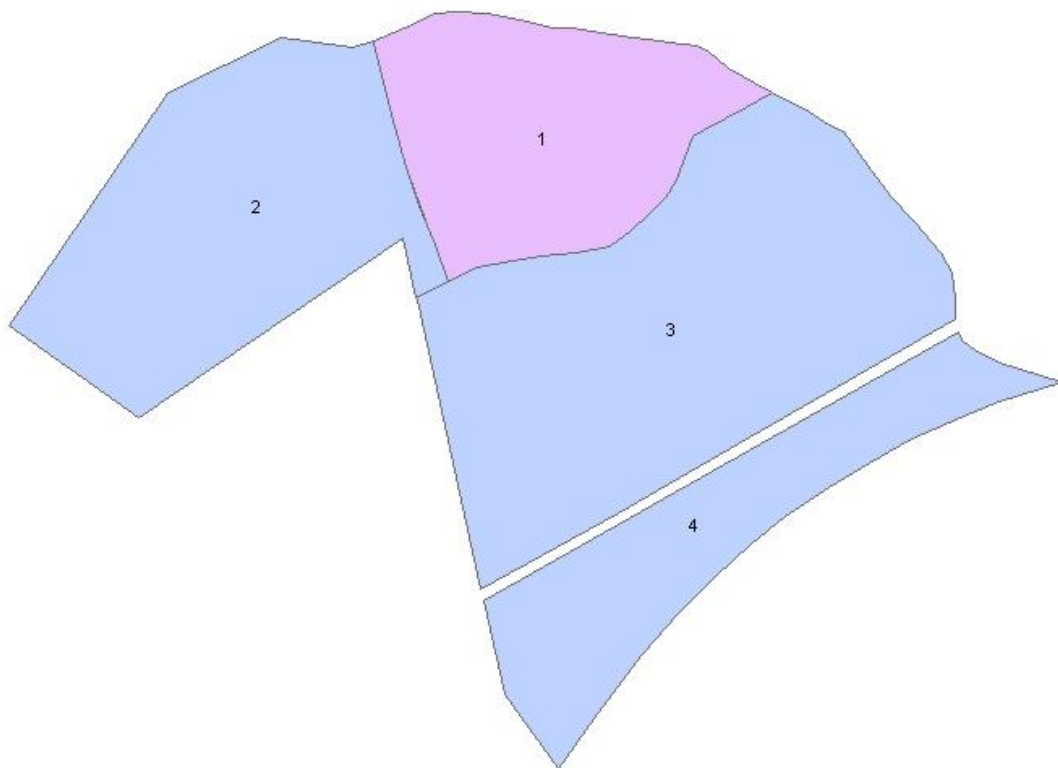
**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Combahee Unit - Compartment 8 - Yemassee South (YS)**



0 750 1,500 Feet
1 inch = 1,500 feet

- Barrow Area 2 ac.
- Bottomland Hardwood 681 ac.
- Pine-Hardwood Mixed 24 ac.
- Pine Plantation 302 ac.
- Upland Hardwood 4 ac.

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Map (2010)
Combahee Unit - Compartment 9 - Yemassee North (YN)**



0 500 1,000 Feet
1 inch = 1,000 feet

Bottomland Hardwood 271 ac.
Pine-Hardwood Mixed 64 ac.

**APPENDIX B. ACE BASIN NWR COVER TYPE INVENTORY:
COMPARTMENTS 1-9**

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Edisto Unit – Compartment 1 – Barrelville (BV)**

Compartment 1 (BV) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	PP-LB(3)	13	NP	32	
2	PP-LB(3)	45	PP-LB	349	
3	BH(2)	34	BH	282	
4	PP-LB(2)	39	PH	41	
5	NP-LB(1)	3	BA	3	
6	BH(2)	51			
7	PP-LB(3)	86	TOTAL	707	
8	BH(2)	22			
9	PP-LB(3)	23			
10	BA	3			
11	PP-LB(2)	29			
12	BH(2)	19			
13	PP-LB(2)	29			
14	NP-LB(1)	6			
15	NP-LB(1)	16			
16	PH(2)	36			
17	PP-LB(2)	18			
18	BH(2)	74			
19	BH(3)	50			
20	PP-LB(2)	22			
21	BH(3)	7			
22	PH(2)	5			
23	NP-LB(1)	7			
24	PP-LB(2)	45			
25	BH(2)	25			

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
PP – Pine Plantation
BH – Bottomland Hardwood
PH – Pine-Hardwood Mixed
BA – Borrow Area

LL – Longleaf Pine
LB – Loblolly Pine
PC – Planted Cypress
GT – Greentree Reservoir
MS – Moist Soil
FW – Fresh Water
BW – Brackish Water
(4) - Sapling
(5) - Seedling

FOREST SIZE CLASS(in '05)

DESCRIPTIONS

(1) - Sawtimber
(2) - Sawtimber & Pulpwood
(3) - Pulpwood

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Edisto Unit – Compartment 2 – Grove North (GN)**

Compartment 2 (GN) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	PH(2)	91	NP	122	
2	BH(2)	64	BH	222	
3	BH(2)GT	12	PH	237	
4	PH(2)	103	GL	5	
5	BH(2)	10	AA	3	
6	BH(2)	60	(GT)	(59)	
7	NP(2)	85			
8	NP(4)	8	TOTAL	589	
9	NP(4)	6			
10	NP(4)	10			
11	NP(4)	4			
12	NP(4)	3			
13	NP(4)	5			
14	GL	1			
15	GL	3			
16	GL	1			
17	PH(3)	3			
18	BH(2)	18			
19	BH(2)GT	47			
20	BH(2)	4			
21	BH(2)	7			
22	PH(2)	40			
23	AA	3			
24	NP(4)	1			

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
 BH – Bottomland Hardwood
 PH – Pine-Hardwood Mixed
 GL – Grassland
 AA – Administrative Area

DESCRIPTIONS

LL – Longleaf Pine
 LB – Loblolly Pine
 PC – Planted Cypress
 GT – Greentree Reservoir
 MS – Moist Soil
 FW – Fresh Water
 BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
 (2) - Sawtimber & Pulpwood
 (3) - Pulpwood
 (4) - Sapling
 (5) – Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Edisto Unit – Compartment 3 – Grove South (GS)**

Comp. 3 (GS) Site #	Type-Descript Class	Acres	Comp. 3 (GS) Site #	Type-Descript Class	Acres	Cover Type Summary	Acres Summary
1	PH(2)	33	16	NP(1)	19	NP	19
1A	PH(2)GT	1	17	ES	18	PH	511
1B	PH(2)	35	17A	ES	4	BH	10
1C	PH(2)	4	17B	ES	4	ES	151
2	ES	12	18	ES	8	MW	369
2A	ES	17	19	ES	18	NM	394
2B	ES	4	20	ES	20	GL	40
3	PH(2)	14	21	ES	10	AA	14
4	NM	67	22	PH(2)	7	(GT)	(1)
5	ES	2	22A	PH(2)	6		
5A	PH(2)	11	22B	PH(2)	5	TOTAL	1508
5B	BH(2)	6	22C	PH(2)	4		
5C	BH(2)	2	22D	PH(2)	1		
6	GL	1	23	ES	12		
6A	GL	1	23A	ES	14		
6B	GL	1	24	PH(2)	7		
6C	GL	1	24A	PH(2)	2		
6D	GL	1	25	PH(3)	9		
6E	GL	2	26	MW-FW	25		
6F	GL	1	27	AA	12		
6G	GL	1	27A	AA	2		
6H	GL	2	28	PH(2)	40		
6I	ES	1	28A	PH(2)	22		
7	MW-FW-PC	14	28B	PH(2)	7		
8	MW-FW-PC	5	28C	PH(2)	8		
9A	MW-FW-MS	189	28D	PH(2)	4		
9B	MW-FW-MS	132	28E	PH(2)	1		
10	GL	27	28F	BH(3)	2		
11	ES	7	28G	GL	2		
12	NM	246	29	PH(2)	59		
12A	MW-FW	4	29A	PH(2)	15		
13	NM	55	29B	PH(2)	41		
13A	NM	26	29C	PH(2)	21		
14	PH(2)	8	29D	PH(2)	20		
14A	PH(2)	23	29E	PH(2)	29		
14B	PH(2)	24	29F	PH(2)	28		
15	PH(2)	10	29G	PH(2)	8		
15A	PH(2)	4					

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
 BH – Bottomland Hardwood
 PH – Pine-Hardwood Mixed
 ES – Early Succession
 MW – Managed Wetland
 NM – Natural Marsh
 GL – Grassland
 AA – Administrative Area

DESCRIPTIONS

LL – Longleaf Pine
 LB – Loblolly Pine
 PC – Planted Cypress
 GT – Greentree Reservoir
 MS – Moist Soil
 FW – Fresh Water
 BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
 (2) - Sawtimber & Pulpwood
 (3) - Pulpwood
 (4) – Sapling
 (5) – Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Edisto Unit – Compartment 4 – Jehossee East (JE)**

Compartment 4 (JE) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	MW-BW	91	NP	244	
2	MW-BW	166	PH	252	
3	ES	15	MW	257	
4	PH(4)	10	ES	15	
5	PH(2)	58	NM	2329	
6	GL	4	GL	4	
7	PH(2)	18	DS	172	
8	PH(2)	87	CN	48	
9	NP(2)	82			
10	NP(2)	55	Total	3321	
11	NP(2)	6			
12	NP(2)	94			
13	PH(2)	74			
14	PH(2)	1			
15	PH(2)	4			
16	NP(2)	1			
17	NP(2)	5			
18	NP(2)	1			
19	DS	19			
20	DS	49			
21	DS	52			
22	DS	52			
23	NM	22			
24	NM	347			
25	NM	776			
26	NM	350			
27	NM	817			
28	NM	17			
29	CN	12			
30	CN	36			

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
 PH – Pine-Hardwood Mixed
 MW – Managed Wetland
 ES – Early Succession
 NM – Natural Marsh
 GL – Grassland
 DS – Dredge Spoil
 CN – Canal/Pond/Open
 Water

DESCRIPTIONS

LL – Longleaf Pine
 LB – Loblolly Pine
 PC – Planted Cypress
 GT – Greentree Reservoir
 MS – Moist Soil
 FW – Fresh Water
 BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
 (2) - Sawtimber & Pulpwood
 (3) - Pulpwood
 (4) - Sapling
 (5) - Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Edisto Unit – Compartment 5 – Jehossee West (JW)**

Compartment 5 (JW) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	NM	738	PH	153	
2	PH(2)	2	BH	11	
3	PH(2)	50	MW	57	
4	PH(4)	3	NM	948	
5	NM	210			
6	PH(1)	79	TOTAL	1169	
7	PH(4)	19			
8	MW-BW	57			
9	BH(3)	11			

LEGEND

FOREST/COVER TYPE

PH – Pine-Hardwood Mixed
BH – Bottomland Hardwood
MW – Managed Wetland
NM – Natural Marsh

DESCRIPTIONS

LL – Longleaf Pine
LB – Loblolly Pine
PC – Planted Cypress
GT – Greentree Reservoir
MS – Moist Soil
FW – Fresh Water
BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
(2) - Sawtimber & Pulpwood
(3) - Pulpwood
(4) – Sapling
(5) - Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Combahee Unit – Compartment 6 – Combahee Fields (CF)**

Compartment 6 (CF) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	MW-FW-MS	261	PH	12	
2	MW-FW-MS	417	MW	1298	
3	MW-FW-MS	193	NM	530	
4	MW-FW-MS	76	AA	2	
5	MW-FW-MS	42			
6	MW-FW-MS	82	TOTAL	1842	
7	MW-FW-MS	227			
8	NM	328			
9	NM	75			
10	NM	98			
11	NM	16			
12	NM	13			
13	PH(2)	12			
14	AA	2			

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
BH – Bottomland Hardwood
PH – Pine-Hardwood Mixed
AA –Administrative Area

DESCRIPTIONS

LL – Longleaf Pine
LB – Loblolly Pine
PC – Planted Cypress
GT – Greentree Reservoir
MS – Moist Soil
FW – Fresh Water
BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
(2) - Sawtimber & Pulpwood
(3) - Pulpwood
(4) - Sapling
(5) - Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Combahee Unit – Compartment 7 – Bonny Hall (BH)**

Comp. 7 (BH) Site #	Type-Descript Class	Acres	Comp.7 (BH) Site #	Type-Descript Class	Acres	Cover Type Summary	Acres Summary
1	MW-FW-MS	185	19B	PP-LB(2)	7	PH	269
2	MW-FW-MS	6	19C	PP-LB(2)	8	BH	47
3	MW-FW-MS	8	19D	PP-LB(2)	7	NP	7
4	CN	22	20	NP-LB(3)	721	PP	31
5	MW-FW-MS	413	21	NM	17	MW	879
5A	MW-FW-MS	46	22	PH(2)	109	ES	23
6	MW-FW-MS	106	23	PH(2)GT	11	CN	32
7	MW-FW-MS	79	24	NM	6	(GT)	(11)
8A	MW-FW-MS	12	25	BH(2)	7	NM	129
8B	MW-FW-MS	11	26	BH(2)	22	GL	2
8C	MW-FW-MS	9	27	PH(2)	14	AA	6
9	PH(2)	17	28	PH(2)	9		
10	AA	5	29	AA	0	TOTAL	1425
11	GL	2					
12	BH(2)	18					
13	NM	57					
13A	NM	23					
13B	NM	24					
14	CN	10					
14A	MW-FW	1					
14B	MW-FW	3					
14C	PH	0					
14D	PH	1					
15	NM	2					
16	ES	23					
17	PH(2)	26					
17A	PH(2)	13					
17B	PH(2)	61					
18	PH(2)	8					
19	PP-LB(2)	5					
19A	PP-LB(2)	4					

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
 BH – Bottomland Hardwood
 PH – Pine/Hardwood Mixed
 PP – Pine Plantation
 MW – Managed Wetlands
 NM – Natural Marsh
 ES – Early Succession
 GL – Grassland
 CN – Canal/Pond/Open Water
 AA – Administrative Area

DESCRIPTIONS

LL – Longleaf Pine
 LB – Loblolly Pine
 PC – Planted Cypress
 GT – Greentree Reservoir
 MS – Moist Soil
 FW – Fresh Water
 BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
 (2) - Sawtimber & Pulpwood
 (3) - Pulpwood
 (4) – Sapling
 (5) - Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Combahee Unit – Compartment 8 – Yemassee South (YS)**

Compartment 8 (YS) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	PP-LB(2)	23	BH	681	
2	PP-LB(2)	48	PH	24	
3	PP-LB(3)	36	PP	302	
4	PP-LB(3)	18	UH	4	
5	PP-LB(3)	21	BA	2	
6	PP-LB(3)	5			
7	PP-LB(2)	68	TOTAL	1013	
8	PP-LB(2)	9			
9	PP-LB(2)	17			
10	PP-LB(2)	50			
11	PH(2)	7			
12	PH(2)	7			
13	PP-LB(2)	7			
14	UH(2)	4			
15	BH(2)	3			
16	BH(2)	4			
17	BA	2			
18	PH(2)	10			
19	BH(2)	328			
20	BH(2)	2			
21	BH(2)	30			
22	BH(2)	143			
23	BH(2)	42			
24	BH(4)	50			
25	BH(4)	52			
26	BH(4)	27			

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
 BH – Bottomland Hardwood
 PH – Pine-Hardwood Mixed
 UH – Upland Hardwood
 PP – Pine Plantation
 BA – Borrow Area

DESCRIPTIONS

LL – Longleaf Pine
 LB – Loblolly Pine
 PC – Planted Cypress
 GT – Greentree Reservoir
 MS – Moist Soil
 FW – Fresh Water
 BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
 (2) - Sawtimber & Pulpwood
 (3) - Pulpwood
 (4) - Sapling
 (5) - Seedling

**E.F.H. ACE Basin National Wildlife Refuge
Cover Type Inventory 2010
Combahee Unit – Compartment 9 – Yemassee North (YN)**

Compartment 9 (YN) Site #	Type – Descript.- Class	Acres	Cover Type Summary	Acres Summary	
1	PH(2)	64	PH	64	
2	BH(2)	86	BH	271	
3	BH(2)	130			
4	BH(2)	55	TOTAL	335	

LEGEND

FOREST/COVER TYPE

BH – Bottomland Hardwood
PH – Pine-Hardwood Mixed

DESCRIPTIONS

LL – Longleaf Pine
LB – Loblolly Pine
PC – Planted Cypress
GT – Greentree Reservoir
MS – Moist Soil
FW – Fresh Water
BW – Brackish Water

FOREST SIZE CLASS(in '05)

(1) - Sawtimber
(2) - Sawtimber & Pulpwood
(3) - Pulpwood
(4) - Sapling
(5) - Seedling

APPENDIX C. ACE BASIN NWR COVER TYPE INVENTORY
COMPARTMENT SUMMARY

Compartment

COVER TYPE	1(BV)	2(GN)	3(GS)	4(JE)	5(JW)	6(CF)	7(BH)	8(YS)	9(YN)	TOTAL ACRES
PH	41	237	511	252	153	12	269	24	64	1563
BH	282	222	10	0	11	0	47	681	271	1524
PP	349	0	0	0	0	0	31	302	0	682
UH	0	0	0	0	0	0	0	4	0	4
ES	0	0	151	15	0	0	23	0	0	189
GL	0	5	40	4	0	0	2	0	0	51
MW	0	0	369	257	57	1298	879	0	0	2860
BA	3	0	0	0	0	0	0	2	0	5
CN	0	0	0	48	0	0	32	0	0	80
DS	0	0	0	172	0	0	0	0	0	172
NM	0	0	394	2329	948	530	129	0	0	4330
NP	32	122	19	244	0	0	7	0	0	424
AA	0	3	14	0	0	2	6	0	0	25
TOTAL	707	589	1508	3321	1169	1842	1425	1013	335	11909
(GT)*	-	(59)	(1)	-	-	-	(11)	-	-	(71)

*Greentree Reservoir (GT) acres above are already included within the cover type acres in the Compartment where they are located.

LEGEND

FOREST/COVER TYPE

NP – Natural Pine
 BH – Bottomland Hardwood
 PH – Pine/Hardwood Mixed
 PP – Pine Plantation
 UH – Upland Hardwood
 MW – Managed Wetlands
 NM – Natural Marsh
 ES – Early Succession
 GL – Grassland
 CN – Canal/Pond/Open Water
 BA – Borrow Area

DS – Dredge Spoil
 AA – Administrative Area

DESCRIPTIONS

LL – Longleaf Pine
 LB – Loblolly Pine
 PC – Planted Cypress
 GT – Greentree Reservoir
 MS – Moist Soil
 FW – Fresh Water
 BW – Brackish Water

APPENDIX D. REFUGE BIOTA

Wildlife species likely found on ACE Basin National Wildlife Refuge

BIRDS

Common Name	Scientific Name
-------------	-----------------

LOONS

Common Loon	<i>Gavia immer</i>
-------------	--------------------

GREBES

Pied-billed Grebe	<i>Podilymbus podiceps</i>
-------------------	----------------------------

PELICANS AND ALLIES

Double-crested Cormorant	<i>Phalacrocorax auritus</i>
Anhinga	<i>Anhinga anhinga</i>
Brown Pelican	<i>Pelecanus occidentalis</i>

HERONS, EGRETS AND ALLIES

American Bittern	<i>Botaurus lentiginosus</i>
Least Bittern	<i>Ixobrychus exilis</i>
Great Blue Heron	<i>Ardea herodias</i>
Great Egret	<i>Ardea alba</i>
Snowy Egret	<i>Egretta thula</i>
Little Blue Heron	<i>Egretta caerulea</i>
Tricolored Heron	<i>Egretta tricolor</i>
Cattle Egret	<i>Bubulcus ibis</i>
Green-backed Heron	<i>Butorides striatus</i>
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>
Yellow-crowned Night-Heron	<i>Nycticorax violaceus</i>

IBISES, SPOONBILL, STORK

Glossy Ibis	<i>Plegadis falcinellus</i>
White Ibis	<i>Eudocimus albus</i>
Wood Stork	<i>Mycteria americana</i>

WATERFOWL

Fulvous Whistling-Duck	<i>Dendrocygna bicolor</i>
Tundra Swan	<i>Cygnus columbianus</i>
Snow Goose	<i>Chen caerulescens</i>
Canada Goose	<i>Branta canadensis</i>
Wood Duck	<i>Aix sponsa</i>
Green-winged Teal	<i>Anas crecca</i>
American Black Duck	<i>Anas rubripes</i>
Mottled Duck	<i>Anas fulvigula</i>
Mallard	<i>Anas platyrhynchos</i>
Northern Pintail	<i>Anas acuta</i>
Blue-winged Teal	<i>Anas discors</i>
Northern Shoveler	<i>Anas clypeata</i>
Gadwall	<i>Anas strepera</i>
American Wigeon	<i>Anas americana</i>
Canvasback	<i>Aythya valisineria</i>
Redhead	<i>Aythya americana</i>
Ring-necked Duck	<i>Aythya collaris</i>
Greater Scaup	<i>Aythya marila</i>
Lesser Scaup	<i>Aythya affinis</i>
Common Goldeneye	<i>Bucephala clangula</i>
Bufflehead	<i>Bucephala albeola</i>
Hooded Merganser	<i>Lophodytes cucullatus</i>
Common Merganser	<i>Mergus merganser</i>
Red-breasted Merganser	<i>Mergus serrator</i>
Ruddy Duck	<i>Oxyura jamaicensis</i>

VULTURES, HAWKS AND ALLIES

Black Vulture	<i>Coragyps atratus</i>
Turkey Vulture	<i>Cathartes aura</i>
Osprey	<i>Pandion haliaetus</i>
American Swallow-tailed Kite	<i>Elanoides forficatus</i>
Mississippi Kite	<i>Ictinia mississippiensis</i>
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Northern Harrier	<i>Circus cyaneus</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
Broad-winged Hawk	<i>Buteo platypterus</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
American Kestrel	<i>Falco sparverius</i>
Merlin	<i>Falco columbarius</i>
Peregrine Falcon	<i>Falco peregrinus</i>

GALLINACEOUS BIRDS

Wild Turkey	<i>Meleagris gallopavo</i>
Northern Bobwhite	<i>Colinus virginianus</i>

RAILS, GALLINULES, COOTS AND CRANES

Clapper Rail	<i>Rallus longirostris</i>
Black Rail	<i>Laterallus jamaicensis</i>
King Rail	<i>Rallus elegans</i>
Virginia Rail	<i>Rallus limicola</i>
Sora	<i>Porzana carolina</i>
Purple Gallinule	<i>Porphyrio martinica</i>
Common Moorhen	<i>Gallinula chloropus</i>
American Coot	<i>Fulica americana</i>

SHOREBIRDS AND GULLS

Killdeer	<i>Charadrius vociferous</i>
Greater Yellowlegs	<i>Tringa melanoleuca</i>
Lesser Yellowlegs	<i>Tringa flavipes</i>
Spotted Sandpiper	<i>Actitis macularia</i>
Common Snipe	<i>Gallinago gallinago</i>
American Woodcock	<i>Scolopax minor</i>
Laughing Gull	<i>Larus atricilla</i>
Ring-billed Gull	<i>Larus delawarensis</i>
Herring Gull	<i>Larus argentatus</i>
Caspian Tern	<i>Sterna caspia</i>
Royal Tern	<i>Sterna maxima</i>
Sandwich Tern	<i>Sterna sandvicensis</i>
Forster's Tern	<i>Sterna forsteri</i>
Least Tern	<i>Sternula antillarum</i>

PIGEONS, DOVES

Rock Dove	<i>Columba livia</i>
Mourning Dove	<i>Zenaida macroura</i>
Common Ground-Dove	<i>Columbina passerina</i>

CUCKOOS

Yellow-billed Cuckoo	<i>Coccyzus americanus</i>
----------------------	----------------------------

OWLS

Barn Owl	<i>Tyto alba</i>
Eastern Screech-Owl	<i>Megascops asio</i>
Great Horned Owl	<i>Bubo virginianus</i>
Barred Owl	<i>Strix varia</i>

GOATSUCKERS

Common Nighthawk	<i>Chordeiles minor</i>
Chuck-will's-widow	<i>Caprimulgus carolinensis</i>

Whip-poor-will *Caprimulgus vociferus*

SWIFTS, HUMMINGBIRDS

Chimney Swift *Chaetura pelagica*
Ruby-throated Hummingbird *Archilochus colubris*

KINGFISHERS

Belted Kingfisher *Megaceryle alcyon*

WOODPECKERS

Red-headed Woodpecker* *Melanerpes erythrocephalus*
Red-bellied Woodpecker* *Melanerpes carolinus*
Yellow-bellied Sapsucker *Sphyrapicus varius*
Downy Woodpecker* *Picoides pubescens*
Hairy Woodpecker* *Picoides villosus*
Red-cockaded Woodpecker *Picoides borealis*
Northern Flicker* *Colaptes auratus*
Pileated Woodpecker* *Dryocopus pileatus*

FLYCATCHERS

Eastern Wood-Pewee *Contopus virens*
Acadian Flycatcher *Empidonax virescens*
Eastern Phoebe *Sayornis phoebe*
Great Crested Flycatcher *Myiarchus crinitus*
Eastern Kingbird *Tyrannus tyrannus*

MARTINS AND SWALLOWS

Purple Martin *Progne subis*
Tree Swallow *Tachycineta bicolor*
Northern Rough-winged Swallow *Stelgidopteryx serripennis*
Barn Swallow *Hirundo rustica*

JAYS AND CROWS

Blue Jay *Cyanocitta cristata*
American Crow *Corvus brachyrhynchos*
Fish Crow *Corvus ossifragus*

CHICKADEES AND TITMICE

Carolina Chickadee *Parus carolinensis*
Tufted Titmouse *Parus bicolor*

NUTHATCHES

White-breasted Nuthatch *Sitta carolinensis*

Brown-headed Nuthatch *Sitta pusilla*

WRENS

Carolina Wren *Thryothorus ludovicianus*
House Wren *Troglodytes aedon*
Sedge Wren *Cistothorus platensis*
Marsh Wren *Cistothorus palustris*

KINGLETS AND GNATCATCHERS

Golden-crowned Kinglet *Regulus satrapa*
Ruby-crowned Kinglet *Regulus calendula*
Blue-gray Gnatcatcher *Poliophtila caerulea*

BLUEBIRDS, THRUSHES AND ROBIN

Eastern Bluebird *Sialia sialis*
Veery *Catharus fuscescens*
Swainson's Thrush *Catharus ustulatus*
Hermit Thrush *Catharus guttatus*
Wood Thrush *Hylocichla mustelina*
American Robin *Turdus migratorius*

THRASHERS

Gray Catbird *Dumetella carolinensis*
Northern Mockingbird *Mimus polyglottos*
Brown Thrasher *Toxostoma rufum*

PIPITS

American Pipit *Anthus rubescens*

WAXWINGS

Cedar Waxwing *Bombycilla cedrorum*

STARLINGS

European Starling *Sturnus vulgaris*

SHRIKES

Loggerhead Shrike *Lanius ludovicianus*

VIREOS

White-eyed Vireo *Vireo griseus*
Solitary Vireo *Vireo solitarius*
Philadelphia Vireo *Vireo philadelphicus*

Red-eyed Vireo

Vireo olivaceus

WARBLERS

Northern Parula	<i>Parula americana</i>
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>
Black-throated Green Warbler	<i>Dendroica virens</i>
Yellow-rumped Warbler	<i>Dendroica coronata</i>
Black-throated Gray Warbler	<i>Dendroica nigrescens</i>
Yellow-throated Warbler	<i>Dendroica dominica</i>
Pine Warbler	<i>Dendroica pinus</i>
Prairie Warbler	<i>Dendroica discolor</i>
Palm Warbler	<i>Dendroica palmarum</i>
Black-and-white Warbler	<i>Mniotilta varia</i>
American Redstart	<i>Setophaga ruticilla</i>
Prothonotary Warbler	<i>Protonotaria citrea</i>
Swainson's Warbler	<i>Limnothlypis swainsonii</i>
Ovenbird	<i>Seiurus aurocapilla</i>
Northern Waterthrush	<i>Seiurus noveboracensis</i>
Kentucky Warbler	<i>Oporornis formosus</i>
Common Yellowthroat	<i>Geothlypos trichas</i>
Hooded Warbler	<i>Wilsonia citrine</i>
Yellow-breasted Chat	<i>Icteria virens</i>

TANAGERS

Summer Tanager	<i>Piranga rubra</i>
Scarlet Tanager	<i>Piranga olivacea</i>

NEW WORLD FINCHES

Northern Cardinal	<i>Cardinalis cardinalis</i>
Blue Grosbeak	<i>Passerina caerulea</i>
Indigo Bunting	<i>Passerina cyanea</i>

SPARROWS

Rufous-sided Towhee	<i>Pipilo erythrophthalmus</i>
Chipping Sparrow	<i>Spizella passerine</i>
Field Sparrow	<i>Spizella pusilla</i>
Henslow's Sparrow	<i>Ammodramus henslowii</i>
Vesper Sparrow	<i>Pooecetes gramineus</i>
Savannah Sparrow	<i>Passerculus sandwichensis</i>
Sharp-tailed Sparrow	<i>Ammodramus caudacutus</i>
Seaside Sparrow	<i>Ammodramus maritimus</i>
Song Sparrow	<i>Melospiza melodia</i>
Swamp Sparrow	<i>Melospiza georgiana</i>
White-throated Sparrow	<i>Zonotrichia albicollis</i>

BLACKBIRDS, GRACKLES, COWBIRDS AND ORIOLES

Bobolink	<i>Dolichonyx oryzivorus</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Eastern Meadowlark	<i>Sturnella magna</i>
Rusty Blackbird	<i>Euphagus carolinus</i>
Boat-tailed Grackle	<i>Quiscalus major</i>
Common Grackle	<i>Quiscalus quiscula</i>
Brown-headed Cowbird	<i>Molothrus ater</i>
Orchard Oriole	<i>Icterus spurius</i>

OLD WORLD FINCHES

Purple Finch	<i>Carpodacus purpureus</i>
American Goldfinch	<i>Carduelis tristis</i>

WEAVER FINCHES

House Sparrow	<i>Passer domesticus</i>
---------------	--------------------------

MAMMALS

Big Brown Bat	<i>Eptesicus fuscus</i>
Red Bat	<i>Lasiurus borealis</i>
Seminole Bat	<i>Lasiurus seminolus</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Evening Bat	<i>Nycticeius humeralis</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Eastern Pipistrel	<i>Pipistrellus subfiavus</i>
Rafinesque's Big-eared Bat	<i>Plecotus rafinesquii</i>
Southeastern Myotis	<i>Myotis austroriparius</i>
Whitetail Deer	<i>Odocoileus virginianus</i>
Bobcat	<i>Lynx rufus</i>
Raccoon	<i>Procyon lotor</i>
Opossum	<i>Didelphis marsupialis</i>
Eastern Cottontail	<i>Sylvilagus floridanus</i>
Marsh Rabbit	<i>Sylvilagus palustris</i>
River Otter	<i>Lutra canadensis</i>
Mink	<i>Mustela vison</i>
Longtail Weasel	<i>Mustela frenata</i>
Beaver	<i>Castor canadensis</i>
Gray Fox	<i>Urocyon cinereoargenteus</i>
Southern Flying Squirrel	<i>Glaucomys volans</i>
Eastern Gray Squirrel	<i>Sciurus carolinensis</i>
Eastern Fox Squirrel	<i>Sciurus niger</i>
Golden Mouse	<i>Peromyscus nuttalli</i>
Eastern Woodrat	<i>Neotoma floridana</i>
Rice Rat	<i>Oryzomys palustris</i>
Hispid Cotton Rat	<i>Sigmodon hispidus</i>

Meadow Vole
Pine Vole
Norway Rat
Black Rat
Shorttail Shrew
Eastern Mole
Black Bear

Microtus pennsylvanicus
Pitymys pinetorum
Rattus norvegicus
Rattus rattus
Blarina brevicauda
Scalopus aquaticus
Ursus americanus

AMPHIBIANS AND REPTILES

American Alligator
Common Snapping Turtle
Common Musk Turtle (Stinkpot)
Striped Mud Turtle
Eastern Mud Turtle
Carolina Diamondback Terrapin
Spotted Turtle
Eastern Chicken Turtle
Florida Cooter
Yellowbelly Slider
Eastern Box Turtle
Gulf Coast Spiny Softshell
Green Anole
Southern Fence Lizard
Ground Skink
Five-lined Skink
Broadhead Skink
Southeastern Five-lined Skink
Six-lined Racerunner
Eastern Glass Lizard
Eastern Slender Glass Lizard
Banded Water Snake
Redbelly Water Snake
Brown Water Snake
Glossy Crayfish Snake
Carolina Black Swamp Snake
Eastern Garter Snake
Eastern Ribbon Snake
Pine Wood Snake
Midland Brown Snake
Florida Redbelly Snake
Rough Earth Snake
Eastern Earth Snake
Southern Ringneck Snake
Southern Hognose Snake
Eastern Hognose Snake
Eastern Worm Snake
Northern Scarlett Snake
Rough Green Snake
Rainbow Snake

Alligator mississippiensis
Chelydra serpentina serpentina
Sternotherus odoratus
Kinosternon bauri
Kinosternon subrubrum
Malaclemys terrapin centrata
Clemmys guttata
Deirochelys reticularia reticularia
Chrysemys floridana
Trachemys scripta scripta
Terrapene carolina carolina
Trionyx spiniferus asperus
Anolis carolinensis
Sceloporus undulates undulatus
Scincella lateralis
Eumeces fasciatus
Eumeces laticeps
Eumeces inexpectatus
Cnemidophorus sexlineatus sexlineatus
Ophisaurus ventralis
Ophisaurus attenuatus longicaudus
Natrix fasciata fasciata
Natrix erythrogaster erythrogaster
Natrix taxispilota
Regina rigida
Seminatrix pygaea paludis
Thamnophis sirtalis sirtalis
Thamnophis sauritus sauritus
Rhadinaea flavilata
Storeria dekayi
Storeria occipitomaculata
Virginia striatula
Virginia valeriae valeriae
Diadophis punctatus punctatus
Heterodon simus
Heterodon platyrhinus
Carphophis amoenus amoenus
Cemophora copei copei
Opheodrys aestivus
Farancia erytrogramma erytrogramma

Eastern Mud Snake	<i>Farancia abacura abacura</i>
Southern Black Racer	<i>Coluber priapus priapus</i>
Eastern Coachwhip	<i>Masticophis flagellum flagellum</i>
Northern Pine Snake	<i>Pituophis melanoleucus</i>
Yellow Rat Snake	<i>Elaphe obsoleta quadrivittata</i>
Corn Snake	<i>Elaphe guttata guttata</i>
Eastern Kingsnake	<i>Lampropeltis getulus getulus</i>
Mole Kingsnake	<i>Lampropeltis calligaster rhombomaculata</i>
Scarlet Kingsnake	<i>Lampropeltis traingulum elapsoides</i>
Southeastern Crowned Snake	<i>Tantilla coronata</i>
Eastern Cottonmouth	<i>Agkistrodon piscivorus piscivorus</i>
Southern Copperhead	<i>Agkistrodon contortrix</i>
Eastern Coral Snake	<i>Micrurus fulvius fulvius</i>
Carolina Pygmy Rattlesnake	<i>Sistrurus miliarius miliarius</i>
Timber Rattlesnake	<i>Crotalus horridus</i>
Eastern Diamondback Rattlesnake	<i>Crotalus adamanteus</i>
Greater Siren	<i>Siren lacertina</i>
Eastern Lesser Siren	<i>Siren intermedia intermedia</i>
Broad-striped Dwarf Siren	<i>Pseudobranchius striatus striatus</i>
Two-toed Amphiuma	<i>Amphiuma means</i>
Dwarf Waterdog	<i>Necturus punctatus</i>
Broken-striped Newt	<i>Notophthalmus viridescens dorsalis</i>
Mole Salamander	<i>Ambystoma talpoideum</i>
Mabees Salamander	<i>Ambystoma mabeei</i>
Flatwoods Salamander	<i>Ambystoma cingulatum</i>
Eastern Tiger Salamander	<i>Ambystoma tigrinum</i>
Spotted Salamander	<i>Ambystoma maculatum</i>
Marbled Salamander	<i>Ambystoma opacum</i>
Southern Dusky Salamander	<i>Desmognathus auriculatus</i>
Eastern Mud Salamander	<i>Pseudotriton montanus montanus</i>
Many-lined Salamander	<i>Stereocheilus marginatus</i>
South Carolina slimy Salamander	<i>Plethodon variolatus</i>
Southern Two-lined Salamander	<i>Eurycea cirrigera</i>
Three-lined Salamander	<i>Eurycea longicauda guttolineata</i>
Dwarf Salamander	<i>Eurycea quadridigitata</i>
Eastern Spadefoot	<i>Scaphiopus holbrookii holbrookii</i>
Eastern Narrowmouth Toad	<i>Gastrophryne carolinensis</i>
Southern Toad	<i>Bufo terrestris</i>
Oak Toad	<i>Bufo quercicus</i>
Green Treefrog	<i>Hyla cinerea</i>
Pine Woods Treefrog	<i>Hyla femoralis</i>
Barking Treefrog	<i>Hyla gratiosa</i>
Squirrel Treefrog	<i>Hyla squirella</i>
Gray Treefrog	<i>Hyla chrysoscelis</i>
Northern Spring Peeper	<i>Pseudacris crucifer crucifer</i>
Brimleys Chorus Frog	<i>Pseudacris brimleyi</i>
Southern Chorus Frog	<i>Pseudacris nigrita nigrita</i>
Little Grass Frog	<i>Pseudacris ocularis</i>
Ornate Chorus Frog	<i>Pseudacris ornata</i>
Southern Cricket Frog	<i>Acris gryllus gryllus</i>
Pig Frog	<i>Rana grylio</i>

River Frog
Carpenter Frog
Bronze Frog
Bull Frog
Southern Leopard Frog
Carolina Gopher Frog
Pickerel Frog

Rana heckscheri
Rana virgatipes
Rana clamitans clamitans
Rana catesbeiana
Rana utricularia
Rana capito capito
Rana palustris

FISHES

Alewife
American Eel
American Shad
Atlantic Sturgeon
Banded Killfish
Banded Pygmy Sunfish
Banded Sunfish
Black Crappie
Blackbanded Sunfish
Blueback Herring
Bluegill
Bluespotted Sunfish
Bowfin
Broadtail Madtom
Brook Silverside
Brown Bullhead
Carp
Carolina Pygmy Sunfish
Chain Pickerel
Channel Catfish
Coastal Shiner
Creek Chubsucker
Dollar Sunfish
Dusky Shiner
Eastern Mosquitofish
Eastern Mudminnow
Everglades Pygmy Sunfish
Flat Bullhead
Flathead Catfish
Flier
Freshwater Goby
Gizzard Shad
Golden Shiner
Golden Topminnow
Goldfish
Hickory Shad
Hogchoker
Ironcolor Shiner
Lake Chubsucker
Largemouth Bass

Alosa pseudoharengus
Anguilla rostrata
Alosa sapidissima
Acipenser oxyrinchus
Fundulus diaphanous
Elassoma zonatum
Enneacanthus obesus
Pomoxis nigromaculatus
Enneacanthus chaetodon
Alosa aestivalis
Lepomis macrochirus
Enneacanthus gloriosus
Amia calva
Noturus sp.
Labidesthes sicculus
Ameiurus nebulosus
Cyprinus carpio
Elassoma boehlkei
Esox niger
Ictalurus punctatus
Notropis petersoni
Erimyzon oblongus
Lepomis marginatus
Notropis cummingsae
Gambusia holbrooki
Umbra pygmaea
Elassoma evergladei
Ameiurus platycephalus
Pylodictis olivaris
Centrarchus macropterus
Gobionedillus schufeldti
Dorosoma cepedianum
Notemigonus crysoleucas
Fundulus chrysotus
Carassius auratus
Alosa mediocris
Trinectes maculatus
Notropis chalybaeus
Erimyzon sucetta
Micropterus salmoides

Least Killifish	<i>Heterandria formosa</i>
Lined Topminnow	<i>Fundulus lineolatus</i>
Longnose Gar	<i>Lepisosteus osseus</i>
Margined Madtom	<i>Noturus insignis</i>
Mud Sunfish	<i>Acantharchus pomotis</i>
Pirate Perch	<i>Aphredoderus sayanus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Rainwater Killifish	<i>Lucania parva</i>
Red Drum	<i>Sciaenops ocellatus</i>
Redbreast Sunfish	<i>Lepomis auritus</i>
Redear Sunfish	<i>Lepomis microlophus</i>
Redfin Pickerel	<i>Esox americanus americanus</i>
Sawcheek Darter	<i>Etheostoma serriferum</i>
Shortnose Sturgeon	<i>Acipenser brevirostrum</i>
Silvery Minnow	<i>Hybognathus nuchalis</i>
Snail Bullhead	<i>Ameiurus brunneus</i>
Southern Flounder	<i>Paralichthys lethostigma</i>
Spottail Shiner	<i>Notropis hudsonius</i>
Spotted Sucker	<i>Minytrema melanops</i>
Spotted Sunfish	<i>Lepomis punctatus</i>
Striped Bass	<i>Morone saxatilis</i>
Striped Mullet	<i>Mugil cephalus</i>
Summer Flounder	<i>Paralichthys dentatus</i>
Swamp Darter	<i>Etheostoma fusiforme fusiforme</i>
Swamp Darter	<i>Etheostoma fusiforme barratti</i>
Swampfish	<i>Chologaster cornuta</i>
Tadpole Madtom	<i>Noturus gyrinus</i>
Taillight Shiner	<i>Notropis maculatus</i>
Tarpon	<i>Megalops atlanticus</i>
Tessellated Darter	<i>Etheostoma olmstedii</i>
Threadfin Shad	<i>Dorosoma petenense</i>
V-lip Redhorse	<i>Moxostoma papillosum</i>
Warmouth	<i>Lepomis gulosus</i>
White Catfish	<i>Ameiurus catus</i>
White Perch	<i>Morone americana</i>
Yellow Bullhead	<i>Ameiurus natalis</i>
Yellow Perch	<i>Perca flavescens</i>

**APPENDIX E. LOWER MISSISSIPPI VALLEY JOINT VENTURE
GUIDELINES FOR DESIRED STAND CONDITIONS FOR BOTTOMLAND
HARDWOOD FORESTS WITHIN THE MISSISSIPPI ALLUVIAL VALLEY**

Desired stand conditions for bottomland hardwood forests within the Mississippi Alluvial Valley		
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	>90ft ² / 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 / acres	<100ft 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
Den trees/large cavities ⁵ (>10 inch diameter)	1 visible hole / 10 acres or ≥2 stems ≥26 inch dbh (≥8 ft ² BA ≥26 inch dbh)	0 visible holes / 10 acres or <1 stem ≥26 inch dbh (<4 ft ² BA ≥ 26 inch dbh)
Standing dead and/or stressed trees ⁵	>6 stems / acre ≥10 inch dbh or ≥2 stems ≥20 inch dbh (>4 ft ² BA ≥ 10 inch dbh)	<4 stems ≥10 inch dbh / acre or <1 stem ≥20 inch dbh (<2 ft ² BA ≥ 10 inch dbh)

APPENDIX F. TIMBER SALES EXHIBITS

Exhibit 1: ACE Basin NWR Timber Sale 20xx-xx

SPECIAL CONDITIONS APPLICABLE TO TIMBER HARVESTING

Before commencing 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. Additionally, careful forest logging will lessen the chance of public disagreement with refuge forest management philosophy.

1. Except where specifically authorized by a special use permit, all regulations governing activities on national wildlife refuges in general and specific public use regulations for ACE Basin NWR (including littering, possession and use of firearms, and protection of wildlife) apply.
2. All logging will be within the boundaries specified (see attached map) and coordinated with the refuge forester or his designee.
3. Trees larger than or equal to 16 inches in diameter at breast height (dbh) shall be cut so as to leave a stump not more than 6 inches above the root collar. Trees less than 16 inches in dbh shall be cut so as to leave a stump not more than 6 inches in height on the side adjacent to the highest ground. Stump heights will be measured on the side adjacent to the highest ground. Trees are painted at eye level and at stump; ground level paint spot must be visible after tree has been cut. All marked trees must be cut. In the event any marked trees are not cut by permittee, refuge personnel will have the trees cut and will withhold from the permittee's performance guarantee a sufficient amount to cover the cost incurred.
4. Logging will not be permitted when the ground is wet and subject to rutting or severe soil compaction. The permittee and his employees will do all in their power to prevent rutting and erosion. Permittee will be required to fill any ruts made as a result of his operation.
5. Only marked or designated trees shall be cut, unless otherwise agreed on by both parties. Utmost care shall be exercised to protect all other trees and vegetation from damage. Additional trees marked by refuge personnel for roads or loading sites will be paid for at bid price. Unmarked trees which are cut or injured through carelessness shall be paid for at double the market value stumpage price. Additional damages may be assessed or merchandising methods adjusted based on the severity of the damage.
6. Trees will be delimbed and topped at the point of felling, unless special conditions are permitted.
7. If excessive skidding damage occurs, skidding lengths can be shortened by refuge forester.
8. A refuge forester must approve the location of all loading sites and temporary roads.
9. Trees and tops cut shall not be left hanging or supported by any other living or dead tree or brush. Any tree that becomes lodged when cut shall be immediately rendered unlodged and felled flush to the ground. All tree tops and other logging debris will be removed from roads, roadside ditches, trails, firebreaks, fields, streams, and drainages immediately after felling.

10. When timber sale is adjacent to private land, all logging debris will be pulled back onto the refuge to avoid damage to private property.
11. Vehicles and other equipment will be operated in a safe manner at all times. Both refuge personnel and the visiting public use the refuge roads. The speed limit on refuge roads is 25 miles per hour unless posted otherwise.
12. Each bidder will submit with his bid, or have on file in the refuge office, a current statement demonstrating his financial ability and the ownership or control of necessary equipment to carry out the operation on the basis herein specified. To properly construct and/or maintain, roads will require the use of a crawler tractor and road grader.
13. The permittee and his/her employees will be reasonably prudent in preventing and suppressing forest fires. Permittee shall be liable for all fire suppression cost resulting from his operations.
14. The permittee shall protect all known (identified on the ground) archaeological sites against disturbance, destruction, or damage during harvesting operations. If, during the course of the harvest activity, the permittee notices illegal excavation or archaeological resources removal activities, this information shall be immediately provided to the refuge manager.
15. All known archaeological sites will be identified on the ground by refuge personnel placing a wooden stake at the center and flagging the perimeter with pink or pink/black ribbon. If unrecorded cultural resources or human remains are discovered on Service land, thinning activities will be immediately halted. There can only be minimal soil disturbance within these areas.
16. If, during the course of the harvest activity, the permittee deliberately damages a recorded site, the permittee will be responsible for the resultant site damage assessment and mitigation.
17. The normal operating season on this sale will be _____ through _____.
18. Any operations outside the normal season must be approved in advance by the refuge forester. For safety reasons and to minimize conflict, the permittee will cease logging operations during the refuge's deer hunts.
19. A pre-entry conference between the refuge forester (or designee) and the successful bidder representative will be required before beginning logging operations to ensure understanding of the permit conditions and thus avoid serious conflicts.
20. The refuge manager or his/her designee (i.e., administrative forester) shall have the authority to stop timber harvesting operations at any time justifiable reasons develop.
21. Loggers are required to implement South Carolina Best Management Practices (BMPs) guidelines.
22. Clean up of oil, hydraulic fluid, and other contaminants as a result of the logging operation is the responsibility of the permittee.

23. The permittee will remove plugs, dams, and bridges constructed by the permittee upon completion of the contract.
24. The Federal Government accepts no responsibility to provide right-of-way over private lands for transfer of harvested materials. .
25. Maintenance of all roads on ACE Basin NWR used in the logging operation will be the responsibility of the permittee. These roads must be maintained to pre-harvest condition or to the standards described under these permit conditions.

Exhibit 2: Bid Form

BID FORM

ACE Basin NWR Timber Sale 20xx-xx

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

Lump sum bid for compartment/stand 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 or official.

Name of Firm: _____

Address: _____

_____ Zip Code: _____

Signature of Bidder: _____ Date: _____

Telephone: _____

Comments: _____

Exhibit 3: Bid Invitation

ACE Basin National Wildlife Refuge
P.O. Box 848
Hollywood, SC 29449

Phone: 843-889-3084
FAX: 843-889-3282
[Date]

**ACE Basin National Wildlife Refuge
Compartment/Stand x
Timber Sale 20x-xx**

BID INVITATION

The purpose of this sale is to harvest the forested area in a portion of compartment/stand 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 or stand boundary will be marked with 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/or refuge forester.

Prospective buyers can contact [insert refuge forester's name] at the above phone number if they want to arrange a visit to the sale area. **All-terrain vehicle access may be allowed with permission in the sale area for timber inspection purposes only.** 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 2 miles south on Jehossee Island Rd. off Willtown Rd. near Hollywood, SC. 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 Federal 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 forester 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 forester. 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: ACE Basin NWR Timber Sale 20xx-xx"

If you have any questions about this packet, feel free to call [forester's name] at (843-889-3084) for additional information. If you are not planning on submitting a bid, a negative reply would be greatly appreciated.

Exhibit 4: 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.)

- (a) 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:
- (1) 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;
 - (2) 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
 - (3) 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.
- (b) Each person signing this bid or proposal certifies that:
- (1) 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 (a) (1) through (a) (3), above; or
 - (2) (i) 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 (a) (1) through (a) (3), above, and as their agent does hereby so certify; and

(ii) He has not participated, and will not participate, in any action contrary to (a) (1) through (a) (3), above.
- (c) This certification is not applicable to a foreign bidder or offeror submitting a bid or proposal for a contract, which requires performance or delivery outside the United States, its possessions, and Puerto Rico.
- (d) A bid or proposal will not be considered for award where (a) (1), (a) (3), or (b), above, has been deleted or modified. Where (a) (2), above, has been deleted or modified, the bid or proposal will not be considered for award unless the bidder or offeror furnished with the bid or proposal includes 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 5: 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 G. ENVIRONMENTAL ASSESSMENT

ENVIRONMENTAL ASSESSMENT FOR
**ERNEST F. HOLLINGS ACE BASIN
NATIONAL WILDLIFE REFUGE
HABITAT MANAGEMENT PLAN**

Beaufort, Charleston, Colleton, and Hampton Counties, South Carolina

Southeast Region



Table of Contents

1.0	INTRODUCTION	156
1.1	Ernest F. Hollings ACE Basin National Wildlife Refuge.....	156
1.2	Background.....	157
1.3	Proposed Action	157
1.4	Decisions to Be Made	158
1.5	Relation to Statutes, Regulations, and Other Plans.....	158
2.0	DESCRIPTION OF ALTERNATIVES	159
2.1	Alternative A – No Action	159
2.3	Alternative B – Proposed Action.....	159
2.4	Alternatives Considered but Eliminated from Further Analysis	160
3.0	AFFECTED ENVIRONMENT	160
4.0	ENVIRONMENTAL CONSEQUENCES	160
4.1	Effects on the Physical Environment.....	160
4.2	Effects on the Biological Environment.....	161
4.3	Effects on Cultural Resources.....	164
4.4	Irreversible and Irrecoverable Commitment of Resources.....	165
4.5	Unavoidable Adverse Effects	165
4.6	Relationship between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity	165
4.7	Cumulative Impacts	165
5.0	COORDINATION AND ENVIRONMENTAL REVIEW	166
5.1	Agency Coordination.....	166
5.2	National Environmental Policy Act	166
5.3	Environmental Assessment.....	167
5.4	Distribution and Availability	167
6.0	PUBLIC INVOLVEMENT	167
7.0	REFERENCES	167

List of Tables

Table 1. Habitat acreages and management activities by alternative **Error! Bookmark not defined.**



1.0 INTRODUCTION

This environmental assessment (EA) documents the purpose of and the issues, alternatives, and analysis associated with implementation of a habitat management plan (HMP) for Ernest F. Hollings ACE Basin National Wildlife Refuge (ABNWR).

The EA provides a comparison of two alternatives: (1) not implementing a habitat management plan for the refuge (no action) and (2) implementation of the habitat management plan for the Refuge (proposed action). This represents the full range of alternatives and evaluates potential effects on resources protected by the refuge and associated cultural, socioeconomic, and aesthetic resources that may be affected during implementation of the habitat management plan.

1.1 Ernest F. Hollings ACE Basin National Wildlife Refuge

The Ernest F. Hollings ACE Basin National Wildlife Refuge helps protect the largest undeveloped estuary along the Atlantic Coast, with rich bottomland hardwoods and fresh and salt water marsh offering food and cover to a variety of wildlife. ACE Basin stands for the Ashepoo, Combahee, and Edisto Rivers, which form the estuary and parts of the Refuge boundary. The entire basin encompasses more than 350,000 acres, of which the Refuge comprises just less than 12,000 acres.

From the early 1700's to mid-1800s, much of the ACE Basin was home to large plantations owned by a small number of individuals who managed their wetlands primarily to grow rice. The ABNWR is managed to provide a complex of habitats for a diversity of wildlife. Habitats are maintained and managed for endangered species, wintering waterfowl, other migratory and resident birds, mammals, reptiles, amphibians, and plants.

The natural marsh is protected under both federal and South Carolina law. Impoundments (formerly rice fields) are managed for specific foods favored by various wildlife species. Forest management includes selective thinning of trees, clearing to create edge zones, hardwood and shrub planting, and burning of some forest under stories. Certain abandoned fields will undergo disking and burning to control overgrowth and enhance habitat variety. Water levels in refuge impoundments (managed wetland units) are controlled to stimulate growth of natural plant species and an abundance of insects, crustaceans, and small fish.

"Moist soil management," as this technique is called, has proven to be a highly successful method of producing nutritious food that is beneficial to waterfowl and other wildlife. No other tool is more important in this type management than the rice field trunks which control water flow between the tidal creeks or rivers and the impoundments.

First used in the 1700's on rice plantations, trunks remain the most efficient, economical water control structure in tidal situations. Trunks operate on tidal surge and consist of wooden culverts with flap gates. At least 17 species of waterfowl, such as pintail, mallard, and wood

duck, as well as bald eagles, wood storks, alligator, herons, egrets, ibis, and numerous other wildlife species utilize the refuge impoundments.

1.2 Background

The HMP is a step-down management plan of the Comprehensive Conservation Plan (CCP) that was approved in 2009 (USFWS 2009). The intent of the HMP is to provide additional details regarding specific strategies and implementation schedules for meeting goals and objectives set forth in the CCP during a 15-year period. In addition, an HMP provides an opportunity to evaluate the applicability of goals and objectives previously established in the CCP and determine if changes are required based on available data and other information. HMPs are dynamic documents that are modified using an adaptive management process that is based on monitoring progress toward achieving goals and objectives. In addition, the HMP is evaluated when a refuge considers revisions to the CCP (at least every 15 years) or at 5-year intervals using a peer review process.

Section 4(a) and 4(b) of the National Wildlife Refuge System Improvement Act (Improvement Act) directs the Secretary, when administering the National Wildlife Refuge System, to “ensure that the biological integrity, diversity, and health of the System are maintained for the benefit of present and future generations of Americans...” The Improvement Act clearly mandates the use of sound professional judgment when determining the relationships between refuge purposes and biological integrity, diversity, and environmental health (BIDEH). Further, the BIDEH policy (U.S. Fish and Wildlife Service 2001) clearly emphasizes management that restores historical ecosystem processes and functions as they are directly related to biological integrity and health. Collectively, these mandates instruct refuge managers to evaluate the potential to restore BIDEH when critical elements have been lost or severely degraded. The ABNWR HMP plays a key role in this process by defining historical ecosystem functions and to what degree they can be restored and maintained.

1.3 Proposed Action

The Service began development of this HMP in 2011. The proposed action is to implement the HMP for the ABNWR using the principles of adaptive management. The scope of this HMP is to:

1. Identify important resources of management concern on ABNWR.
2. Develop goals and objectives that, once achieved, will ensure perpetuation of those resources.
3. Identify management strategies necessary to attain stated goals and objectives.
4. Identify appropriate monitoring strategies to measure progress toward achieving goals and objectives.

Using adaptive management techniques, the Service would implement the goals, objectives, and strategies included in the HMP over the next 15 years. Impounded wetlands, such as freshwater moist-soil units and brackish water units, and greentree reservoirs, would be

managed for a diversity of birds. Natural marsh would be maintained. Forested areas would be managed for a range of bird species. Early successional and grassland areas would continue to be provided to benefit breeding and wintering landbirds.

1.4 Decisions to Be Made

Based on the analysis provided in this final EA, the Service will make two decisions:

1. Determine whether the Service should implement a habitat management plan for Ernest F. Hollings ACE Basin National Wildlife Refuge, in accordance with its planning policy.
2. If yes, determine whether the selected alternative will have a significant impact on the quality of the human environment. This decision is required by the National Environmental Policy Act (NEPA). If the quality of the human environment would not be affected, a “finding of no significant impact” will be signed and will be made available to the public. If the preferred alternative would have a significant impact, an environmental impact statement will be prepared to further address those impacts.

1.5 Relation to Statutes, Regulations, and Other Plans

The primary statutory authorities for management of ABNWR are the Emergency Wetlands Resources Act of 1986, the Fish and Wildlife Act of 1956, and the Migratory Bird Act, thus outlining the primary purposes of these lands and waters. Additional relevant statutes, regulations, and/or plans follow:

National Environmental Policy Act

NEPA (42 USC 4321-4370f) requires federal agencies to examine the environmental impact of their actions, incorporate environmental information, and utilize public participation, as appropriate, in the planning and implementation of their actions. NEPA compliance is required only when a federal agency takes an action.

National Historic Preservation Act of 1966, as Amended

Section 106 of the National Historic Preservation Act requires federal agencies to assess the effects of an undertaking on historical and cultural resource sites. This is accomplished by inventorying proposed disturbance areas or the area of potential effect (APE), evaluating site importance and eligibility to the NRHP, assessing the effect of the undertaking on National Historic Preservation Act eligible sites, and consulting with appropriate historic preservation agencies. Compliance with Section 106 of National Historic Preservation Act of 1966 was followed for the disturbance activities described in this EA.

Archaeological Resources Protection Act of 1979

The Archaeological Resources Protection Act of 1979 (16 USC 470aa-470mm) and amendments provide for the protection of archaeological resources on public and Native American lands and provide for exchange of information between governmental entities and academic or private archaeological researchers. An archaeological resource under this act is

defined as material remains of past human life or activities that are of archaeological interest and includes but is not limited to pottery, basketry, bottles, weapons, tools, structures, rock paintings or carvings, intaglios, graves, and human skeletal materials.

Migratory Bird Treaty Act and Migratory Bird Conservation Act

The Migratory Bird Treaty Act (MBTA) (16 USC 703-712) implements various treaties between the United States and other nations of the MBTA, and provides for the protection of migratory birds and specifies penalties for harming or unlawfully killing migratory birds.

Endangered Species Act

The Endangered Species Act (16 USC 1531-1544) provides for the protection of endangered and threatened species and the habitats upon which they depend. Section 7 of the act requires federal agencies to consult with the Secretary of the Interior or the Secretary of Commerce in cases where the agencies' action may affect a listed species, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat for these species.

2.0 DESCRIPTION OF ALTERNATIVES

This section describes the two alternatives identified for this project:

- no-action alternative
- proposed action, giving the Service the authority to implement a habitat management plan for Ernest F. Hollings ACE Basin National Wildlife Refuge

These alternatives were developed according to NEPA §102(2)(E) requirements to “study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternatives uses of available resources.” The alternatives consider the effects of planned habitat management activities within the ABNWR boundary.

2.1 Alternative A – No Action

The Service would continue with its management of ABNWR in accordance with the goals and objectives outlined in the CCP (USFWS 2009).

2.3 Alternative B – Proposed Action

Using adaptive management techniques, the Service would implement the goals, objectives, and strategies included in the HMP over the next 15 years. The refuge would continue to manage freshwater moist-soil and brackish water wetlands for a diversity of birds. It would provide green tree reservoir (GTR) habitat for waterfowl, and maintain natural marsh in the present successional stage. The refuge would provide upland and wetland forest habitat

conditions conducive to supporting refuge resources of concern. Early successional and grassland areas would be provided to benefit breeding and wintering land birds.

2.4 Alternatives Considered but Eliminated from Further Analysis

The HMP is a step-down management plan. There was little controversy associated with the direction outlined in the CCP, and there were no additional alternatives considered in this analysis.

3.0 AFFECTED ENVIRONMENT

For a discussion of the resources and affected environment, refer to the HMP and CCP (USFWS 2009, USFWS 2013 draft).

4.0 ENVIRONMENTAL CONSEQUENCES

For alternatives A and B described in section 2, the following narrative documents the analysis of any significant environmental effects expected to occur from implementing each of the alternatives. No impacts to geology, topography, noise, or socioeconomics are expected under any of the alternatives. For the purposes of this EA, the Service analyzed the potential effects of implementing each alternative on all resources protected by the refuge, including the following:

4.1 Effects on the Physical Environment

The estimated effects of each alternative on soils, air, and water resources, and on the Service's ability to address climate change, are described below.

Soils

Alternative A

Under this alternative, soils will generally be protected and natural soil-formation processes will be allowed to continue. Some soil disturbance may result from forest thinning operations, but these effects are expected to be localized and temporary.

Alternative B

Impacts to soils will generally be similar to those described under Alternative A. Some additional impacts may result from the use of herbicides. However, these effects are expected to be minimal, as only approved chemicals will be used in accordance with manufacturer's instructions.

Air

Alternative A

Vegetated areas tend to improve air quality by filtering pollutants (Karl et al. 2010). Periodic prescribed fire will lead to some reductions in air quality. However, the effects are expected to be infrequent and temporary. Any air pollution caused by refuge motor vehicles is expected to be insignificant.

Alternative B

Same as Alternative A.

Water Quality

Alternative A

Vegetated areas benefit water quality through the reduction in erosion/sedimentation. Some localized erosion may occur as a result of heavy equipment used during thinning operations, for example. Best management practices will be utilized to reduce soil disturbance and subsequent erosion. Hence, these impacts are expected to be short-lived and localized, with minimal effects on water quality.

Alternative B

Same as Alternative A.

Climate Change

Alternative A

Forests and wetlands serve as areas of carbon sequestration. Prescribed fire operations and refuge motor vehicle use will contribute some carbon to the atmosphere. However, these amounts are insignificant compared to a global scale. Furthermore, management of pine-dominated stands will help reduce the risk of disease and insect outbreaks, as well as catastrophic wildfire which can make these forests a net source of carbon.

Alternative B

Same as Alternative A.

4.2 Effects on the Biological Environment

This section describes the likely effects of the project on habitats and the wildlife dependent upon them. Table 1 provides a summary comparison of the habitat management activities under each alternative.

Habitat

Table 1. Habitat acreages and management activities by alternative

Habitat	Acres	Management Activity	
		Alternative A: No Action	Alternative B: Proposed Action
Natural Pine	424	0 acres burned 0 acres thinned	424 acres to burn on 1-3 yr. cycle 424 acres to thin
Pine-hardwood Mixed	1,563	850 acres burned 0 acres thinned	1,100 acres to burn 1,500 acres to thin
Greentree Reservoir	(1)	1 acre flooded	1 acre to flood
Pine Plantations	682	355 acres thinned 0 acres burned	327 acres to thin 682 acres to burn
Bottomland Hardwood	1,524	0 acres thinned 0 acres burned	1,524 acres to thin 0 acres to burn
Greentree Reservoir	(70)	70 acres flooded	70 acres to flood
Upland Hardwood	4	0 acres thinned 0 acres burned	4 acres to thin 4 acres to burn
Natural Marsh	4,330	2,800 acres burned every 3 yrs.	3,277 acres to burn every 3 yrs.
Moist-soil	2,494	1,500 acres burned annually 2,000 acres winter flooded annually	2,494 acres to burn annually 2,494 acres to winter flood annually
Fresh Water	52	52 acres irregularly flooded annually	52 acres to irregularly flood annually
Brackish Water	314	223 acres burned every 2-4 yrs. 314 acres flooded annually	314 acres to burn every 2-4 yrs. 314 acres to flood annually
Greentree Reservoir*	(71*)	71 acres flooded	71 acres to flood
Early Successional	189	151 acres burned or mowed annually	189 acres to mechanically or chemically treat, or to burn annually
Grassland	51	51 acres mowed annually 99 acres mowed or burned every 1 or 2 yrs.	150 acres to mow, burn or herbicide annually
Canal, Pond, Open Water	80	None dredged- 80 acres existed when refuge was acquired	Same 80 acres to remain in as-is condition
Dredge Spoil Sites	172	172 acres of US Army COE sites with dikes existed when refuge was acquired	172 acres maintained by COE as active dredge deposition sites under long term lease
Borrow Area	5	5 acres existed when refuge was acquired	5 acres to remain in as-is condition
Administrative Area	25	N/A	N/A
TOTAL	11,909		

*Greentree reservoir acres above are already included within the cover type acres where they are located i.e. bottomland hardwoods and pine-hardwood mixed above. The refuge sum of those greentree reservoir acres is shown in the above table under managed wetlands but that sum (71) is not included in the managed wetland acres total of 2,860 shown.

Alternative A

Pine-dominated Forests

Natural pine stands will not benefit from thinning or prescribed fire under this alternative. Stands may become overstocked and no beneficial understory or groundcover will develop, minimizing the abundance and diversity of wildlife species these areas would otherwise support. Additionally, at high densities, pine stands would be at a higher risk of insect damage, disease, or catastrophic wildfire. Pine plantations will be thinned, resulting in a more heterogeneous forest composition.

Mixed Pine-Hardwood

Prescribed fire will help maintain a more open forest structure, supporting healthier trees better protected from insects and disease. Additionally, the risk of catastrophic wildfire damage would be minimized in less densely packed stands. Periodic fire will also prevent hardwood encroachment, helping maintain an appropriate balance of pine and hardwood cover.

Hardwoods

Under this alternative, neither bottomland nor upland hardwoods will be managed. Less desirable tree species could dominate, leaving these areas less productive in terms of their mast.

Natural Marsh

Under this alternative, natural marsh will be periodically subjected to prescribed fire. Woody vegetation will be suppressed, benefitting a range of bird species and other wildlife that utilize this habitat.

Managed Wetlands

Under this alternative, moist-soil and brackish water wetlands will be burned periodically, helping reduce woody encroachment and stimulating the growth of wetland plants that are used as forage. Annual flooding of all managed wetlands will provide a range of bird species with areas for loafing, resting, and foraging.

Early Successional/Grasslands

Early successional and grassland habitats will be annually burned or mowed, helping to maintain a preferred vegetation composition and structure.

Alternative B

Pine-dominated Forests

Under Alternative B, pine forests will be thinned where needed and periodically burned. As a result, stands will develop a more heterogeneous structure, with an understory and more diverse groundcover. In addition, more open, healthy stands will help minimize disease and insect outbreaks and be less prone to catastrophic wildfire.

Mixed Pine-Hardwoods

As under Alternative A, mixed pine-hardwood stands will benefit from periodic prescribed fire. Additionally, thinning of selected areas will result in improved structure, with a more diverse understory and groundcover.

Hardwoods

Compared to Alternative A, management of bottomland hardwoods under this alternative should result in more diverse, productive stands. Selective thinning will optimize growth of more favorable mast-producing species. Upland hardwood stands should benefit from the combination of thinning and prescribed fire.

Natural Marsh

Similar to Alternative A, with additional acreage benefitting from prescribed fire.

Managed Wetlands

Managed wetlands will benefit as under Alternative A. However, a greater portion of the moist soil and brackish water impoundments will be subjected to prescribed fire under this alternative.

Early Successional/Grasslands

Compared to Alternative A, more acreage of these habitats will be subjected to management. In addition, herbicidal treatment will be among the tools used to set back succession under this alternative.

Wildlife

Alternative A

Overall, this alternative will provide suitable habitat for a range of species. In particular, a host of bird species will benefit, including waterfowl, shorebirds, secretive marsh birds, and wading birds. Under this alternative, pine-dominated habitats may remain overstocked and not have the variety in structure to support an abundance and diversity of wildlife. Likewise, bottomland hardwoods may not provide optimal foraging conditions for waterfowl. Furthermore, habitat will be provided for a range of mammal, reptile, and amphibian species, most of which are common to the region.

Alternative B

Under this alternative, wildlife will generally benefit in a similar manner as described under Alternative A. Because more acreage will be treated under this alternative, it is expected that abundances of certain species will be greater than compared to Alternative A. Furthermore, improved conditions in pine-dominated habitats will benefit species such as brown-headed nuthatch, wild turkey, and bobwhite quail. Waterfowl that utilize bottomland hardwoods will have an improved forage base due to increased productivity of mast-producing species.

4.3 Effects on Cultural Resources

The estimated effects of each alternative on cultural resources are described below.

No effects on cultural resources are expected under either alternative. Under both alternatives, the Service would continue with its management of the ABNWR in accordance with the goals and objectives outlined in its CCP and in accordance with the National Historic Preservation Act of 1966 and Archaeological Resources Protection Act of 1979.

4.4 Irreversible and Irretrievable Commitment of Resources

Any commitments of resources that may be irreversible or irretrievable because of carrying out alternatives A or B are described below.

Alternative A

There would be no commitment of resources by the Service if alternative A were selected. The Service could still exercise its existing authority to manage the Refuge in accordance with the 1996 CMP.

Alternative B

Implementation of the HMP would not, of itself, constitute an irreversible or irretrievable commitment of resources. The implementation of habitat management activities and appropriate monitoring of these actions would represent a minor increase in overall Service costs borne by the ABNWR.

4.5 Unavoidable Adverse Effects

Unavoidable adverse effects are the effects of those actions that could cause significant harm to the human environment and that cannot be avoided, even with mitigation measures. Some minor, localized unavoidable adverse effects would occur under both alternatives. The No Action alternative would maintain the status quo for management, including some forest thinning, prescribed fire, etc. as described above. Under Alternative B, these same management activities would occur, but likely with increased intensity and over a greater area. However, none of these effects associated with habitat management actions rise to the level of significance. Some would be mitigated, and there would be no significant unavoidable adverse impacts under the Proposed Action.

4.6 Relationship between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity

Both alternatives would strive to maintain or enhance the long-term productivity and sustainability of natural resources on refuge lands, for the benefit of resources of concern, as well as common wildlife species.

4.7 Cumulative Impacts

As defined by NEPA regulations, a cumulative impact on the environment “results from the incremental impact of the action when added to other past, present, and reasonably foreseeable

future actions regardless of what agency or person undertakes such other actions” (40 CFR 1508.7). The following describes the past, present, and reasonably foreseeable actions related with implementation of a habitat management plan. A discussion follows regarding the cumulative impacts of these actions in combination with the actions of Alternatives A and B.

As previously mentioned, there would be no impacts to geology, topography, noise, or socioeconomics expected under any of the alternatives.

Physical Resources

Neither alternative will have any cumulative effects on soils, air or water quality, or climate change. Some minor soils disturbance will occur, but best management practices will keep this a minimum. Habitat management will contribute some air pollutants, but these will be insignificant levels, likewise for carbon emissions as they related to climate change. Water quality will not be adversely affected.

Biological Resources

Under each alternative, biological resources are expected to benefit, and no cumulative effects are expected. Habitat quality will be maintained or improved, with positive changes expected in forest structure. In addition, the quality and function of managed wetlands will be maintained. Early successional areas, including grasslands and natural marsh, will also be maintained. The existing or improved habitat conditions will benefit wildlife, and no adverse cumulative effects are expected to the range of species that utilize the refuge.

Cultural Resources

There will be no cumulative effects on archaeological or historical resources on the refuge as a result of either alternative. Any activities that disturb the ground will be kept at a minimum.

5.0 COORDINATION AND ENVIRONMENTAL REVIEW

This section describes how the Service coordinated with others and conducted environmental reviews of various aspects of the project proposal and analysis. Additional coordination and review would be needed to carry out the proposed action, if selected.

5.1 Agency Coordination

The Service coordinated internally in the development of this EA as well. ABNWR staff conducted the analysis and prepared this document, as well as the HMP. An intra-service Endangered Species Act Section 7 consultation was conducted, and resulted in a finding of “May affect but not likely to adversely affect” ESA protected or candidate species (Appendix A). The Region 4 regional archeologist has also reviewed this plan.

5.2 National Environmental Policy Act

The Service conducted this environmental analysis under the authority of and in compliance with NEPA, which requires an evaluation of reasonable alternatives that will meet stated objectives, and an assessment of the possible effects on the natural and human environment.

5.3 Environmental Assessment

This EA will be the basis for determining whether the implementation of the proposed action would constitute a major federal action significantly affecting the quality of the natural and human environments. NEPA planning for this EA involved other government agencies and the public in the identification of issues and alternatives for the proposed project.

5.4 Distribution and Availability

The Service will make the draft EA (with the associated HMP in the same volume) available to the project mailing list, which includes federal and State legislative delegations; tribes; federal, State, and local agencies; nongovernmental organizations; and interested individuals. Copies may be requested from ABNWR.

6.0 PUBLIC INVOLVEMENT

On March 26, 2014, a press release was issued by the refuge which announced the release of a draft HMP and associated EA for 30 days of public comment. Announcements were also made on the refuge website, as well as notices at local libraries and the refuge headquarters.

7.0 REFERENCES

Karl, T., Harley, P., Emmons, L., Thornton, B., Guenther, A., Basu, C., Turnipseed, A., and K. Jardine. 2010. Efficient atmospheric cleansing of oxidized organic trace gases by vegetation. *Science*, 330, 816-819, 10.1126/science.1192534.

U. S. Fish and Wildlife Service. 2009. Ernest F. Hollings ACE Basin National Wildlife Refuge Comprehensive Conservation Plan. Atlanta, GA. 191pp.

U.S. Fish and Wildlife Service. 2014. Ernest F. Hollings ACE Basin National Wildlife Refuge draft Habitat Management Plan. Atlanta, GA. 167pp.