Lacassine National Wildlife Refuge

Habitat Management Plan

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Southeast Region

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Submitted by: _____ Date: 25 Jan 2012
Rob Gosnell, Complex Wildlife Biologist, SWLA NWR Complex

Concur: _____ Date: 1.25.2012
Matthew Johnson, Fire Management Officer, SWLA NWR Complex

Submitted by: _____ Date: 1-25-2012
Richard Meyers, Refuge Manager, LNWR

Concur: _____ Date: 1-25-2012
Don Voros, Project Leader SWLA NWR Complex

Concur: _____ Date: 3/25/2012
Chuck Hunter, Chief, Division of Planning and Natural Resources

Concur: _____ Date: 3/27/12
Ricky Ingram, Regional Supervisor, Southeast Region

for Approved by: _____ Date: 3-28-12
Acting
David Viker, Regional Chief, Southeast Region

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1.0 INTRODUCTION

National Wildlife Refuges have been in existence for more than a century, and during that time they have played a crucial role in providing habitat for trust fish and wildlife species, as natural laboratories for the advancement of the science of wildlife management, and as places where the American public can go to hunt, fish, and learn about our nation's natural heritage. As the United States enters the second decade of the Twenty-first Century, the role of the US Fish and Wildlife Service's National Wildlife Refuge System is becoming increasingly important. Threats on an unprecedented scale—global climate change, exotic invasive species, and unsustainable land use—are causing irreversible changes to the natural systems on which we all depend. Properly managed conservation lands, scaled to the level of the threats they face, not only continue to serve their traditional purposes, but are also becoming increasingly essential to ensure the survival of natural systems and species, including our own. To meet these challenges, managers will have to become more flexible and adaptable. Adaptive management, a system of land management in which outcomes from past actions are used to adjust future actions, will increase flexibility and effectiveness of management on Service lands.

Lacassine National Wildlife Refuge (LNWR or Lacassine NWR) covers approximately 34,000 acres in Cameron Parish, 334 acres in Evangeline Parish, and 124 acres in Jefferson Davis Parish in southwestern Louisiana (Figure 1). Created in 1937, Lacassine National Wildlife Refuge was the 123rd refuge established within the National Wildlife Refuge System. It is located at the edge of Grand Lake and 15 miles from the Gulf of Mexico. The refuge is located on the boundary of coastal marsh and agricultural habitats, as well as at the southern terminus of the Mississippi and Central Flyways, making it strategically important to migratory birds, especially wintering waterfowl.

LNWR encompasses a complex range of habitats including freshwater marshes, coastal prairie, and moist soil units, which support a great variety of resident and migratory species. The refuge's location is at the junction of upland prairie (much of it developed as farmland) and freshwater marsh habitats (Figure 1) contributes to this diversity, as does its semitropical climate. The mixture of wetlands and uplands that make up the refuge provides for the needs of a wide range of fish, wildlife, and plants including migrating waterfowl such as northern pintail (*Anas acuta*), resident waterfowl such as the mottled duck (*Anas fulvigula*), a variety of shore and waterbirds including black rail (*Laterallus jamaicensis*), and buff-breasted sandpiper (*Tryngites subruficollis*), as well as terrestrial birds like loggerhead shrike (*Lanius ludovicianus*) (USFWS 2004). Other species of concern found on the refuge include alligator snapping turtle (*Macroclemys temminckii*) and paddlefish (*Polyodon spathula).*

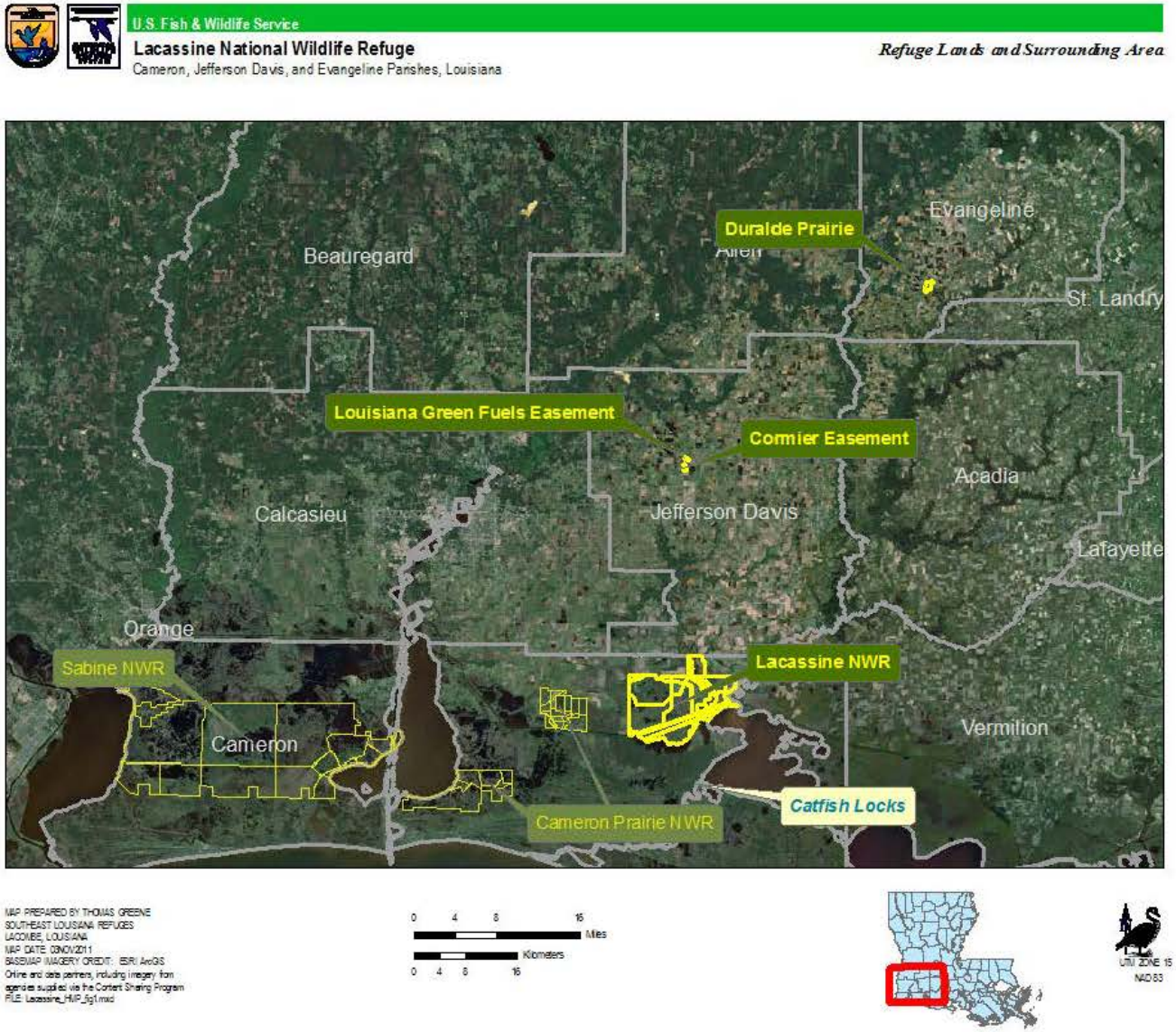

Figure 1. Location of Lacassine NWR, including non-contiguous refuge lands.

1.1 Scope and Rationale

This Habitat Management Plan (HMP) is a step-down plan from the Lacassine National Wildlife Refuge Comprehensive Conservation Plan (CCP). It lays out habitat management goals, objectives, and strategies for a 15-year period for LNWR. The wildlife and habitat management goals and objectives contained in the HMP are a reflection of the information and recommendations derived from the goals, objectives and strategies related to habitat management activities discussed in the Lacassine National Wildlife Refuge Comprehensive Conservation Plans (CCP) and Environmental Assessments which were completed during 2006, internal scoping within the Service, and information and recommendations gathered from the public and governmental partners during public scoping in 2006 for the CCP (USFWS 2007). The planning process of the CCP defined a mission for the refuge, identified the priority issues to be addressed, and delineated goals and objectives to provide direction and guidance for refuge management.

The primary purpose of this HMP is to provide managers with clear, science-based goals, objectives, and strategies for managing Lacassine NWR to achieve the vision and goals set forth in the CCP. The intent is that managers will have, in one document, a compendium of all the information needed to devise annual habitat management work plans and budgets for the refuge. The HMP also serves to inform and educate the public about the reasons the refuge exists, its priorities, and the resources (money and personnel) it takes to manage a large, complex, and interconnected collection of habitats which itself is only a small part of a larger, integrated landscape.

Global climate change is a transformational issue which is also being addressed through the implementation of the HMP. Over the last five years, Refuges within the Southwest Louisiana National Wildlife Refuge Complex (NWRC) were subjected to several high water and wind events which included four named storms; Hurricanes Rita, Gustav, and Ike and Tropical Storm Edouard. These storms were devastating to coastal marshes. Powerful tropical systems such as hurricanes can create large open water areas in previously contiguous marshes which, when intact, would normally slow down destructive storm surges. Recent global climate change models predict that while tropical cyclone frequency may not change, or may decrease, the intensity of those storms will increase over time as surface sea temperatures increase (International Workshop on Tropical Cyclones 2006, Webster et al. 2005). Therefore, it is even more important to protect and restore marsh, both for its habitat value and also because it helps protect adjacent habitat, municipal structures, and oil and gas industrial infrastructure throughout coastal Louisiana. Without these marshes, wildlife, municipalities and the local economy could be seriously jeopardized.

Dynamic weather conditions such as tropical storms, hurricanes, high and low tides, droughts, severe freezes, wildfires, and invasive plant species responding to global climate change may significantly alter management strategies over time. Natural resource managers must be prepared to be flexible in adapting to change to fulfill the purposes for which the Refuges within the NWRS have been established.

1.2 Legal Mandates

Legal mandates are discussed in detail in the LNWR CCP (USFWS 2007). However, a synopsis is warranted to give the reader some insight as to the legal authorities under which habitat management operates.

1.2.1 Establishment of the Refuge

Created in 1937, Lacassine National Wildlife Refuge was the 123rd refuge established within the National Wildlife Refuge System. The Refuge administers 34,724 acres in Cameron, Evangeline and Jefferson Davis Parishes, Louisiana. Land for the refuge was purchased from private landowners.

The southern portion of the refuge, south of the pipeline canal and west of Bayou Misere, was designated Lacassine Wilderness in 1976 by Congress (94-557).

1.2.2 Federal Laws, Mandates, and Policies

LNWR operates under a variety of laws and policy statements. The principle ones are listed.

- The National Wildlife Refuge System Administration Act of 1966
- The Endangered Species Act
- National Wildlife Refuge System Improvement Act of 1997
- Title 50 of the Code of Federal Regulations
- U.S. Fish and Wildlife Service Manual – specifically 601 3(D2G), which states: Through the comprehensive conservation planning process, interim management planning, or compatibility reviews, determines the appropriate management direction to maintain and, where appropriate, restore, biological integrity, diversity, and environmental health, while achieving refuge purpose(s).
- The Service further lays out specific planning policies for CCPs and HMPs in policies 602 FW 1 and 620 FW 1, respectively. Policy 620 FW 1 states: "We will manage all refuge habitats in accordance with approved CCPs and HMPs that, when implemented, will help achieve refuge purposes, fulfill the System mission, and meet other mandates."
- National Historic Preservation Act-- The Service, like other federal agencies, is legally mandated to inventory, assess, and protect cultural resources located on those lands that the agency owns, manages, or controls. The Service's cultural resource policy is delineated in 614 FW 1-5 and 126 FW 1-3. In the Service's Southeast Region, the cultural resource review and compliance process is initiated by contacting the Regional Historic Preservation Officer/Regional Archaeologist (RHPO/RA). The RHPO/RA would determine whether the proposed undertaking has the potential to impact cultural resources, identify the "area of potential effect", determine the appropriate level of scientific investigation necessary to ensure legal compliance, and initiate consultation with the pertinent State Historic Preservation Office (SHPO) and federally recognized Tribes.

1.2.3 Refuge Purpose

Lacassine National Wildlife Refuge was established on December 30, 1937, as Lacassine Migratory Waterfowl Refuge by the following: 1) Executive Order 7780, "...as a Refuge and breeding ground for migratory birds and other wildlife...;" 2) the Migratory Bird Conservation Act, "... for use as an inviolate sanctuary, or any other management purpose, for migratory birds," (U.S.C. 715d). Additional lands were added to the refuge under 3) Fish and Wildlife Act of 1956 "...for the development, advancement, management, conservation, and protection of fish and wildlife resources..." [16 U.S.C. 742f(a)(4)] and 4) "...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services" [16 U.S.C. 742f(b)(1)].

1.3 Relationship to Other Plans

In addition to the legal and policy mandates, management on Lacassine NWR is influenced by other plans, those that are national or regional in scope, those that relate to activities of local entities, and those that relate to the refuge itself. Many of these plans are consistent with refuge goals and objectives, but, since different agencies have varying missions, it is inevitable that conflicts will sometimes arise. When this occurs, the refuge recognizes the differences of opinions and takes measures to address the other agency's concerns, where possible. However, the refuge will continue to manage with the mission, goals, objectives, and purpose of the refuge taking precedence.

1.3.1 National and Regional Plans

1.3.1.1 Gulf Coast Prairie Landscape Conservation Cooperative

Lacassine NWR will work with the following goal of Strategic Habitat Conservation (SHC) in the Gulf Coast Prairie Landscape Conservation Cooperative. Lacassine NWR is in the Gulf Coast Prairie Landscape (Figure 2). "The goal of SHC is to make natural resource management agencies more efficient and transparent, thereby making them more credible and wide-reaching in effect. Conservation efficiency may be thought of as the ratio of population impacts to management costs" (USFWS 2008).

According to the recent MOU between USFWS and USGS, both commit their respective leadership teams to adopt procedures and protocols to support the SHC framework's elements, and to develop shared capacity at the landscape level. The bureaus agree that they will engage additional partners to grow SHC expertise, involvement and contribution. The USFWS and USGS will:

- Engage partners and the public in development of fish and wildlife population objectives;
- Develop and share scientific information to assess and forecast the functional landscapes needed to support fish and wildlife populations;
- Align programs and conservation efforts to contribute to population and landscape habitat conservation;
- Engage the best science along with management to design actions, measure outcomes and continually refine and improve conservation results;
- Communicate shared efforts to implement science-based landscape conservation at a national scale.

The Gulf Coast Prairie LCC has recently hired a Director and will be developing objectives and plans. Lacassine NWR will engage and participate in this process and will contribute habitat and management actions that contribute to the goals established for the LCC.

1.3.1.2 North American Bird Conservation Initiative

The North American Bird Conservation Initiative aims to ensure that populations and habitats of North America's birds are protected, restored and enhanced through coordinated efforts at international, national, regional and local levels guided by sound science and effective management. It is designed to increase the effectiveness of existing and new initiatives through: effective coordination, building on existing regional partnerships, and fostering greater cooperation among the nations and the peoples of the continent.

The U.S. North American Bird Conservation Initiative (NABCI) Committee is a forum of government agencies, private organizations, and bird initiatives helping partners across the continent meet their common bird conservation objectives. The Committee's strategy is to foster coordination and collaboration on key issues of concern, including coordinated bird monitoring, conservation design, private land conservation, international conservation, and institutional support in state and federal agencies for integrated bird conservation.

Lacassine NWR contributes to NABCI breeding population objectives by participating in the Gulf Coast Joint Venture, providing 34,198 acres of habitat for migrating waterfowl and neotropical songbirds.

1.3.1.3 North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP) was signed by the United States and Canadian governments in 1986 and undertook an intensive effort to protect and restore North America’s waterfowl populations and their habitats. With its update in 1994, Mexico became a signatory to the Plan. Restoration of wetlands and associated ecosystems is the main premise of the plan in order to restore waterfowl populations to levels observed in the 1970s.

Lacassine NWR will contribute to the goals of the NAWMP by providing 16,882 acres of impounded freshwater marsh, 14,725 acres of unimpounded freshwater marsh habitat, and 1,641 acres of early-successional wetland including crop land, fallow land, and moist soil management areas, to sustain wintering ducks and geese, including mallard, northern pintail, American wigeon, green-winged teal, blue-winged teal, cinnamon teal, northern shoveler, mottled ducks, ring-necked ducks, redhead, golden eye, Canada goose, snow goose, and white-fronted goose.

1.3.1.4 North American Waterbird Conservation Plan

The North American Waterbird Conservation Plan was developed under a partnership, the Waterbird Conservation for the Americas, which is a group of individuals and organizations having interest and responsibility for conservation of waterbirds and their habitats in the Americas. Lacassine NWR is located in the Southeast U.S. Regional Waterbird Conservation Planning Area. The Refuge can contribute to a key objective of this region, which is to standardize data collection efforts and analysis procedures to allow better tracking of regional movements and the association of these movements with environmental or land use changes.

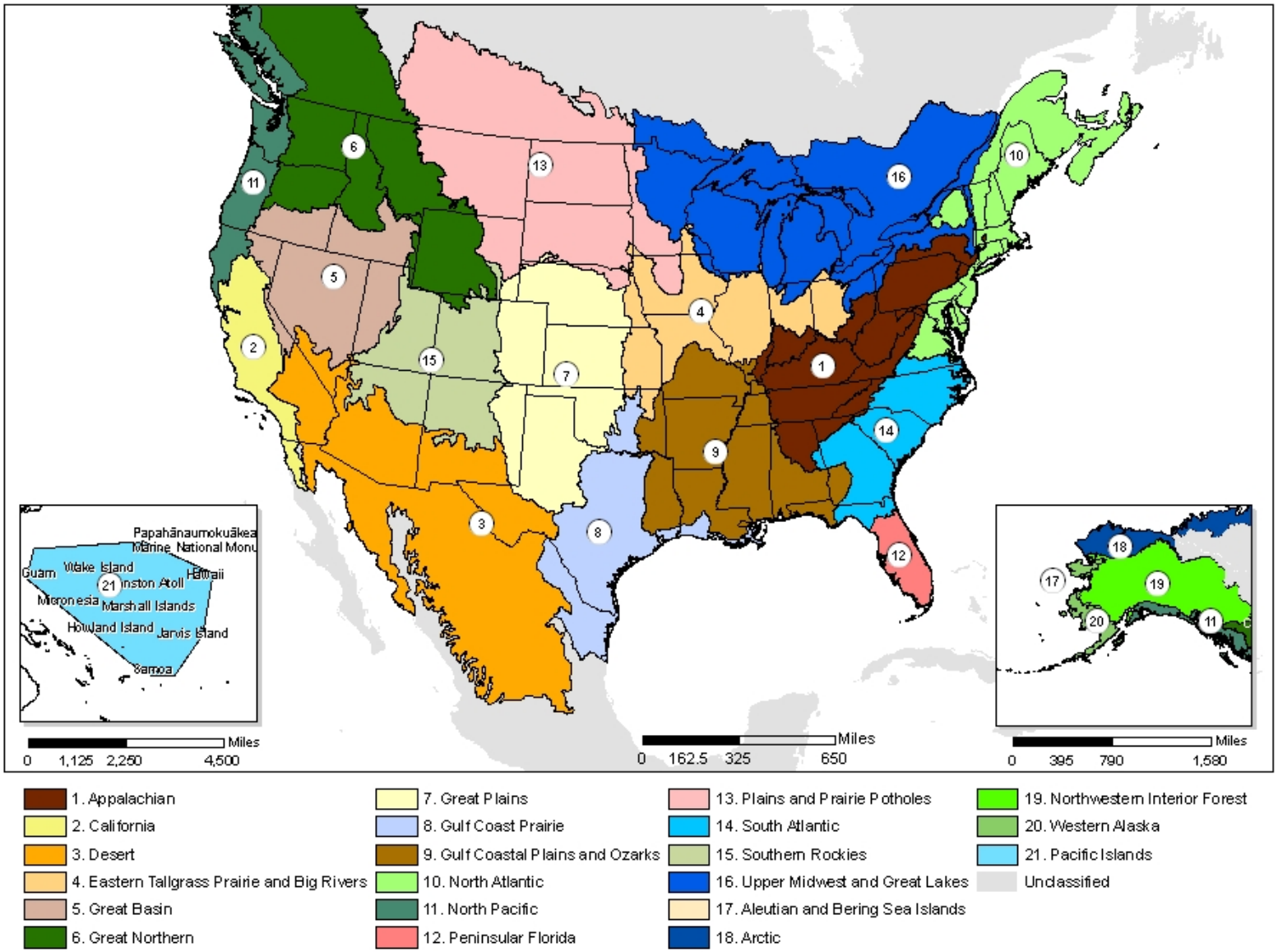

Figure 2. Strategic Habitat Conservation Landscapes.

1.3.2 State and Local Plans

1.3.2.1 Gulf Coast Joint Venture (Chenier Plain Initiative)

Regional partnerships or joint ventures composed of individuals, sportsmen's groups, conservation organizations, and local, state, provincial, and Federal governments were formed under the NAWMP. One such partnership—the Gulf Coast Joint Venture (GCJV)—formed to conserve priority waterfowl habitat range along the Western United States Gulf Coast, one of the most important waterfowl areas in North America. The Gulf Coast is the terminus of the Central and Mississippi Flyways which provides both wintering and migration habitat for significant numbers of the continental goose and duck populations. The Gulf Coast Joint Venture's greatest contribution to the North American Waterfowl Management Plan is to provide wintering grounds for waterfowl. A great diversity of birds, mammals, fish, shellfish, reptiles and amphibians also rely on the wetlands of the Gulf Coast for part of their life cycles.

The GCJV is divided geographically into six initiative areas, one of which is the Chenier Plain Initiative area of southwest Louisiana and southeast Texas. The goal of the Chenier Plain Initiative is to provide wintering and migration habitat for significant numbers of dabbling ducks, diving ducks and geese (especially lesser snow (*Chen caerulescens*) and greater white-fronted (*Anser albifrons*)), as well as year-round habitat for mottled ducks.

The Refuge contributes to the objectives of this initiative by increasing moist soil management capabilities on 1,641 acres through cooperative efforts with Ducks Unlimited, providing resting and breeding habitat for mottled ducks, banding approximately 200 mottled ducks per year in cooperation with the Louisiana Department of Wildlife and Fisheries, and managing fields and creating grit sites to promote use by waterfowl.

1.3.2.2 Louisiana Comprehensive Wildlife Conservation Strategy

The Louisiana CWCS (Lester et al. 2005) detailed species of conservation concern for freshwater marsh and coastal prairie habitats and listed conservation strategies for those species and their habitats. Lacassine NWR can contribute specifically to the following strategies listed in that document:

Coastal Prairie

- Partner with NGOs, state and federal agencies, private landowners, etc. to promote protection, restoration, and expansion of coastal prairie habitat.
- Promote fire as [an] essential management tool. Burn these areas as needed and promote alternatives to fire where prescribed burning is not an option.
- Encourage maintenance of rice agriculture and discourage conversion to crops with lower value to waterfowl.

Freshwater Marsh

- Provide public education regarding the importance of waterbird nesting colonies and shorebird feeding areas. Reduce the negative effects on these areas from recreational and other uses.

Waterfowl

- Continue to encourage the creation/enhancement/maintenance of high-quality habitat across Louisiana.
- Work with DU, DW, and USFWS to assur[e] that quality habitat, including refuge from hunting and other disturbance, is distributed across the landscape.

1.3.3 Refuge Plans

In 2007, the Lacassine NWR Comprehensive Conservation Plan (USFWS 2007) established a Vision for Lacassine NWR:

> Lacassine National Wildlife Refuge will continue to be a haven for the protection and management of migratory birds, especially waterfowl, in a region of the continent that is critically important for their survival. Working with partners, the refuge will protect the habitats of wildlife and fish, focusing on conserving the integrity of the vanishing freshwater marshes of the Chenier Plain. Lacassine Refuge will improve existing opportunities for visitors to use and enjoy its unique biological resources in a way that does not compromise their value and that increases awareness of their importance.

This Habitat Management Plan is a step-down plan which details management actions which will be taken to fulfill that vision.

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2.0 ENVIRONMENTAL SETTING AND BACKGROUND

2.1 Location

Lacassine National Wildlife Refuge, one of four refuges in the Southwest Louisiana National Wildlife Refuge Complex, is located about 25 miles southeast of Lake Charles, Louisiana, in north central Cameron Parish (Figure 3). The 34,724-acre refuge contains a large freshwater impoundment, unimpounded freshwater marsh, fields used for rice production, and moist soil units and is managed to preserve and protect wintering waterfowl and their habitat (Table 1). It is located four miles east of the eastern boundary of Cameron Prairie National Wildlife Refuge, and is bordered on the north and west by private land. The Gulf- Intracoastal Waterway bisects the refuge from northeast to southwest, while the Mermetau River passes through the eastern portion of the refuge on its way to Grand Lake (Fig. 3, 4).

2.2 Management Compartments and Descriptions

Lacassine National Wildlife Refuge is divided into management units to facilitate management activities including prescribed burning, hydrologic manipulation, monitoring, etc. Each of the 16 fee-owned units and sub-units at Lacassine NWR (Figures 4, 5) has its own management capabilities and constraints that figure into management prescriptions for that unit or sub-unit. The refuge includes a fee-owned tract in Evangeline Parish, Louisiana, which has been restored to native coastal prairie. This tract is referred to as the Duralde Prairie Unit (Figures 1, 5). In addition to fee lands, Lacassine NWR includes two conservation easements, both of which are located in Jefferson Davis Parish, Louisiana, north of the city of Welch (Figures 1, 6). Habitat type, size, current condition and past management history for each management unit and the two easements is described in Table 2.

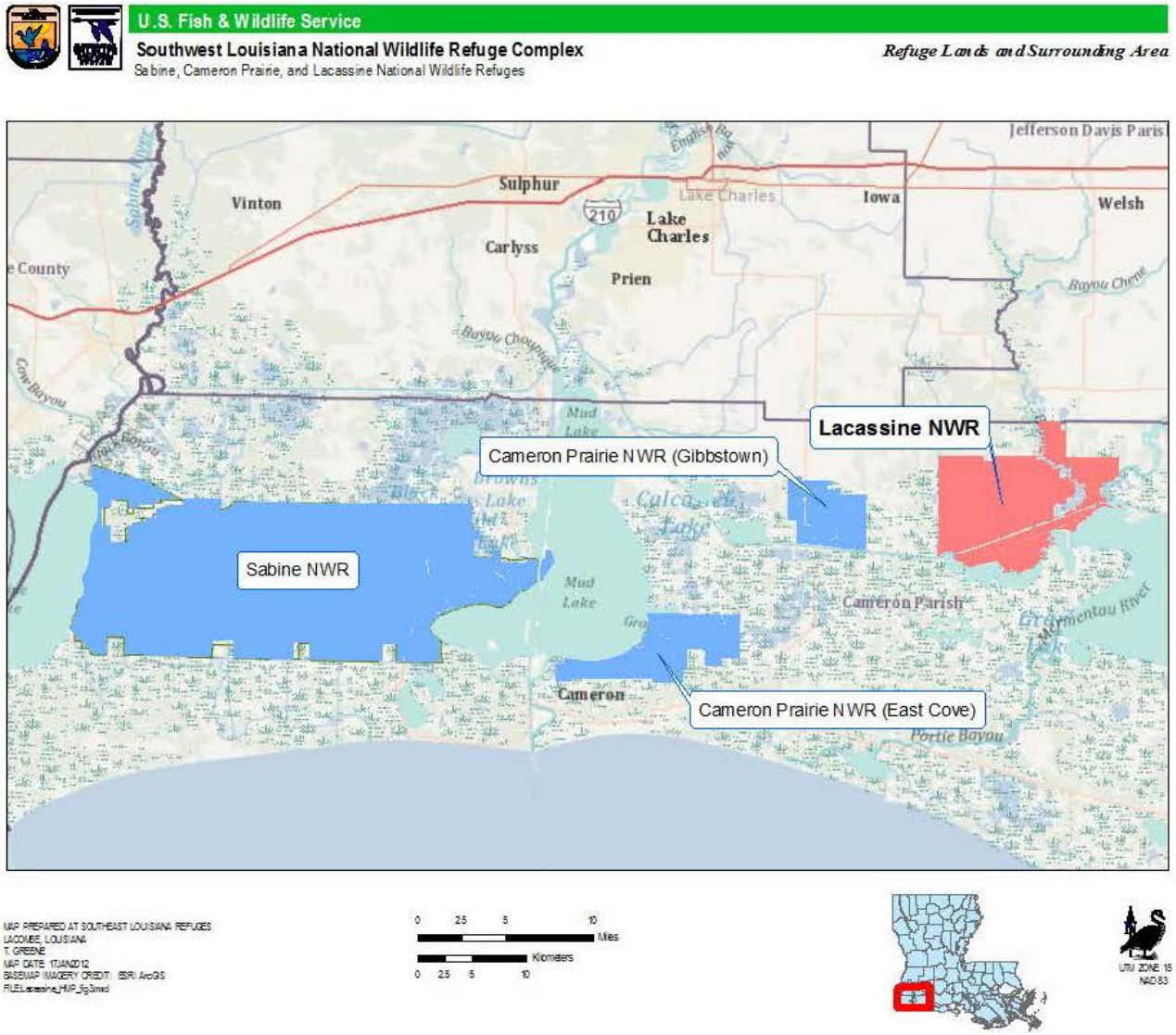

Figure 3. Location of Lacassine NWR within the Southwest Louisiana Refuges Complex.

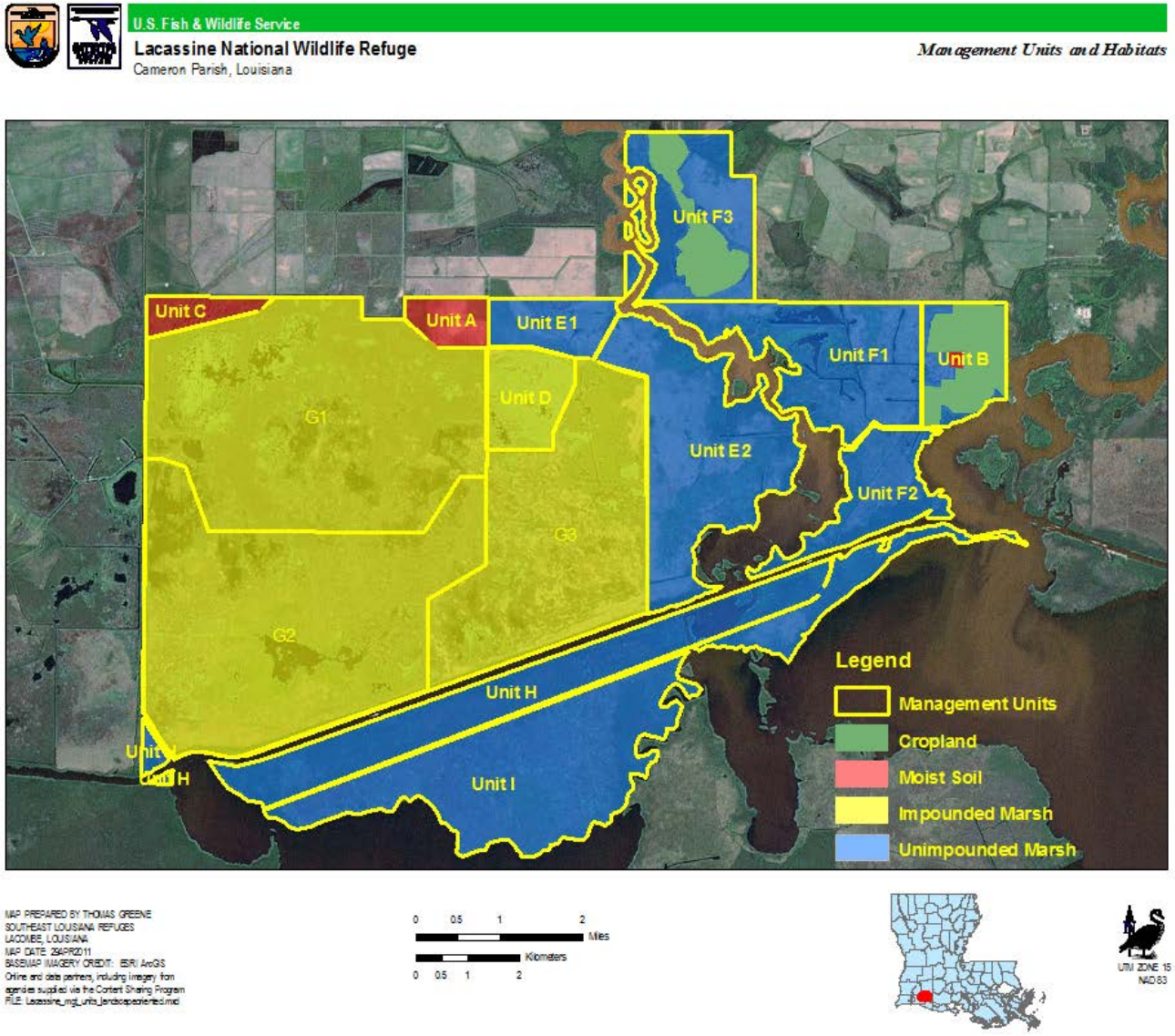

Figure 4. Management units and habitat types of Lacassine NWR, Cameron Parish, Louisiana.

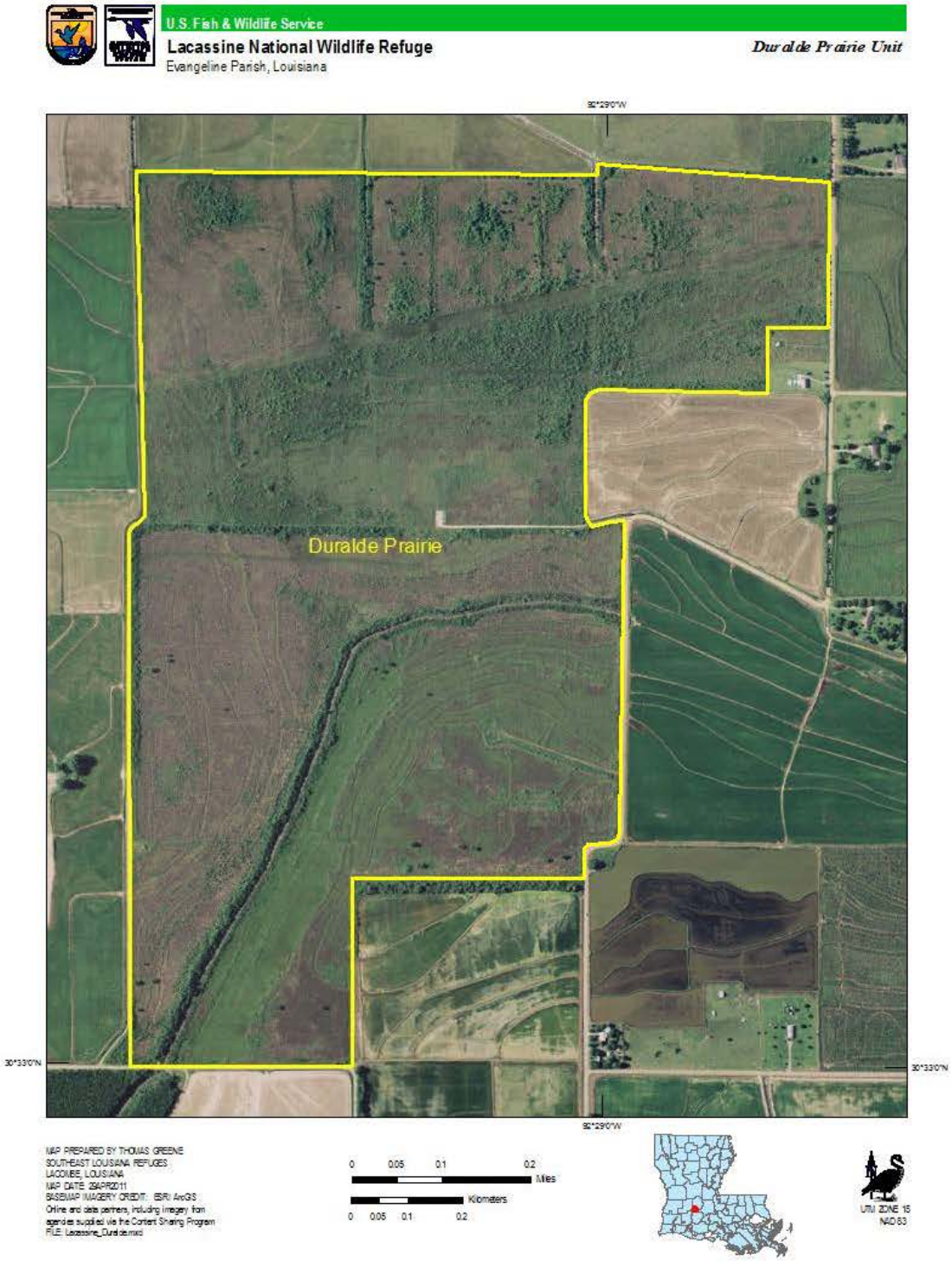

Figure 5. Duralde Prairie Unit, Lacassine NWR, Evangeline Parish, Louisiana.

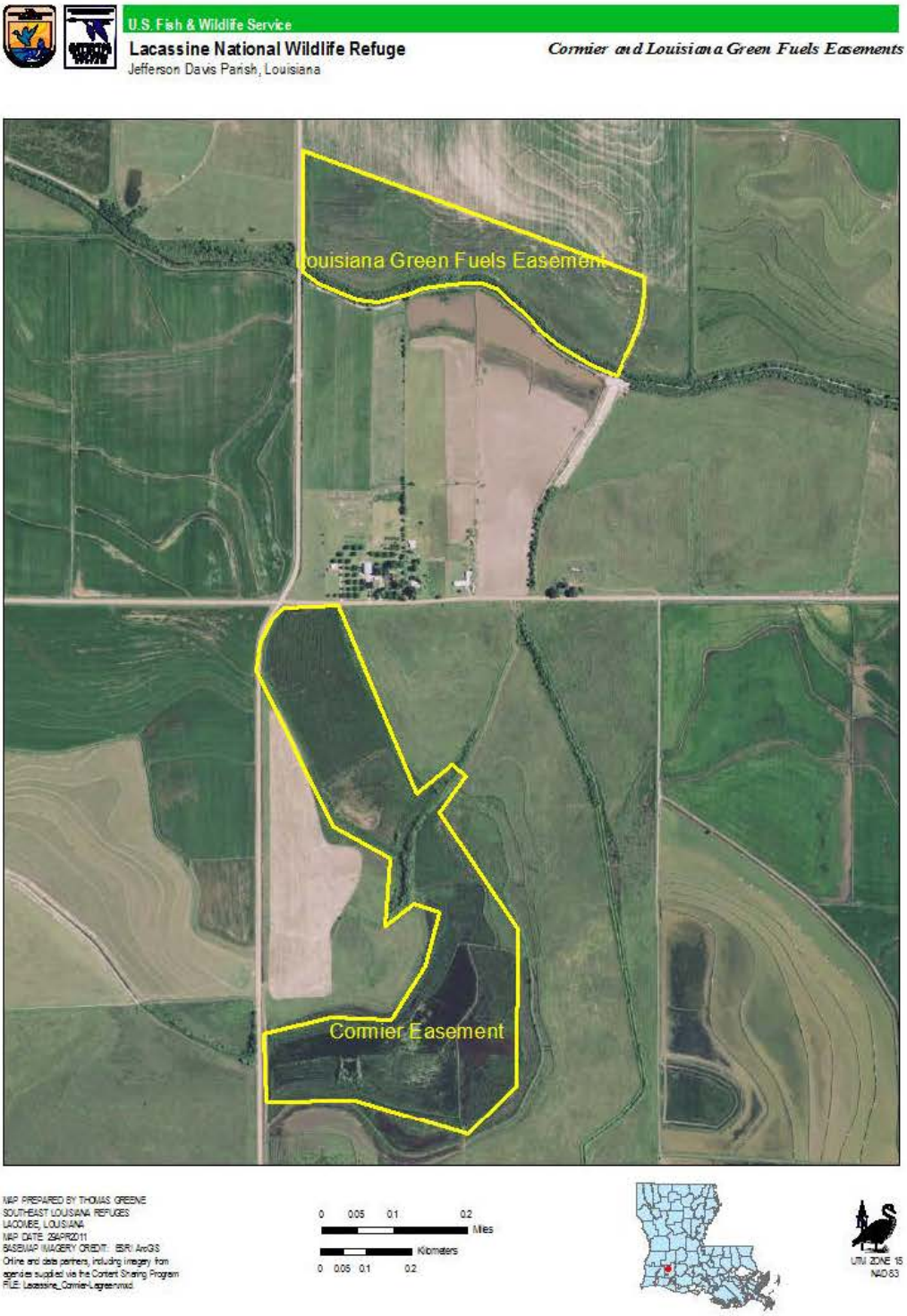

Figure 6. Easement Tracts, Lacassine NWR, Jefferson Davis Parish, Louisiana.

Table 1. Habitat types and approximate acreage on Lacassine NWR. Acreage figures are from CCP (USFWS 2007).

Habitat/Cover	Approximate Acres
Impounded Fresh Marsh (Lacassine Pool)	16,000
Unimpounded Fresh Marsh	14,242
Forested wetlands	352
Shrub wetlands	348
Open Water	1,048
Managed Fresh Marsh (moist soil impoundment)	784
Coastal Prairie	334
Croplands (rice and fallow)	1090
Artificial Uplands (Roads, levees, miscellaneous)	526
Total Acres	**34,724**

Source: USFWS 2003

Table 2. Management units, acreage, current habitat, and management history for Lacassine NWR. Acreage figures in this table were determined by GIS and are considered approximate.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
A	293	Managed Fresh Marsh (Moist Soil)	5% Aquatic vegetation (mostly alligator weed and primroses) 90 % emergent vegetation (genera include: *Eleocharis, Cyperus, Panicum, Echinochloa, Saccolepis, Setaria, Leptochloa, and Carex*); 5% Woody Vegetation (*Baccharis*) Unit A can be flooded from Lacassine Pool through a stoplog water control structure in the southeast corner of the unit. It is drained by a 24-inch pump or another stoplog water control structure near the same location that feeds into a canal connecting to Lacassine Bayou.	Unit was originally farmed approximately from the 1940's to 1980's. Since the late 1980's the unit has been drained almost annually in the spring and early summer; and reflooded in late summer to encourage a variety of moist soil plants such as millets and smartweeds.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
B	724	Croplands, Moist Soil, unimpounded marsh	Marsh (194 acres) is 5% Aquatic vegetation (mostly alligator weed) 85% Emergent vegetation (mostly maidencane); 10% Woody Vegetation (willow, Chinese tallow) Agriculture is 511 acres of prepared or fallow rice. Pumps are used to flood and drain the fields. Flooding is from the Mermentau River and draining is to the Mermentau River or outside marshes. Rice is the primary crop being farmed on a two-year rotation. A portion of the second crop is normally left for waterfowl food. Marsh habitat is in the western portion of the unit, away from the Mermentau River and off the natural levee. There is a 19-acre moist soil field in Unit B, converted from farm field as mitigation for the new terrace in the Lacassine Pool. See Appendix F.	Unit was farmed for many years. Since 1988, the unit has been farmed for rice by a cooperative farmer. Marsh has been managed with prescribed fire only. Unit B (P&H Tract) is a 724-acre area, which includes 511 acres of rice impoundments that have been managed since 1990 by a cooperative farmer. Rice is planted in a field every other year, alternating with fallow. The farmer harvests a percentage, which fluctuates, and leaves the rest of the crop for waterfowl. Wheat or perennial ryegrass is planted as green browse for wintering geese. No subunits are designated.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
C	288	Managed Fresh Marsh (Moist Soil)	5% Aquatic vegetation (mostly bulltongue) 92% Emergent vegetation (mostly *Cyperus*, *Ludwigia*, and *Juncus*); 3% Woody Vegetation (willow, Chinese tallow) Fields in the unit range from 30 to 70 acres in size. The east side of this unit is flooded from Lacassine Pool by a water control structure. The western portion is flooded through a water control structure connecting the eastern and western portions or through a water control structure at the Bell City ditch. The entire unit is drained into the drainage canal by a pump in the southwest corner.	Unit was originally farmed approximately from the 1940's to 1980's. Since the early 1990's the unit has been managed as moist soil.
D	713	Impounded Fresh Marsh	85% Aquatic vegetation (bladderwort, water shield, and Am. lotus) 10% Emergent vegetation (maidencane); and 5% Woody Vegetation (willow and Chinese tallow) Two screw gates control water movement to and from the unit and the pool.	Unit impounded in the mid 1980's and dewatered and burned during 1990 to 1993 to allow consumption of the peat layer and increased water depth.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
E-1	650	Unimpounded Fresh Marsh	Marsh is dominated by maidencane. Marsh is 5% Aquatic vegetation (alligator weed) 85% Emergent vegetation (maidencane, vasey grass, and common ragweed); and 10% Woody Vegetation (baccharis). Unit contains high ground that is only infrequently flooded as well as low areas that are flooded most of the time. This area is part of the land leased from the Cameron Parish school board. The area has three fields of 21, 50, and 165 acres. Fields drain to the south into a ditch and the ditch is drained by a screw gate that flows into Lacassine Bayou. With the western screw gate closed, the fields can be flooded by pumping from Unit A or releasing water through a stop log structure into the ditch. The remaining 410 acres on the eastern side of the unit are unimpounded marsh connected hydrologically to Lacassine Bayou. This portion of the unit is managed with periodic disturbance. Hydrology of this portion of the unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Approximately 240 acres were leveed in 1991 and has been mowed, disked, burned, planted, and flooded in various years.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
E-2	2800	Unimpounded Fresh Marsh, Forested Wetland	10% Aquatic vegetation (alligator weed) 80% Emergent vegetation (maidencane, cattail, primroses); and 10% Woody Vegetation (willow, buttonbush, and Chinese tallow) Unimpounded marsh is managed with a target of prescribed fire on a 3-year return interval. Invasive exotic plants are controlled with herbicides. Hydrology of this unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE. Forested wetlands in E-2 are in the eastern portion of the unit along Lacassine Bayou. These areas are dominated by baldcypress and tupelogum.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool, units D, G1-G3) from brackish to freshwater. Hurricanes in the mid 1990's converted much of the habitat from emergent to open water and cattail.
F-1	1700	Unimpounded Fresh Marsh	10% Aquatic vegetation (submerged aquatics) 75% Emergent vegetation (maidencane); and 15% Woody Vegetation (willow and Chinese tallow) Unimpounded marsh is managed with a target of prescribed fire on a 3-year return interval. Invasive exotic plants are controlled with herbicides. Hydrology of this unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Hurricanes in the mid 1990's converted much of the habitat from emergent to open water and cattail. This area is split by canals from oil and gas drilling.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
F-2	1500	Unimpounded Fresh Marsh, Forested Wetland	Marsh is 5% Aquatic vegetation (mostly alligator weed) 75% Emergent vegetation (mostly maidencane); 20% Woody Vegetation (willow, Chinese tallow) Unimpounded marsh is managed with a target of prescribed fire on a 3-year return interval. Invasive exotic plants are controlled with herbicides. Hydrology of this unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE. Forested wetlands in F-2 are in the eastern portion of the unit along the Mermentau River. These areas are dominated by baldcypress and tupelogum.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Hurricanes in the mid 1990's converted much of the southern habitat from emergent vegetation to open water and cattail.
F-3	1960	Cropland, Unimpounded Fresh Marsh	Marsh (1430 acres) is 5% Aquatic vegetation (mostly alligator weed) 85% Emergent vegetation (mostly maidencane); 10% Woody Vegetation (willow, Chinese tallow) located in lower areas of unit and not under water management. Unimpounded marsh is managed with a target of prescribed fire on a 3-year return interval. Invasive exotic plants are controlled with herbicides. Hydrology of this portion of the unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE. Agriculture is 530 acres of prepared or fallow rice.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. The refuge acquired the 530-acre cropland portion of Unit F3 (Coto Plot) in 1996 (Figure 4); since then, it has been cooperatively farmed similar to Unit B. On average, approximately half of the tract is planted in rice every year, alternating with fallow.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
G-1	6006	Impounded Fresh Marsh	30% Aquatic vegetation (mostly white water lily, watershield, and bladderworts) 65 % Emergent vegetation (mostly maidencane); 5% Woody Vegetation (willow) Can control water through water control structures and pumps.	Lacassine Pool (Units D, G1-3; see Figure 4) was impounded and three water control structures were constructed in the early 1940's. Frankfort levee was completed and Unit D impounded in the mid 1980's. Infrastructure of pumps, levees, and water control structures were completed 2008 to allow water control for each of the three pool units.
G-2	6176	Impounded Fresh Marsh	25% Aquatic vegetation (mostly white water lily, lotus, and bladderwort) 72% Emergent vegetation (mostly maidencane and cattail); 3 % Woody Vegetation (cypress)	Lacassine Pool (Units D, G1-3; see Figure 4) was impounded and three water control structures were constructed in the early 1940's. Frankfort levee was completed and Unit D impounded in the mid 1980's. Infrastructure of pumps, levees, and water control structures were completed 2008 to allow water control for each of the three pool units. Hurricanes in the mid 1990's converted much of the habitat from emergent to open water and cattail.
G-3	3987	Impounded Fresh Marsh	20% Aquatic vegetation (mostly white water lily, lotus, and bladderwort) 79 % Emergent vegetation (mostly maidencane and cattail); 1% Woody Vegetation (cypress)	Lacassine Pool (Units D, G1-3; see Figure 4) was impounded and three water control structures were constructed in the early 1940's. Frankfort levee was completed and Unit D impounded in the mid 1980's. Infrastructure of pumps, levees, and water control structures were completed 2008 to allow water control for each of the three pool units. Hurricanes in the mid 1990's converted much of the habitat from emergent to open water and cattail.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
H	2600	Unimpounded Fresh Marsh	5% Aquatic vegetation (mostly alligator weed and white water lily) 85% emergent vegetation (mostly maidencane and cattail); 10% woody vegetation (willow, Chinese tallow). Hydrology of this unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Hurricanes in the mid 1990's killed maidencane and Chinese tallowtrees.
I	3345	Unimpounded Fresh Marsh	10% Aquatic vegetation (mostly alligator weed) 75% Emergent vegetation (mostly maidencane and cattail); 15% Woody Vegetation (willow, approximately 600 acres infested with Chinese tallow) This unit is a designated Wilderness Area under the 1964 Wilderness Act. Hydrology of this unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Hurricanes in the mid 1990's killed maidencane and Chinese tallowtrees. Area was designated wilderness in 1976.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
J	700	Unimpounded Fresh Marsh, Forested Wetland	10% Aquatic vegetation (mostly alligator weed) 50% Emergent vegetation (mostly maidencane and cattail); 40% Woody Vegetation (willow, Chinese tallow). Hydrology of this unit is influenced by the Catfish Locks (located at the soutwest end of Mermentau Lake), which are operated by the USACE. Forested wetlands in J are in the eastern portion of the unit along the Mermentau River. These areas are dominated by baldcypress and tupelogum.	In 1951, the Catfish Locks were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River (see Figure 1). These weirs, built to provide irrigation water, initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Hurricanes in the mid 1990's killed maidencane and Chinese tallowtrees.
Duralde Prairie (fka Vidrine tract)	334	Coastal Prairie	90% grasses (mainly little bluestem), 7% various forbs, and 3% woody vegetation (mainly baccharis). Restoration of native prairie vegetation to this tract was begun in 1994. Area is managed by prescribed fire. See species list in Appendix C.	The Duralde Prairie Unit, located in Evangeline Parish, was purchased by USFWS in 1993. Prairie vegetation was restored to the tract, which was formerly a rice field, by disking and planting seed collected from local prairie remnants. Area was farmed until the 1980s and was invaded by Chinese tallow prior to acquisition in 1993. Chinese tallowtrees were removed and burned, area was plowed in 1994 and seeded to prairie grasses in 1995. Unit normally has been burned annually.
Louisiana Green Fuels (Easement)	46	coastal prairie agricultural land	100% fallow , 25% woody vegetation , 35% forbs, 40% grasses	Has been an easement for the refuge since 1990. Area has been in sugar cane production within the last four years. This was due to Louisiana Green Fuels boundary mistake. No active management is in place.

Management Unit	Acreage	Habitat Types	Current Habitat Conditions and Management	Management History
Cormier (Easement)	78	Wetland	90% wetland vegetation, 20% white water lily, water smartweed, southern naiad, 10% willow trees	Has been an easement for the refuge since 1989. This area was managed for crawfish 1997 to 2001 and 2006. Since 2006, hydrology has not been altered. This is an original wetland still in place with surrounding rice agriculture. It is currently being utilized as a rookery by several species of birds.

2.3 Physical Features

2.3.1 Climate

2.3.1.1 General Climatic Conditions

The climate at Lacassine National Wildlife Refuge is subtropical with short, mild winters, hot, humid summers, and no substantial spring or fall seasons. Summer weather patterns usually begin in April and prevail through October.

2.3.1.2 Temperature

Summer temperatures (degrees Fahrenheit) range from the low 70s to the upper 80s and into 90s during the afternoon. November may have some cool days, but winter weather typically starts in December and lasts through March. Average temperatures during the winter range from lows in the 40s to highs in the mid 60s. Temperature extremes range from a low of 19° to a high of 100^{o} (National Weather Service 2009).

2.3.1.3 Atmospheric Moisture

As would be expected with large bodies of water in and around the refuge, the relative humidity (RH) is typically high. Morning mean RH is between 88 and 95% throughout the year, while readings in the mid-afternoon are between 55% and 67%. RH of 100% is not uncommon with fog occurring 100 days per year on average.

2.3.1.4 Precipitation

The average annual precipitation for the refuge (1978-2003), as recorded at Lacassine NWR headquarters (LNWR), is 59.91 inches. Fall is normally the drier part of the year.

From November to February, the weather patterns are influenced by cold continental air masses. Rainfall during this period comes from the effects of frontal passage. Rain events are more widespread and less intense than those in the summer. The transitional periods between these two wet seasons tend to be dry (Figure 7). Although uncommon, snow does occur on the refuge. Snow has been reported in both December and January; accumulations were less than 0.05 inches.

Annual precipitation amounts can vary widely. In the years 2005 and 2008 Hurricanes Rita and Ike struck Southwest Louisiana. The refuge was inundated with saltwater from storm surge and freshwater from heavy rains. These fluctuations in precipitation and salinity can impact refuge management operations to a great extent.

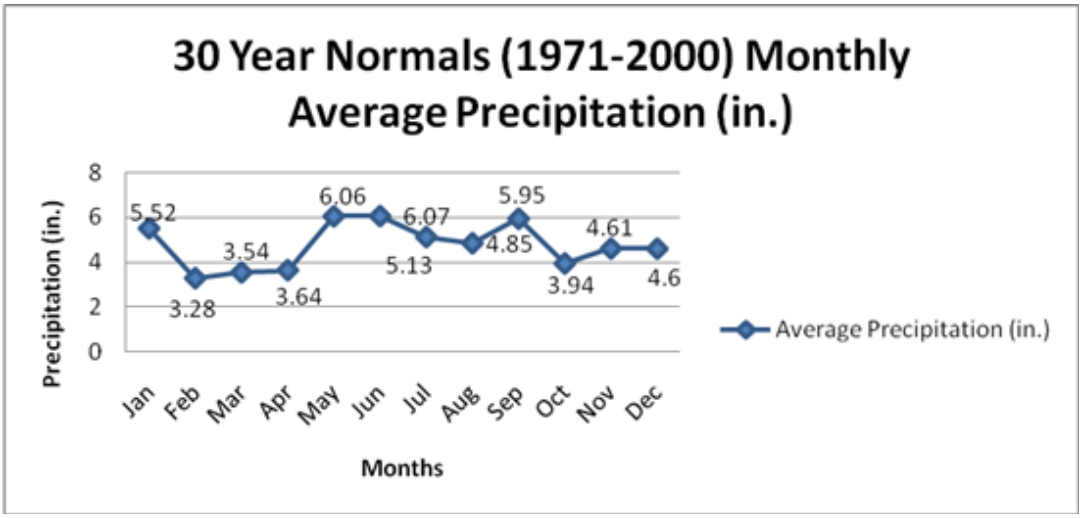

Figure 7. Monthly average precipitation over 30 years (Data collected at refuge headquarters).

2.3.1.5 Lightning

Due to its importance in fire management, a refuge management activity, lightning deserves to be addressed. Vaisala's National Lightning Detection Network states that Southwest Louisiana has an 8 to 10 average flash per sq. km/yr. (Vaisala NLDN Poster). VNLDN data indicate that over 22,000 lightning strikes occur in Southwest Louisiana each year. On Lacassine NWR, over the 12 years from 2000 through 2011, 9 lightning-caused fires burned 6,496 acres, while all other wildfires, including those of undetermined cause, totaled 19 and burned 6,113 acres (Matthew Johnson, pers. comm.).

2.3.1.6 Hurricanes

Tropical cyclones are an important feature of the climate of southwestern Louisiana. Tropical storms strike the southwestern Louisiana/southeastern Texas coast on the average every 1.6 years, and hurricanes every 3.3 years (Roth 1998). These storms have shaped the landscape, vegetation, and ecology of the area for millenia, and continue to do so today. Storm surges can completely reshape coastal landforms, and periodic inundation with salt water restricts the range of vegetation types that can occupy an area. High winds associated with these storms also affect growth forms of woody vegetation, favoring windfirm species like baldcypress and longleaf pine, and those with above-ground growth forms that are resistant to wind like live oak, and providing disturbance which increases biodiversity (Merry et al. 2009, Mitchell and Duncan 2009).

Lacassine NWR is located approximately 14 miles from the coast, and elevations on the refuge range from 0-4 ft. above msl. This means that the entire refuge is subject to inundation in even moderate storm surges, and high winds and rain associated with tropical cyclones can be

expected as well. Intensification of tropical cyclones associated with global climate change will increase the effects they have on the refuge.

2.3.2 Air Quality

Lacassine National Wildlife Refuge is considered to be a class II clean air area, under the Clean Air Act (PL 88-206 as amended, Sec. 264). This means that limited development (i.e. additional sources of pollution) can be permitted near the refuge as long as the levels of particulate matter, sulfur dioxide, and nitrogen dioxide do not exceed the class II increments. The ambient air quality is influenced by regional land management practices, such as prescribed burning; vehicle traffic; and off site emission sources. The daily air quality conditions are most influenced by the onsite vehicle traffic, intracoastal canal traffic (which runs thru the refuge system), oil and gas operations, as well as seasonally by prescribed burning and wildfires.

2.3.3 Geomorphology and Topography

Refuge topography is basically flat with minor ridges and spoil banks deposited from canal dredging. Lacassine Refuge is located on the boundary of the coastal marsh and agricultural habitats. The dominant feature of the refuge is the Lacassine Pool, which was created by enclosing a 16,000-acre marsh with a low levee during the 1940s. The refuge consists predominantly of freshwater marsh, wetlands, and croplands. Surface geology on the refuge is characterized by Holocene deposits to the south and Pleistocene deposits to the north (Spearing 1995).

Underlying much of Louisiana, including Cameron Parish, is the Louann Salt, a layer of ancient salt deposits left as a shallow inland sea which became the Gulf of Mexico repeatedly evaporated and re-filled during Triassic and Jurassic time (245-144 million years before present). Salt from this layer, which is thousands of feet thick, has intruded upwards ten miles through overlying alluvial sediment and formed “salt domes,” several of which are found on the Chenier Plain. Salt domes are best known for their role in trapping and accumulating petroleum, and some are significantly elevated above the surrounding landscape (Spearing 1995).

2.3.4 Hydrology

Hydrologic processes dominate ecosystem function in coastal Louisiana. Precipitation, infiltration and runoff, flow of ground water, and storm-related and tidal fluctuations in sea level determine the type and extent of habitats on Lacassine NWR.

2.3.4.1 Surface Water

Anthropogenic changes to surface water hydrology implemented specifically to facilitate hydrologic management of the land that became Lacassine NWR include ditches, levees, and water control structures (valves and gates). Additionally, other structures and practices have had collateral effects on the hydrology of the refuge. These include roads and containment levees

associated with oil and gas activities, the Gulf Intracoastal Waterway, and the Bell City Drainage Canal.

At present, surface hydrology on the refuge is under some degree of management control as a result of these structures. Lacassine Pool (Units D and G) can be dewatered when the Bell City Ditch has low water, and can only be filled by precipitation or backflow from the Bell City Ditch with high water and good salinities. Water level data, measured at three water control structures (WCS) on the Lacassine Pool, from 2006 through 2011 Q3 are presented in Figure 8. Data show the level of control managers have over levels at each structure by adjusting the structures. Also evident is the multi-year wet/dry cycle with dry years in 2006 and 2010-11 and wet years from 2007 through 2009. Croplands can be flooded, either from adjacent surface water or from wells,

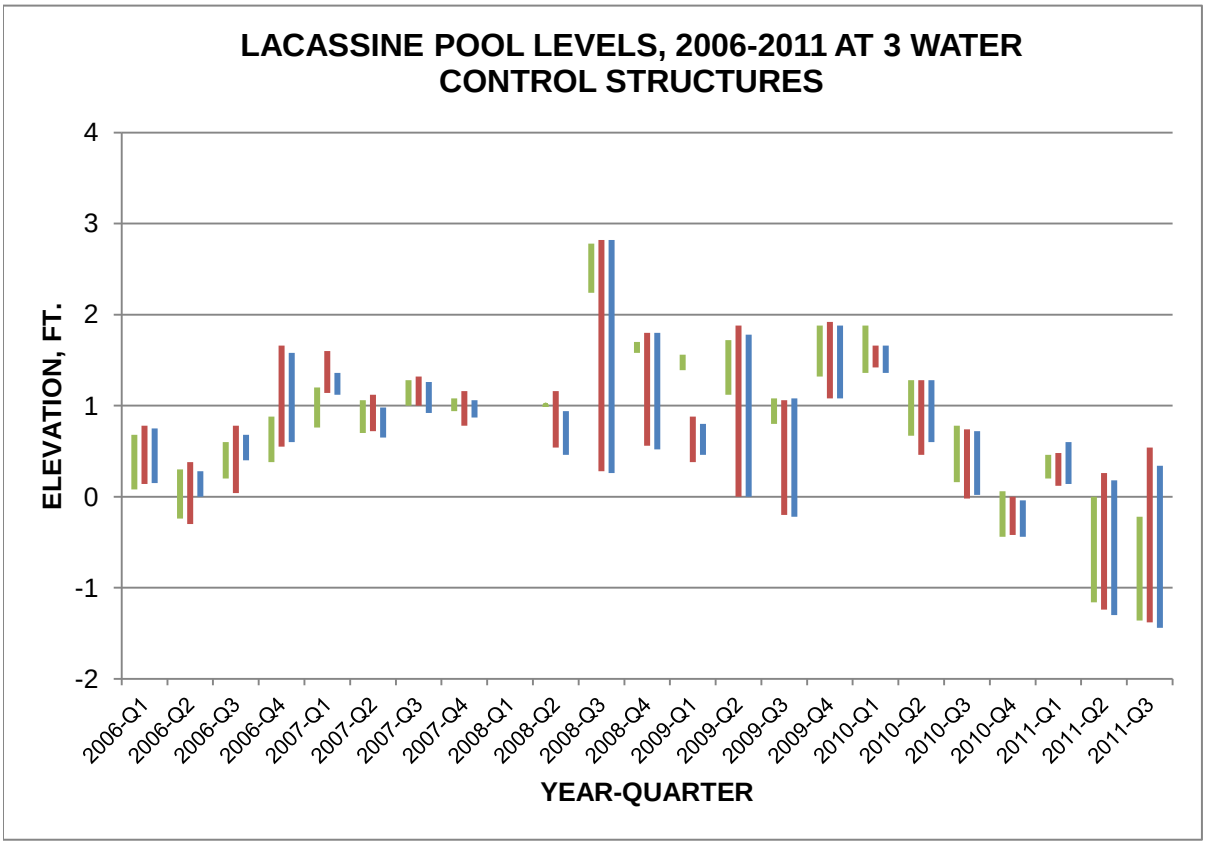

Figure 8. Water level range by quarter, 2006-Q1-2011-Q3, at three stoplog structures on the perimeter of the Lacassine Pool.

Green bars represent the southwest structure, which drains Unit G2; red bars represent the northeast structure, and blue bars represent the southeast structure, both of which drain Unit G3. 2008-Q1 data missing.

and can be drained except when flood conditions exist downstream. Moist soil units depend on precipitation and backwater from high tide conditions. The east side of unit C is flooded from

Lacassine Pool by a water control structure. The western portion is flooded through a water control structure connecting the eastern and western portions or through a water control structure at the Bell City ditch. The entire unit is drained into the drainage canal by a pump in the southwest corner. Unit A can be flooded from Lacassine Pool through a stoplog water control structure in the southeast corner of the unit. It is drained by a 24-inch pump or another stoplog water control structure near the same location that feeds into a canal connecting to Lacassine Bayou. Refuge managers currently have no control over water levels in unimpounded marsh in Units B, E1, E2, F1, F2, F3, H, I, and J, since the water levels in these areas are controlled by the US Army Corps of Engineers at the Catfish Locks.

2.3.4.2 Ground water

Levels for most ground water quality parameters (1998 to present) were generally not considered damaging to wildlife or their habitats (National Park Service 1984). These recommended maximum levels are the following: sulfate (0.5-90 mg/L SO4), pH (6.5 to 9.0), and nitrogen nitrate (0.7 used by Everglades National Park, NPS Report, 1984). Nitrogen nitrate levels during the 1998-2000 drought exceeded these levels in both the Pool and marsh habitats.

2.3.4.3 Tidal Influence

Lacassine Pool and other units are affected by tidal fluctuations, so tides must be taken into account when pumping and dewatering activities are undertaken.

2.3.5 Soils

Soils on Lacassine NWR range from almost constantly flooded organic, saline soils to medium-textured mineral soils that developed under grassland vegetation (Table 3) Soil mapping units are presented in Appendix D.

Table 3. Soil series on Lacassine NWR (information taken from Soil Conservation Service 1995, and from data available online from Natural Resources Conservation Service (2011).

Series	**Classification**	**Description**	**Management Considerations**
Allemands muck	clayey, montmorillonitic, euic, thermic Terric Medisaprists	Frequently flooded, very poorly drained organic soils of freshwater marshes	Allemands muck is suitable for wildlife habitat, but not for crop production due to severe restrictions imposed by poor drainage and shrinkage/subsidence potential.

Series	Classification	Description	Management Considerations
Aquents, Frequently Flooded	[unclassified]	Soils which have formed in spoil material excavated during dredging of waterways	Aquents are poorly drained and very slowly permeable; salinity varies from slight to moderate. Use is limited to wildlife habitat due to repeated application of fresh spoil.
Ged mucky clay	very fine, mixed, thermic Typic Ochraqualfs	Very poorly drained, very slowly permeable soils of freshwater marshes	Ged mucky clay is suitable for wildlife habitat, or if properly drained and managed, for rice production.
Crowley-Vidrine silt loams	Crowley: fine, montmorillonitic, thermic Typic Albaqualfs Vidrine: coarse-silty over clayey, mixed, thermic Glossaquic Hapludalfs	Somewhat poorly drained coastal prairie soils which formed on ridges of late Pleistocene age	Moderately well suited to crops; well suited for pasture; drainage limits development potential.
Judice silty clay	fine, montmorillonitic, thermic, Vertic Haplaquolls	Poorly drained, very slowly permeable soils formed in late Pleistocene clayey and silty alluvium	Judice silty clay is moderately well suited for crop production, and well suited for rangeland. Cultivation is only possible within a narrow range of moisture content.
Kaplan silt loam	fine, mixed, thermic, Aeric Ochraqualfs	Level, somewhat poorly drained soil of convex ridges on the coastal prairie. These soils formed in clayey and loamy, late Pleistocene alluvium.	Kaplan silt loam is well suited for pasture and crops; main crops are rice and soybeans, with corn and small grains occupying lesser acreages of this soil.

Series	Classification	Description	Management Considerations
Larose muck	very fine, montmorillonitic, nonacid, thermic, Typic Hydraquents	Very poorly drained, frequently flooded soil of freshwater marshes. Parent material is decomposing herbaceous plant remains and clayey alluvium.	Larose muck is suitable for wildlife habitat and wildlife-based recreation; poor drainage precludes other uses.
Leton silt loam	fine-silty, mixed, thermic Typic Glossaqualfs	Leton silt loam is level and poorly drained, and subject to rare flooding.	This soil is moderately well suited for crops and pasture; main limitations are wetness and low fertility.
Mamou silt loam	Fine-silty, siliceous, active, thermic Aeric Albaqualfs	“very deep, somewhat poorly drained, slowly permeable soils. These nearly level terrace soils on elongated deltaic natural levees formed in loamy sediments of the Pleistocene age Prairie Terrace Formation. Slope ranges from 1 to 3 percent”	"The potential for cropland and pastureland is good. Suitable crops are corn, millet, ryegrass, and soybeans. Suitable pasture plants are bermudagrasses, bahiagrass, tall fescue, and vetch. Traffic pans develop easily, but can be broken by chiseling or deep plowing. Ditching will improve surface drainage. Crop residue on the surface will reduce erosion. Most crops, other than legumes respond well to nitrogen fertilizers. Lime and other fertilizers are usually needed."
Midland silty clay loam	fine, montmorillonitic, thermic, Typic Ochraqualfs	Poorly drained, very slowly permeable soils formed in late Pleistocene clayey and silty alluvium	Midland soils occur on broad flats and slight depressions. This soil is moderately well suited for crop production, and well suited for pasture. Cultivation is only possible within a narrow range of moisture content.

Series	Classification	Description	Management Considerations
Morey silt loam	fine-silty, mixed, thermic Typic Argiaquolls	Poorly drained prairie soil formed on broad flat areas of loamy and clayey, late Pleistocene alluvial deposits.	Morey silt loam is moderately suited for crops; tillage while the soil is wet will cause the formation of a plow pan. Other uses for which this soil is suitable include pasture and range.
Mowata-Vidrine silt loams	Mowata: fine, montmorillonitic, thermic Typic Glossaqualfs Vidrine: coarse-silty over clayey, mixed, thermic Glossaquic Hapludalfs	Mowata soil is poorly drained, while Vidrine soil is somewhat poorly drained. Both are prairie soils which formed on broad flats with small natural mounds called mima mounds. The Vidrine soil is associated with the mounds, while the Mowata soil is found between the mounds. Most mima mounds on the coastal prairie have been leveled for agriculture.	Mowata and Vidrine soils are used for crops, mostly rice, milo, and soybeans, and pasture.
Pine Island loam	fine-silty, siliceous, semiactive, hyperthermic Oxyaquic Fraglossudalfs	Moderately well drained soil which formed on terraces of natural levees	"This group consists of wet, occasionally to frequently flooded loamy soils with a high potential for productivity. Equipment limitations are severe and seedling mortality is moderate to severe. This is due primarily to excess water."

Series	Classification	Description	Management Considerations
Udifluvents, 1 to 20 % slopes	[unclassified]	Sandy, loamy, and clayey material excavated from waterways and deposited on spoil banks.	Typical vegetation is a collection of early successional and exotic herbs and woody plants. These soils are suitable for wildlife habitat, which can be improved by proper vegetation management.

2.3.6 Changing Environmental Conditions

Among the most serious consequences of predicted climate change are sea level rise and the likely increase in hurricane intensity and associated storm surge (U.S. Global Change Research Program 2009). Sea level has been rising over the past few decades, and this trend is expected to accelerate (USFWS 2010, US Global Change Research Program 2009). The result will be shoreline retreat and inundation of inland areas. Subsidence, or land sinking, also contributes heavily to coastal erosion and land loss in Louisiana and the surrounding Gulf states. Geological modeling has suggested that the weight of Pleistocene sediments on the Earth's crust on the coast of Louisiana can explain between 0.1 and 0.8 centimeters (0.04 and 0.3 inches) of sinking per year (NASA 2008). "These sediments contribute a part of the region's sinking that's inevitable and must be considered when predicting rates of sinking and future sea level change in coastal Louisiana," said study co-author Roy Dokka of Louisiana State University. Other impacts of sea level rise include increased risks of erosion, conversion of wetlands to open water, increase in salinity of estuaries and freshwater aquifers and flooding for coastal communities (Climate Change Science Program 2009). Rising sea temperatures are expected to increase the frequency and strength of hurricanes (Emanuel 2005). Stronger storms with higher wind speeds, more intense rainfall, and more powerful surges are expected to cause more severe damage (Knutson and Tuleya 2004).

Increasing intensity and frequency of storms, combined with sea level rise and local land subsidence, mean that over time, Lacassine NWR and the surrounding lands will become more saline and more frequently inundated by salt water or brackish water. If the magnitude of the change is great enough, even freshwater impoundments will be affected, as they were in the recent storms (2005, 2008). As salinity increases, vegetation zones will migrate inland; present salt marsh will convert to open water, brackish marsh will become saline, freshwater marsh will become brackish, and freshwater swamps and shrub communities will convert to herbaceous systems as episodes of salt water intrusion become more frequent and occur further inland. Management of the refuge will need to be flexible and adaptive to successfully fulfill the purpose for which it was established.

2.3.7 Flyways

Lacassine NWR and the larger Gulf Coast Vegetation Region (Gould 1975) is a part of the Mississippi Flyway (Figure 9), and receives influence and exchange from the Central Flyway (Figure 10) The Mississippi and Central Flyways are corridors for over two thirds of waterfowl species in the Northern Hemisphere. The immense southern coastal marshes of these flyways constitute an irreplaceable habitat resource for wintering waterfowl. The region is the terminus of the flyways and the destination of scores of species of migrant waterfowl not undertaking the lengthy trans-Gulf flights to more southerly habitats.

Figure 9. Mississippi flyway migration route

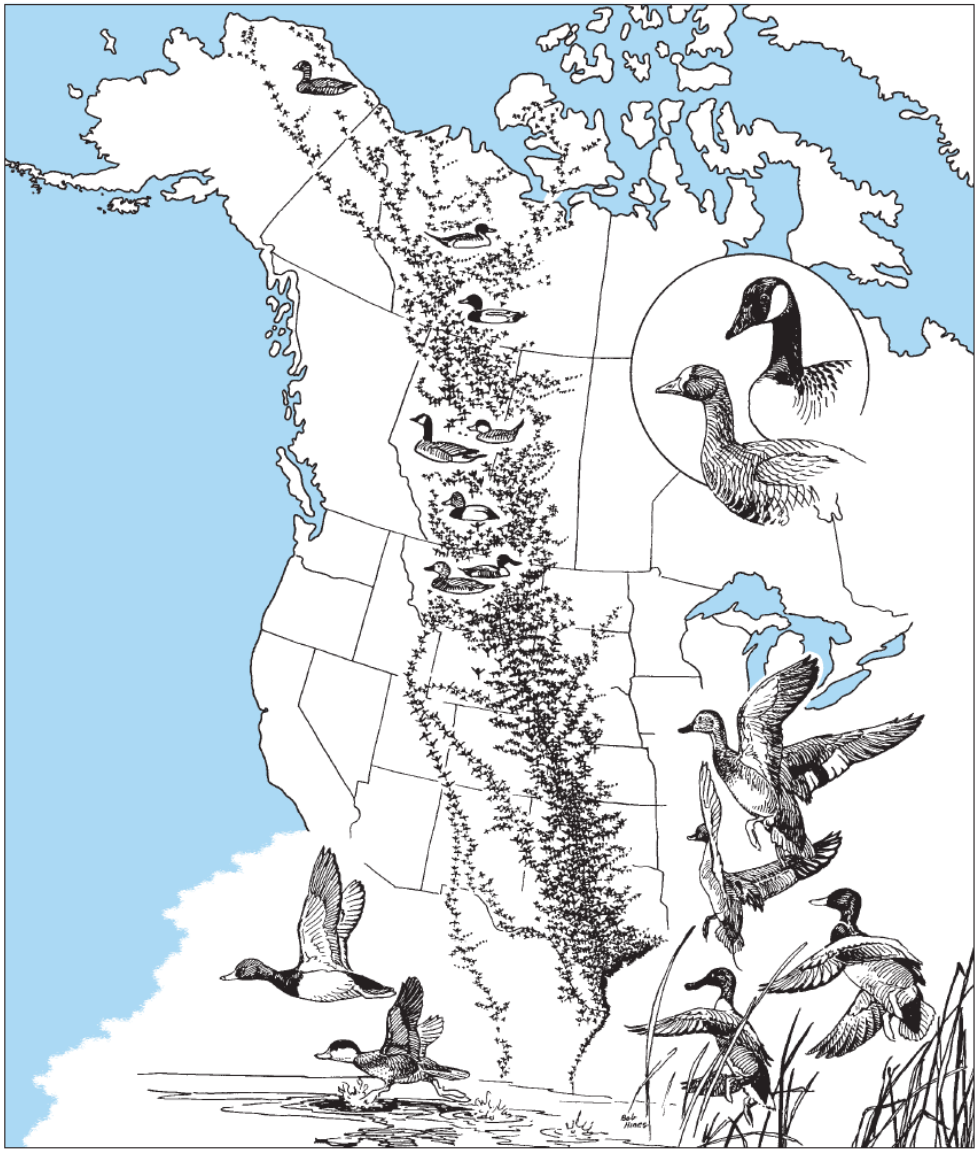

Figure 10. Central flyway migration route

2.4 History of Refuge Lands

2.4.1 Cultural and Refuge Land History

2.4.1.1 Prehistoric Human Occupation

Prior to the arrival of Europeans, the area around Lacassine NWR was inhabited by the Atakapa Indians. The Atakapa people were hunters, fishers, and gatherers whose livelihood depended on the productivity of wetland and aquatic ecosystems in southwestern Louisiana and southeastern Texas. When Spanish explorers arrived, the Atakapa people had occupied the area for at least two millenia, but they succumbed quickly to European diseases and were mostly gone by the start of the Ninteenth Century (Handbook of Texas Online 2010). It can be assumed that the Atakapans, like other prehistoric North American peoples, used fire as a tool to manage their landscape, and probably had the effect of decreasing the fire return interval on lands that they burned (Pyne 1982). However, there is no evidence that these people were agriculturists, subsisting instead by fishing, scavenging, and hunting (Aten and Bollich no date). Therefore, their effects on habitat would have been limited to favoring fire-maintained vegetation types and would probably not include large areas of soil disturbance associated with agriculture such as is seen with prehistoric North Americans in other regions.

2.4.1.2 Historical Human Occupation

Spanish exploration of the Gulf Coast began as early as 1502, and by the end of the Seventeenth Century, Spanish and French settlements had been established in what was to become Louisiana (Kniffen 1968). France ceded Louisiana to the Spanish in 1763, but regained control of the territory east of the Red River, exclusive of the Florida Parishes, in 1803, prior to its sale to the United States later that year. However, the southwestern portion of what is now Louisiana was claimed by France and Spain, and remained a “no man’s land” known as the “Neutral Ground” until 1821, when it became part of the United States (Handbook of Texas Online 2010). European colonization of southwestern Louisiana began in earnest after the Acadians were expelled from British Canada, and began to settle in the area in 1765. The Acadians, or “Cajuns,” as they became known, were farmers, herders, fishers, and hunters, and began transforming the landscape to further those pursuits (Hebert 2003). Immigrants of many origins, including Native Americans from other regions of the continent, African-American, African-Caribbean, English, German, Irish, and Spanish settlers joined the Acadians in southwestern Louisiana and contributed to the unique culture found there today (Owens 1997). Conversion to an agricultural landscape began during this period, causing fragmentation and eventual loss of prairie habitats, increased sediment inputs into streams, and changes in hydrology related to irrigation structures and drainage ditches. Today, most of the prairie is gone, replaced by rice, row crops, and pasture. Waterways have been dredged, straightened, bypassed, and channelized in order to improve navigation, drainage, irrigation, and water supply. Commercial harvest of fish and shellfish has transformed the ecology of the near-shore ocean, and coastal wetlands are being lost at unprecedented rates, despite their critical importance to both terrestrial and marine environments.

2.4.1.3 Recent History

- Although the exact date of the construction of the Bell City ditch is not known the following information documents the first significant hydrologic modifications in the area: Jim Gardner used the Bell City Ditch to bring a houseboat down to Jim's Ridge (area located on the western side of Lacassine Pool) in the mid-1920's. Speculation has it that Capt. Lowry dug the ditch at the turn of the century after purchasing the land from Jim Gardner during the Depression of the 1930s (Thielen, *pers. comm.*).
- 1934--the Gulf Intracoastal Waterway was completed, creating a dredged waterway through what was to become the refuge.
- 1937--Lacassine NWR was created when primary jurisdiction over 22,992 acres of wetlands was transferred from the Resettlement Administration to USFWS. Subsequently 8,981 acres were purchased fee title, , 653 acres were included by lease agreement with the Cameron Parish School Board, and 334 acres were transferred from Farmers Home Administration..
- 1939—construction of the pool begins, dredging gives the pool a minimum depth of 4 1/2'and a maximum of 7'
- 1940-water levels controlled by rain, levee system keeps it under 4'
- 1941-planted 8 bushels of sago pondweed, *Potamogeton pectinatus*, 8 bushels of southern waternymph, *Najas guadalupensis*
- 1942-vegetative cover becomes too dense; plan initiated to open the pool, lots of duck food
- 1943-area of pool opened up with mudboat, high water levels used in attempt to eliminate water hyacinth, duck food spread throughout the pond due to high water
- 1943- planted watershield, *Brasenia schreberi* planted (60 bushels), squarestem spikerush, *Eleocharis quadrangulata* ,wild rice, (*Zizania aquatica*) (13 bushels), delta duck potato, *Sagittaria pygmaea* (15 bushels), banana water lily, *Nymphaea mexicana* (6 bushels), Watershield, *Brasenia schreberi* (10 bushels), rice tailings (10 bushels)
- 1944-25 acres of open water created by underwater weedcutter, ducks eat out surface vegetation, *Sagittaria* and *Brasenia* has regeneration, no evidence of *Panicum*
- 1945-planted sago pondweed, *Potamogeton pectinatus* (700 pounds), *Panicum* becoming evident, *Brasenia* spreading over the pool
- 1946-Pool is moving away from rank emergent towards floating and submerged aquatics, sawgrass is dominant in the eastern, southern and western sections while maidencane is dominant in the central and northern sections, invasion of *Brasenia*, jointed spikerush, *Bacopa rotundifolia*, yellow and white water lily, *Scirpus californicus*, duck weeds, squarestem spikerush and golden club can be seen throughout the pool
- 1947-impossible to operate outboard due to floating and submerged vegetation, 70 acres treated with 2,4-D and #2 diesel oil (3 gallons per acre) with 100% kill, also reduced water hyacinth, sawgrass dominance is disappearing, maidencane survives in deeper water by growing on mats, an increase in *Sagittaria falcata*, white water lily, *Utricularia*

and foursquare spikerush growing rapidly, cattails, southern bulrush and *Zizaniopsis* are stationary, and there is an increase in waterhyssop, bull tongue and jointed spikerushes

- 1948-*Brasenia* is dominant in the pool even coming into areas opened up by sawgrass and maidencane die-off, white water lily and foursquare are also dominant species, bull tongue and jointed spikerush on the rise
- 1949-hand removal of water hyacinth on the west side of the pool; 100 acres of American lotus sprayed with 2,4-D, 85% kill; 6 acres of primrose treated with 2,4-D amine salt solution, 100% kill also sprayed 116 acres of water hyacinth with no effect; 2,4-D ester at a rate of 6.88 #D acids/acre mixed with diesel oil (2 parts oil to 1 part 2,4-D), 2 applications 1 by plane and 1 by marsh buggy with a 25% kill rate
- 1950-water hyacinth on north side of pool cleaned by hand, south side by boat using 2,4-D ester 10-12 pd acid equivalent with diesel oil 1:9; 2 applications for lotus, it was treated with 2,4-D ester 2-4 lbs/acre by plane, 90% kill, high water kills bull tongue and jointed spikerush grows in its place, maidencane growth is retarded since floating mats are inundated with water, *Brasenia* is so thick birds walk across it without getting their feet wet, frogbit has been found in the pool, while *Brasenia* is dominant, foursquare, white water lily and jointed spikerush are abundant
- 1951—Catfish Locks (a series of weirs) were completed at the southwest end of Grand Lake across a portion of the original channel of the Mermentau River.
- 1951—Covered entire pool by plane using 2,4-D ester also used backspray pumps for hard to get to areas sprayed for lotus, primrose, and water hyacinth,*Brasenia*, foursquare, white water lily and jointed spikerush continue to be dominant species, bull tongue is reemerging and frogbit (*Limnobium spongia*) coming on strong in areas, wild millet starting to appear
- 1952-*Brasenia*, foursquare, white water lily, jointed spikerush and frogbit are dominant, bull tongue is gone, and maidencane retarded by high water
- 1953-Watershield, foursquare, white water lily, jointed spikerus continue to be dominant species, Floaton (masses of floating vegetation which detach from the bottom and float on top of the marsh) continues to form as peat breaks loose from mineral soil bottom creating vast mats throughout the pool.
- 1954-waterways kept open with marshland ditchers. Maidencane reappearing, bull tongue abundant, white water lily abundant. Sprayed for alligator weed (8pd/acre) with 2,4-D by hand with 20% kill, water hyacinths were sprayed on 320 acres on the north boundary by airboat and by hand with 2,4-D (1:40 w/water), maidencane
- 1955- A newly identified species *Heteranthera reniformis*, kidneyleaf mudplantain was found, watershield, foursquare, white water lily, and jointed spikerush are dominant. American lotus, water celery, and dwarf spikerush becoming abundant. The north, east, and west sections were hand sprayed and air sprayed twice for water hyacinth using 2,4-D
- 1956-mudboats used to keep waterways open. An experimental treatment od HC-1281 (9-12 pd/acre) was tried for alligatorweed with a 10-60% kill (not effective), hand removal

of water hyacinth and alligator weed with 2,4-D was 60% effective and by plane in the north levee area was 100% effective for water lotus

- 1957-watershield, pondweed, bladderwort and water celery are abundant. sawgrass burn opening waterways, Hurricane Audrey created vast areas of open water. Water hyacinth blown in by hurricane cleaned out by airboat and wading, remaining was sprayed using 2,4-D with 75% kill in the north area of the pool and 80% kill in the south area of the pool with aerial spraying
- 1958-Bull tongue killed off due to low water but watershield continues to be abundant, What was thought to be kidneyleaf mudplatain was found out to be *Ottelia alismoides*, duck lettuce and is abundant, submergent vegetation on the rise, water hyacinth was treated on several occasions, water lotus was treated twice with 2,4-D, 75-80% kill by aerial spraying, a land follow-up treatment produced 90% kill
- 1959-Water levels high growth in check, sawgrass flourishing submergents on the rise. Primrose and lotus were treated aerially with 10% 2,4-D producing 95% kill, an additional two treatments produced another 50% kill and water hyacinths were sprayed by hand
- 1960- watershield die off due to drought, emergents fairing well, south pool water hyacinth treated with 2,4-D, lotus treated with 2,4-D aerially
- 1961- Maidencane dominates the pool while pondweeds and spikerushes are abundant, water hyacinth treated by hand, boat and plane on several occasions, 400 acres of lotus was sprayed aerially. Bull tongue was sprayed with 2,4-D as an experiment and ended up with 100% kill rate, water lilies and other aquatics took their place
- 1962- hard freeze in Jan by April aquatics dominated the pool, floaton died back, emergents doing well, hand spraying of water hyacinths with 2,4-D on several occasions, Lotus was sprayed with 2,4-D and diesel on 4 occasions, 90% kill rate, bull tongue treated with same mixture resulting in 95% kill rate
- 1963- Drought until June watershield and spikerushes came on after that point in time, water levels too low to permit adequate inspection and treatment of vegetation
- 1964-watershield covers most of pool, maidencane dominates
- 1965-watershield dominant, chinquapin lily and white water lily present, bladderwort, coontail, fanwort, water milfoil and muskgrass coming on strong, water hyacinth sprayed on north end of pool with 2,4-D ester and water mixture, 90% kill
- 1966-vegetation dominance as in 1965 with submergents taking over, 2 applications of 2,4-D ester on water hyacinth with 2,4-D ester, 90% kill rate
- 1967-water lotus abundant in the west side of the pond, other vegetation patterns follow 1965 & 1966, water hyacinth treatment by hand with 2,4-D ester, 80% kill rate, alligator weed treated by hand south end of pool with a 70% kill rate
- 1968-Spadderdock scattered throughout the pool, remnant stands of sawgrass and bull whip can be found, watershield, white water lily dominant in pool, maidencane present as is wild celery. South edge of pool treated for water hyacinth with 2,4-D ester on 4 acres with 80% kill rate

- 1969-watershield and white water lily continue to dominate, other vegetation same as in 1967 & 1968. 3 applications of 2,4-D ester were used on water hyacinths from power and aerial spraying
- 1970-low water levels cause die off of submergents, little sawgrass and bull whip still found in the pool
- 1971-Influx of water hyacinth from Hurricane Edith's winds, vegetation growth outburst open water reduced by 10%, bull tongue and maidencane becoming impenetrable . aerial application of 2,4-D ester for water hyacinth
- 1972-Bladderwort, coontail, fanwort, water lotus and floaton on the rise, water hyacinth clogging trails making navigation impossible, open areas closing fast. 115 acres received two treatments of 2,4-D ester for water hyacinth by airboat, not all areas were treated due to dense vegetation
- 1974-maintaining high water level to assist in undesirable vegetation control, organic matter building up at an alarming rate in the pool, due to airboat failure unable to treat for 73-74 seasons
- 1975-hand treated 200 acres of water hyacinth with 2,4-D
- 1976- *Bidens laevis*, smooth beggartick growing in north section of the pool. A suggestions has been made to drain, dry out and burn accumulated organic matter in the pool
- 1977-water levels high throughout the year causing organic matter buildup in deeper surface thus causing more floaton from bottom to surface
- 1978-burned off maidencane to open up areas, desired results of open water never came to pass after burn
- 1979-marsh buggies leaving tracks that are remaining visible for years; they seem to be encouraging floaton tmarsh; water hyacinth and alligator weed appear to be eradicated from the pool due to high water and treatments of 2,4-D ester
- 1980-dike work in progress, rebuilding, clearing and surveying, hard stem weeds, especially lizards tail (*Saururus cernuus*) and Chinese tallow invading habitat rapidly
- 1981-bull tongue and maidencane dominant in pool
- 1982-rebuilding levees
- 1983-higher water levels established due to levee renovations, water hyacinth sprayed in boat canals by airboat with 2,4-D on 3 occasions, Chinese tallowtrees continue to proliferate
- 1984-planted 500 cypress trees, December freeze kept water hyacinth in check, minimal spraying done to keep boat trails open, smooth beggartick continues to proliferate and spread, floaton so dense airboats are limited in operations, primrose and alligator weed becoming a huge problem
- 1985-two areas equaling 300 acres leveed and water leveled and converted into moist soil unit A. A gate pipe was installed in Unit E, the school board section; Attempted removal of tallowtrees on schoolboard section prior to flooding, method was mechanical up to 12' tall. Taller trees and willows were treated with Weedone 170. An experimental attempt

was made to open holes in dense watershield stands chemically. Eight ½-acre plots of marsh were chosen and sprayed with 2,4-D and molasses: attempts failed

- 1986-planted 100 cypress trees, continued brush removal on levees with Weedone, smooth beggartick and Chinese tallow continuing to spread throughout pool area
- 1987-planted unspecified amount of cutgrass. School board section burned for tallowtree control. Heavy organic matter is noted in the pool for the first time. A suggestion is made to levee off approximately 800 acres to be drained and burned as an experiment to control organic matter. Burned School Board section for tallowtree control.
- 1988-directed to sub-impound pool and moist soil units with emphasis on moist soil crops for waterfowl. Due to the drought of 1986 the pool levels are critically low and organic matter is dominant. It is suggested to drain the entire pool (16,000 acres) and burn the organic matter, Arsenal used on levees to control brush
- 1989-the 800 acres chosen for the experimental burn plan is named Unit D. Pipes were installed in the north levee to drain the unit
- 1990-a draft environmental assessment was prepared to subdivide the pool into six subunits by constructing 12 miles of levees. The subunits would range from 700 – 3000 acres in size for independent draining. Dewatering of unit D began in March. After dewatering 10-30 inches of water the remaining organic sediments held water. The organic matter never dried enough to burn. Vegetative and soil samples were taken for analysis. An experimental fire was conducted and results appeared satisfactory. A prescribed burn was not set due to lack of construction of a fire line. As the fireline was being created a decision was made in Nov to re-flood for waterfowl.
- 1990 – Weather was extremely wet early in the year, followed by a record dry spell after May.
- 1990 – Dewatering of Unit D began.
- 1991 – Moist soil unit developed in Unit E-1.
- 1991 – Levee completed for the south end of Unit E-1.
- 1991 – Unit D research continues.
- 1992 – Hurricane Andrew.
- 1992 – Approximately 1 foot of wooden boards added to three pool water control structures.
- 1992- 16,000-acre northern boundary expansion was approved
- 1993 – FmHA Conservation Easement (Vidrine Tract) is transferred in fee title to refuge. Plans are initiated to restore native coastal prairie.
- 1994 – 3 D seismic survey conducted in pool.
- 1994 – Approximately 110 acres were plowed and seeded to prairie grasses at the Vidrine site.
- 1995 – Old gas wells in the Streeter's Canal area were reworked and put back into production.
- 1996 - The Cassidy-Fontenot land acquisition was finalized in 1996. An estimated 1,916 additional acres were added to the refuge.

- 1996 - Flores and Rucks, Inc. conducted 3-D seismic survey work on the refuge from August until October.
- 1997 – An additional 224 acres were plowed and then seeded to prairie grasses in 1998 at our Vidrine [=Duralde Prairie] site.
- 1998 – The weather during September was hot and very wet as hurricanes Earl, Francis, and Georges entered the Gulf. Total September precipitation was 16.88 inches.
- 1999 – Drought conditions occurred with pool levels dropping almost two feet.
- 2000 – Drought conditions continued with pool levels dropping almost an additional two feet. Rice farming was halted due to high salinity levels.
- 2001 – Tropical Storm Allison dropped 11.18 inches of rain in early June.
- 2002 – Hurricane Lily brought heavy rains and caused flooding to many refuge roads.
- 2003 – Pool study conducted to measure and map organic layer depths.
- 2004 – Replaced all old concrete and wooden logs at all three water control structures with logs of special treated fiberglass material.
- 2005 – Hurricane Rita hit the refuge on September 24 bringing heavy rain. Salinities increased to 3-6 ppt and remained high through December. Mortality occurred on Chinese tallowtrees (un-impounded marshes) and maidencane, especially in the southern portions of the refuge. These areas changed to mainly cattail and open water. Habitats previously dominated by maidencane were seeing maidencane returning by 2011.
- 2006 – Tree planting occurred at old pool oil and gas sites at the pool to enhance habitat, especially for nesting wading birds.
- 2007 – Survival was poor for the trees planted in 2006.
- 2008 – Hurricanes Gustav and Ike hit the refuge during September. Salinities increased to 10 ppt and decreased slowly during the fall. More mortality of maidencane and Chinese tallow occurred. No fish kills were observed.
- 2009 – Tennessee Valley Authority completed the cross terrace levee construction, pool perimeter ditch cleaning, pump installations, water control structures, and dressing of old levees during June.
- 2010 – During December, approximately 300 water oak, Nuttall oak, and Shumard oak trees were planted north of the Unit B fishing pier between Streeter's Road and the Mermentau River, and bulrush was planted on both sides of the western pool cross levee during June. The refuge experienced extreme dry conditions during the year and water levels dropped about two feet below full pool.
- 2011 – Louisiana Dept. of Wildlife and Fisheries continued to fight the spread of giant salvinia on refuge waters, and refuge staff controlled salt cedar and tallowtrees on pool levees. The refuge experienced extreme drought conditions for the second consecutive year with pool water levels three feet below full pool. Access was limited to the perimeter canals in the G1 Unit. The Complex firecrew conducted a winter prescribed burn in January on the 3500 acre G3 Pool Unit and completed a 5000 acre summer burn of the G1 Pool Unit in July.

2.4.2 Prehistoric Habitat Conditions

Before southwestern Louisiana was colonized by European settlers, the land currently occupied by LNWR was probably fresh marsh bounded by brackish marsh and cheniers to the south, and coastal prairie to the north. Hydrology was primarily driven by freshwater flow from the Mermentau River and smaller streams. Tidal influence was presumably much lower than it is today, since only natural, sinuous channels connected what is now the refuge to the Gulf of Mexico (i.e. there were no dredged channels facilitating saltwater intrusion). Fire return intervals, probably influenced by Native American inhabitants, were short enough to maintain most of the area in prairie and open marsh.

2.4.3 Current Habitat Conditions

Current habitat conditions are much modified from the prehistoric situation. Hydrologic modifications, firebreaks, and vegetation conversion have created a managed landscape on LNWR. Outside the refuge, and across southwest Louisiana, habitat conditions are even more modified, with most of the coastal prairie converted to agriculture and increasingly, urban environments, and much of the coastal marshes compromised by saltwater intrusion through artificial channels. Lacassine NWR, like the other two mainland refuges in the complex, Sabine and Cameron Prairie, is thus more of a habitat island in a highly altered landscape. Its importance to wildlife increases as habitats outside the refuge are lost, and crucially, the refuge must provide more different kinds of habitat, and provide them more dependably than before, because wildlife have fewer options for habitat selection. This means in practice that increasing intensity of management is required to maintain the wildlife values for which the refuge was created. Responding and adapting to natural disturbances like storms and fires must be done thoughtfully, with this level of increased responsibility in mind. For example, after Hurricane Rita deposited salt water over much of the refuge, freshwater marsh habitats were instantly if temporarily transformed by the loss of salt-intolerant species. If freshwater environments were still available inland from the refuge, managers would have had the luxury of depending on those while natural processes played out on the refuge. However, because those environments are highly altered, significant management inputs were required to restore the freshwater environment in Lacassine Pool as quickly as possible. Current conditions in each of the major habitat types are described below. Acreages of each type are given in Table 1.

2.4.3.1 Impounded Freshwater Marsh

The Lacassine Pool (Units D, G1-3) was created in 1943 by enclosing a 16,882-acre marsh with a low levee. Water levels in Lacassine Pool are controlled by three stoplog water control structures on the outside protection levee that allow water to flow in or out of the pool. The maximum depth of water that can be held is 4.50 feet above mean sea level (NAVD 88). Four other water control structures and two pumps allow dividing the pool into three separate areas and pumping water from one area to the other. Water depth at the maximum level ranges from root collars barely below the water level to 4-5 feet deep in the larger ditches and some open

water areas. The outside ditches and interior levees channel water to the water control structures. Current dominant plant species include maidencane, cattail, bulltongue, spikerush, and water lily.

Since water has been kept at a relatively constant level within the Lacassine Pool for over a 60-year period, dead plant material has accumulated within it, and the organic layer has not been allowed to compact and naturally oxidize. Grasses have thrived, open water areas have shrunk, and woody vegetation has become established within Lacassine Pool's interior. If this succession of the unit continues without management intervention, the entire area will fill in and be taken over by undesirable plants, and open water areas will be lost. The utilization of the area by migratory birds will consequently continue to diminish. In addition, the excellent recreational fisheries resource currently enjoyed by refuge visitors will be lost. Visitors to the refuge have expressed their concerns on the future access and management within this area. Refuge records note similar concern for the health of Lacassine Pool as far back as the 1953 Annual Narrative.

In 1993, the refuge staff attempted to correct the problem within Lacassine Pool by raising the water level by approximately 1 to 1.5 feet. The hypothesis was that higher water would drown the unwanted vegetation. However, even after this management action occurred, vegetation continued to quickly overgrow Lacassine Pool and clog the boat passageways. After more than a 10-year period, the loss of open-water areas has continued and it now appears that the higher water level may have aggravated the problem by increasing the number of pop-ups. Pop-ups are floating mats of organic debris that dislodge from pond bottoms, rise to the water surface, and become colonized by emergent vegetation. The elevated water level also placed excessive pressure on the dikes designed to hold water at a lower elevation.

David Fruge (1974) provided insight into why Lacassine Pool's design has everything to do with this problem. He reported that the three small, elevated spillways allow a negligible amount of the tremendous annual crop of plant matter to escape from the impoundment. The resultant accumulation of this detritus therefore would cause aggradations of the substrate with consequent lowering of water levels, and continuing emergence of pop-ups or "floaton", with resultant colonization by emergent species and consequent elimination of open-water areas and the associated floating-leaved submerged aquatic plant community.

Robert Chabreck (1997) experimented with dewatering and prescribed fire within a small subsection of Lacassine Pool. In 1987, a 700-acre area of Unit G was partitioned to form Unit D. Within this new unit, dewatering occurred during a period from 1990 through 1992, and portions of the area were prescribe-burned during 1990, 1991, and 1993; up to 1 foot of the substrate was dried by late summer 1990. From 1990 to 1997, a 64 percent decrease in the thickness of the organic layer was recorded. The vegetative characteristics of Unit D also changed during this period. Prior to the study, maidencane (*Panicum hemitomon*) occurred in 90 percent of the sample plots, bulltongue (*Sagittaria lancifolia*) in 70 percent of the plots, and the aquatic plant coontail (*Ceratophyllum demersum*) was in 20 percent of the plots. By 1997, maidencane was present in only 70 percent of the plots, bulltongue was completely absent, and coontail was in 80 percent of the plots. The 1994 mean elevation for the organic level in Unit G (pool) was 11 cm

greater than in Unit D. Currently, open water continues to cover 70 percent of Unit D, while covering 40 percent of Lacassine Pool.

The participants in a public meeting held in Lake Charles on May 18, 2006 demonstrated strong support for subdividing Lacassine Pool into more manageable components. The Service completed this project in 2009. Details of the project are described in the Mitigation Plan, which is attached as Appendix F.

2.4.3.2 Unimpounded Freshwater Marsh

The major hydrologic channels include Lacassine Bayou, Bayou Misere, Intracoastal Waterway, and the Bell City Ditch. Dominant plant species vary considerably throughout these marshes, mainly due to the depth to mineral soil which is considerably less on the southern portions. Dominant plant species are maidencane, primrose species, cattail, baccharis, and some open ponds and ponds with water lily, etc.

2.4.3.3 Forested Wetlands

Dominant species include black willow, Chinese tallow, baldcypress, sugarberry, and minor brush species. Patches of this habitat range in size from 0.5 to 200-300 acres. Most of the forested wetlands on Lacassine NWR are found along the Mermentau River and Bayou Lacassine, in the eastern portions of Units J, F2, and E2.

2.4.3.4 Shrub Wetlands

Dominant species include buttonbush, baccharis, and minor amounts of other species. Patches range in size from 2-3 to 400-500 acres. Shrub wetland is an ephemeral vegetation type which appears in marsh units which have gone 3+ years since burning. Therefore, no attempt has been made to map the shrub wetlands on the refuge.

2.4.3.5 Open Water

Open water areas in the unimpounded marshes range in size from a few acres to 100-200 acres and in depth from a few inches to 2-3 feet. Salinities currently range from 0.1 to around 2 ppt, however these waters before the hurricanes of 2005 and 2008 were seldom above 0.5 ppt. Amounts of phosphorous, nitrogen etc., range considerably depending on upstream farming practices, but have rarely been high enough to cause fish kills. Levels for pH range roughly from 6-8.

2.4.3.6 Moist Soil Units

Currently there are 600 acres in 3 units where the vegetation is manipulated to encourage annual plant production. Common plants include millets, smartweeds, duck potatoes, and flat sedges.

2.4.3.7 Coastal Prairie

This habitat is found in the Duralde Prairie management unit in Evangeline Parish. Area currently is 334 acres of restored prairie. Dominant species include little bluestem, switchgrass, and eastern gamagrass. Exotic weedy species such as Chinese tallowtree and privet are a minor component of the prairie.

2.4.3.8 Croplands

The 1,041 acres of farmland are managed for rice on a two year rotation. Fallow fields are plowed in the fall to control succession and to prepare the fields for next year's rice, or they are planted to millet and reflooded in the fall and early winter.

2.4.4 Habitat Changes from Historic to Current Conditions

2.4.4.1 Hydrology

The Gulf Intracoastal Waterway was completed in 1934, and the Bell City drainage ditch was completed around the same time. Both of these changed the natural hydrology and have created additional hydrologic connections between Grand and Misere lakes and marshes to the north. These connections allow storm surges from hurricanes to travel further north.

In 1951, the Catfish Locks (a series of weirs) were completed at the southwest end of Grand Lake (Figure 1) across a portion of the original channel of the Mermentau River. These weirs, operated by the US Army Corps of Engineers (USACE) initiated the conversion of all marshes (outside the Lacassine Pool) from brackish to freshwater. Flora and fauna changed significantly as a result. With the change in salinity and loss of hydrological connection to the Gulf of Mexico, the refuge marshes no longer ebbed and flowed as before. This structure, constructed to provide reliable fresh water to benefit agriculture (primarily rice production), resulted in much more stable water levels in unimpounded marshes within and outside the refuge. Therefore, the "unimpounded freshwater marsh," described herein but not within control of the refuge, is subject to USACE water level management practices.

The USACE-installed locks and gates in the Mermentau River basin have increased salinity levels and accelerated land loss in and adjacent to the refuge. Inundated ephemeral marshes, originally prone to flooding and drying events, now remain saturated for extended periods. Soil types present (mucks and mucky clays) cannot withstand the perpetual wave-, wind-, and human-generated splashing, particularly those coming from large boats. There is evidence, refuge-wide, of the impacts of this traffic (vertical, sloughing, unstable banks; uprooted trees and vegetation; and aerial photography depicting land loss through time).

The constant inundation of the unimpounded freshwater marsh, accelerated natural- and human-caused erosion sources, and additional canals through the marsh have created additional hydrological connections between Lacassine Bayou and the Mermentau River.

Hurricanes in 2005 and 2008 caused habitat changes in the southern end of the pool, the south end of Unit E2 and Units H, I and J from predominantly maidencane to 50-75% open water and cattail.

Unimpounded freshwater marsh has been the habitat type most impacted by petroleum exploration and transportation on the refuge. The majority of the 82 wells drilled on the refuge are in the ephemeral marshes east of the Lacassine Bayou (particularly Unit F1). To facilitate these oil and gas activities, numerous canals, and adjacent spoil banks, were created, which converted portions of the marsh to open water (channel) and uplands (spoil banks). The open water has facilitated access into portions of the marsh that previously required a mudboat or airboat; it also benefits some waterfowl species.

2.4.4.2 Invasive Species

Invasive species pose serious threats to biodiversity and management of natural areas all over the world. Several exotic invasive species have reached levels on LNWR such that they pose a management problem and/or a threat to the native systems which allow the refuge to fulfill its purpose.

2.4.4.2.1 Chinese Tallowtree (*Triadica sebifera*)

Chinese tallowtree is a highly invasive woody species originally introduced from Asia as an oilseed crop in the late 18th Century. It is not only able to colonize disturbed areas quickly, but also can invade wet prairies and bottomland forest systems in the absence of disturbance (Stein and Flack 1996). On LNWR, tallowtrees have begun to form monospecific stands on upland areas including spoil banks, levees, and road rights-of-way. This species is also present in large numbers on the Duralde Prairie unit. Undesirable habitat effects of tallowtrees on LNWR include loss of open aspect preferred by waterfowl and grassland birds, displacement of native vegetation of greater value to wildlife for food and cover, and disruption of fire in native grasslands.

2.4.4.2.2 Water Hyacinth (*Eichhornia crassipes*)

Water hyacinth, native to tropical areas of South America, was introduced as an ornamental in 1884 in New Orleans (Center for Invasive Species and Ecosystem Health 2010). It produces floating mats of vegetation that quickly shade out rooted aquatic plants and causes low light and low dissolved oxygen levels in the water column (Center for Invasive Species and Ecosystem Health 2010). It can cover open freshwater very quickly and cause catastrophic changes to aquatic ecosystems in the Gulf Coast region. This plant forms extensive mats which are nearly impenetrable to boat traffic. Water hyacinth produces very little in the way of wildlife habitat value, and crowds out other, more beneficial plants (Fassett 1960).

2.4.4.2.3 Giant Salvinia (*Salvinia molesta*)

Giant salvinia is a free-floating fern with rootless stems which was introduced from Brazil and escaped cultivation (Wunderlin and Hansen 2003). Able to reproduce year-round, it spreads

very rapidly. Giant salvinia has the capacity to clog waterways and displace native vegetation with higher value for wildlife.

2.4.4.3 Climate Change

The Southeastern United States may be one of the most vulnerable regions in the United States to climate change (Smith, 2004; Karl et al., 2009). It faces risks from climate change because it has a long and low-lying coastline (41% of the coterminous U.S. coastline (NOAA 1975) that is exposed to sea level rise and hurricanes; it is already relatively warm and thus will not, for the most part, benefit from more heat; it will be exposed to more risks of disease; and it has high biodiversity. In addition to being home to almost 60 million people, the Southeast has over 400,000 farms on almost 80 million acres (USDA 2008), over 127 million acres of timberland (USFS 2010), 33% of U.S. (coterminous) estuaries (NOAA 1990), and nearly 30% of all U.S. wetlands (Dahl 1990). For these and other reasons, the region faces many risks from climate change.

2.4.4.3.1 Temperature Increases

Since 1970, the Southeast U. S. has experienced about a 2°F rise in temperature, with the greatest seasonal increase occurring in the winter (Karl et al. 2009). Climate models project warming to occur in the Southeast, with different emissions scenarios predicting that temperatures could rise by about 4.5°F on average by the 2080s. The greatest temperature increases are projected to occur in the summer (Karl et al. 2009).

These temperature increases are having, or are projected to have, a number of effects of interest to Refuge managers:

- The number of freezing days for most of the Southeast has declined by four to seven days per year since the mid-1970s (Karl et al. 2009).
- Higher air temperatures will increase water temperatures, which will likely lead to a
- decrease in dissolved oxygen (DO) in water bodies. Hypoxic conditions (i.e., when DO reaches a minimum threshold that no longer allows aquatic species to survive) are more likely to occur.
- Higher water temperatures will likely lead to more thermal stratification in lakes and reservoirs in the Southeast resulting in less oxygen mixing.
- Higher water temperatures will likely lead to more algae growth.
- Increased temperatures result in higher pathogen replication, persistence, survival, and transmission (CDC, 2009).

2.4.4.3.2 Changes in Precipitation

Changes in amount and timing of precipitation have already been documented, and more are predicted by climate models. Average fall precipitation in the Southeast has increased by 30% since the early 1900s, and summer and winter precipitation declined by nearly 10% in the eastern part of the region (Karl et al. 2009). Averaged together, climate change models project that

Southern states will tend to have a decrease in precipitation by 2070. Increases in fall precipitation will be more than offset by decreases in precipitation over the rest of the year.

In the Southeast, there has been an increase in heavy downpours in many parts of the region (Karl et al. 2009). These heavy precipitation events may lead to an increased chance of flooding. At the same time, certain areas may experience an increased frequency of drought where precipitation has declined during the spring, summer, and winter months. Higher temperatures will also increase the likelihood of droughts (Climate Change Science Program 2008). Expected impacts include increased risk of wildfires, changes in the distribution and types of insects, and possibly some increased salinities.

Karl et al. (2009) reported that there has been an increasing trend of summer drought in the region over the period 1958-2007. Decreases in overall summer precipitation will likely cause reduced water flows, which will contribute to warmer water temperatures and further stress water quality. This is particularly important in the context of seasonal droughts. During low-flow periods, nutrients will become concentrated and flush out of systems more slowly.

2.4.4.3.3 Changes in Storm Intensity or Frequency

Increases in the number of extreme storm events (tropical and inland) will likely result in more runoff of nutrients; pathogens from human and animal waste; sediment from cropland and animal feeding operations; pesticides from combined sewer overflows and nonpoint source runoff; and toxins from industrial, commercial, and other sources. Increased nutrient loading can lead to more algae and plant growth, which results in lower DO levels. Greater runoff can also result in greater pathogen impairments (i.e. designation of a water body as impaired under the Clean Water Act due to the presence of threshold levels of indicator bacteria) (U.S. EPA 2009b).

2.4.4.3.4 Changes in Sea Level

Assuming that average sea levels rise at least 2 feet by 2100 (IPCC 2007b), the Southeast will likely see an increase in the extent of storm surge, which could easily be the most costly consequence of climate change (Karl et al. 2009). Hurricane intensity is also projected to increase, which will likely increase the size of storm surges (Knutson and Tuleya 2004).

Other impacts of sea level rise include increased risks of erosion, storm surge damage, and flooding for coastal communities, especially in the Southeast (Emanuel 2005, Karl et al. 2009). Rising sea levels will also convert wetlands to open water, exacerbate coastal flooding, and increase the salinity of estuaries and freshwater aquifers (Climate Change Science Program 2009).

2.4.4.3.5 Ecological Effects of Climate Change

Currently, climate change is not the most important driver of changes in biodiversity; however, it could be the largest driver by the end of the 21st century (Millennium Ecosystem Assessment 2005). Even so, there have already been measurable changes in global biodiversity due to climate change, particularly with regard to changes in species distributions, population sizes, timing of

reproduction or migration events, and increases in the frequency of pest and disease outbreaks (Millennium Ecosystem Assessment 2005). In the United States, climate change has already impacted terrestrial ecosystems by changing the timing of growing season length, phenology, primary production, and species distributions and diversity (Janetos et al. 2008). Interestingly, there is some evidence that non-native, and particularly non-native invasive, plant species are more phenologically plastic in the face of climate change, and therefore may become more competitive over time relative to native plants (Willis et al. 2010). However, crop plants (though mostly exotic to the southeastern US) are apparently not positioned to benefit from climate change; crop losses, particularly in the southeastern US, are projected to occur with climate change as well (NAST, 2001).

Rising sea levels will increase the vulnerability of spawning and nursery habitat through inundation of wetlands and coastal marshes and saltwater intrusion, leading to a loss of wetland-dependent coastal fish and shellfish (Karl et al. 2009). Increasing temperatures will cause certain species of fish to shift their geographical range (Janetos et al. 2008). Increasing frequency and intensity of storms may result in increased mortality of early life states, altered transport of larval fish, and altered recruitment (Connelly et al. 2007). Increased coastal erosion resulting from sea level rise leads to loss of barrier islands and wetlands (IPCC 2007a, U.S. EPA 2009a). Increased sea level, storm surge, and storm intensity will likely inundate or destroy wetland and barrier island habitat and convert marshlands to open water and forests to marshland.

Sea level rise and increased hurricane intensity will likely cause coastlines to experience periods of erosion and accretion, depending on dynamic natural and anthropogenic conditions. Coastal erosion is also affected by anthropogenic factors including activities like dredging, coastal engineering, land development, and construction of sea walls and dams. Barrier islands and wetlands, features of some coastlines, are vulnerable to changes in sea level, and may even have thresholds that, when crossed, could lead to irreparable damage (Nicholls et al. 2007).

Coastal wetlands (marshes and mangroves) provide many ecosystem services for coastal areas. For example, they reduce peak flood flows by delaying and storing floodwaters; protect water quality; maintain resilience of natural coastal defenses through alluvial plain accumulation; act as a storm surge buffer; provide nurseries for coastal fisheries; and protect freshwater from saltwater intrusion. The interactions of climate change, land subsidence, coastal development, and shore stabilization practices have contributed to the decline of coastal wetlands. Cahoon et al. (2009) conclude that climate change has caused, and will continue to cause, the loss of coastal wetlands.

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3.0 RESOURCES OF CONCERN

3.1 Identification of Refuge Resources of Concern

Priorities associated with wildlife and habitat management for NWRS are determined through directives, policies, and legal mandates. Resources of concern include species, species groups, and/or communities that support refuge purposes as well as FWS trust resources responsibilities (including threatened and endangered species and migratory birds). Resources of Concern are also native species and natural, functional communities such as those found under historic conditions that are to be maintained and, where appropriate, restored on a refuge (601 FW 3.10B[1]).

Resources of concern for LNWR were selected after taking into account the conservation needs identified within international, national, regional, or ecosystems goals/plans; state fish and wildlife conservation plans; recovery plans for threatened and endangered species; and previously approved refuge resource management plans as identified in the Comprehensive Conservation Planning Process policy (602 FW 3.4C[1][E]) as well as Section 1.3 of this HMP. The species/communities selected as resources of concern from these plans support the following NWRS mandates:

- Support refuge purposes and the NWRS mission;
- Conserve biological integrity, diversity, and environmental health
- Give special consideration to rare, declining or unique natural communities, species, and ecological processes within the refuge boundary
- Fulfill FWS trust resource responsibilities

After considering these factors, we selected two groups of animals as Resources of Concern: waterfowl and colonial waterbirds. Each of these groups of species will be discussed below, with justifications for their selection, habitat requirements, and the potential contribution that Lacassine NWR can make to those habitat requirements.

3.1.1 Waterfowl

Lacassine NWR provides habitat for wintering waterfowl and year-round resident mottled ducks. While these resources are similar in many ways, each has unique habitat requirements that are met through management actions on LNWR. Providing habitat for this group of animals fulfills the purpose for which the refuge (then called “Lacassine Migratory Waterfowl Refuge”) was created in 1937: “...as a Refuge and breeding ground for migratory birds and other wildlife...”

3.1.1.1 Wintering Waterfowl.

Coastal Louisiana is one of the most important waterfowl wintering areas in North America. Lacassine NWR is located in the Mississippi and Central flyways, and is therefore in a critical location for migrating ducks and geese in North America (Reinecke et al. 1989). The refuge

attracts tens of thousands of blue-winged teal (*Anas discors*), cinnamon teal (*Anas cyanoptera*), green-winged teal (*Anas carolinensis*), gadwall (*Anas strepera*), northern shovelers (*Anas clypeata*), ring-necked ducks (*Aythya collaris*), northern pintail, and several species of geese during the winter with mallards (*Anas platyrhynchos*) being the most numerous species. Lacassine NWR supports a resident population of wood ducks as well as providing winter habitat to migrant wood ducks which have bred further north (Dugger and Fredrickson 1991). Wood ducks nest in tree cavities throughout most of their range, and are dependent on flooded habitat with low cover (shrubs or emergent vegetation) for brood habitat. Wood duck populations are thought to be increasing or stable (NAWMP 2004), although estimates are difficult because aerial census is not possible in wooded habitat. The refuge provides nest boxes to supplement natural cavities.

Black-bellied whistling-ducks are a neotropical species which has expanded its range in the past few decades and now breed on Lacassine NWR. Like wood ducks, black-bellied whistling-ducks are primarily cavity nesters, although they have also been documented nesting on the ground (James and Thompson 2001). Although their nesting season is somewhat later than wood ducks, biologists have observed competition for artificial nesting cavities between these two species.

Several species of geese migrate southward during the fall in large flocks and spend the winter on the Louisiana-Texas Gulf coast. Species and numbers of geese vary from year to year, but include snow goose, Canada goose, greater white-fronted goose, and Ross's goose. Geese have long life spans and, like many other large water birds, they imprint along migratory corridors using stopovers repetitively year after year. Like other wintering waterfowl, geese are important not only for their ecological value but also as an economic resource harvested by waterfowl hunters each season. As habitats have diminished on private lands outside the refuge, Lacassine NWR and other coastal wildlife refuges and management areas have become more important for these birds.

Lacassine's freshwater marshes, moist soil management units, and impoundments support a diversity of plants favorable for waterfowl and provide loafing and roosting sites to many species of ducks and geese. Management actions envisioned by this plan would support and improve the freshwater marshes, moist soil management units, and impoundments on LNWR.

Because of historic and ongoing habitat losses due to agricultural development, oil and gas exploration and extraction, and climate change, suitable habitat for wintering waterfowl has decreased over the past two centuries, leading to a decrease in waterfowl populations in North America (Batt et al. 1992). When large, unbroken expanses of wetlands and coastal prairies were available for use by waterfowl, the entire system was more resilient in the face of natural disturbances such as fire, drought, and tropical storms. In the current, anthropogenically modified landscape, habitat loss, habitat fragmentation, the introduction of exotic plant and animal species, and disruption of natural hydrological and pyric processes mean that remaining habitat, in order to function in the larger context of the continent-wide ecosystem, must be actively managed. Small fragments of habitat are less resilient to disturbances, and without

management of vegetation, hydrology, fire, and animal populations, will change over time so that they no longer serve as high quality habitat for waterfowl or other desirable species.

3.1.1.2 Mottled Ducks

The Mottled Duck (*Anas fulvigula)* is a year-round resident in coastal marshes along the western Gulf Coast (Texas and Louisiana; *ssp. maculosa)* and in the wetlands of Florida *(ssp. fulvigula)* (Rorabaugh and Zwank, 1983). A report by The Gulf Coast Joint Venture (a partnership between state and local wildlife agencies and nonprofit organizations) showed a dramatic and consistent downward trend in the western mottled duck (*A. f. maculosa*) population between 1966 and 2002. However, only in nearby Texas has the population declined; in Louisiana populations appear stable. Evidence supports low recruitment as the most likely source of the population decline (Wilson 2007).Wetland habitat drainage, declining rice farming, lead exposure, and increasing predator populations have also contributed to population declines (Wilson 2007).

Flooded rice fields appear to be important loafing and feeding habitat for mottled ducks in agricultural lands, especially during drought periods when other wetland types are not available or where natural wetlands have been eliminated (Durham and Afton 2006). Mottled ducks depend on tall, dense, undisturbed stands of grass for nesting (Rorabaugh and Zwank 1983). LNWR has the ability to provide important habitat for breeding mottled ducks and can contribute to the sustainability of the species.

3.1.2 Colonial Waterbirds

Lacassine NWR provides habitat for colonial waterbirds throughout the year. Twelve species of colonial wading birds are documented to breed on the refuge (USFWS 2007, Table 4). Kushlan et al. (2002) ranked North American waterbirds in terms of "Category of Concern", which they define as a measure of the risk of serious population loss. Providing habitat for these birds is a priority for the refuge.

Table 4. Colonial waterbird species known from Lacassine NWR.

COMMON NAME	SCIENTIFIC NAME	WINTER	SUMMER	BREEDS ON REFUGE	CONSERVATION STATUS*
Great Blue Heron	*Ardea herodias*	x	x	x	Not currently at risk
Great Egret	*Ardea alba*	x	x	x	Not currently at risk
Snowy Egret	*Egretta thula*	x	x	x	High risk
Little Blue Heron	*Egretta caerulea*	x	x	x	High risk

COMMON NAME	SCIENTIFIC NAME	WINTER	SUMMER	BREEDS ON REFUGE	CONSERVATION STATUS*
Tricolored Heron	*Egretta tricolor*	x	x	x	High risk
Cattle Egret	*Bubulcus ibis*	x	x	x	Not currently at risk
Black-crowned Night-Heron	*Nycticorax nycticorax*	x	x	x	Moderate risk
Yellow-crowned Night-Heron	*Nyctanassa violacea*	x	x	x	Moderate risk
Green Heron	*Butorides virescens*	x	x	x	Low risk
Roseate Spoonbill	*Plantalea ajaja*	x	x	x	Moderate risk
White Ibis	*Eudocimus albus*	x	x	x	Moderate risk
White-faced Ibis	*Plegadis chihi*	x	x	x	Low risk

*Kushlan et al. 2002

Approximately 15 rookery areas exist on LNWR, with 7-8 active each year (USFWS 2007). These rookeries are in areas of shrubs and trees growing on artificial upland habitats such as levees, oil and gas well sites, and road banks. Total acreage of these areas ranges from 100 to 300 acres in any given year. The refuge manages rookeries by controlling access to reduce human disturbance during the breeding season. Vegetation management in these areas is restricted to selective removal of exotic invasive plants including Chinese tallow. The refuge also provides abundant foraging habitat for wading birds throughout the year on impounded and unimpounded marsh areas and moist soil management units, as described in Table 1.

3.2 Habitat Requirements of Resources of Concern

3.2.1 Waterfowl

3.2.1.1 Wintering Waterfowl

North American waterfowl have seasonally dynamic life-cycle needs that are fulfilled by use of a diversity of habitats and foods throughout their annual range, which, for most species, is continental in scale. Habitat (both its quantity and quality) is the primary nexus for ecological strategies for managing waterfowl (and all wildlife) and a critical determinant of their survival and productivity. Sustaining viable and harvestable populations of waterfowl depends on conservation and management of habitats throughout the flyways of North America. During

winter, dabbling ducks need a diversity of wetland habitats including flooded cropland, natural wetlands, and refuge (i.e., sanctuary) (Reinecke et al. 1989).

Waterfowl managers have long known that flooded cropland provides high energy food for wintering waterfowl (Ringelman 1990). Crops such as rice, grain sorghum, maize, and millets are used to supplement duck winter forage and support large populations on relatively small managed areas (Reinecke et al. 1989). On the Gulf Coast, rice is the preferred grain for this purpose, both because it is adapted to the wet conditions and heavy soils and also because the grain is more resistant to decay under flooded conditions (Ringelman 1990).

In a very broad sense, optimum wintering waterfowl habitat is identified as approximately 50% vegetation and 50% water, dispersed in a mosaic pattern with the largest edge effect possible. Natural wetland habitats that ducks have used historically in Southwest Louisiana are marshes and moist soil habitats. These natural wetlands are critical foraging and resting habitats. Both marshes and moist soil habitats are rich in high-energy natural seeds (e.g., grass-sedge seeds, roots, tubers, etc.) and aquatic invertebrates (Kaminski et al. 2003, Heitmeyer 1988, 2006). Wintering waterfowl satisfied their nutritional and other physiological needs in these wetlands before conversion to agriculture in southwest Louisiana.

Several species of waterfowl utilize marshes and moist soil habitats in winter for resting and foraging for annual seeds, tubers, and invertebrates. Mallards, gadwall, teal, American wigeon, shovelers, and geese all utilize marsh and moist soil units as preferred habitats (Fredrickson and Heitmeyer 1988). These areas are vital to waterfowl for pair bonding, loafing, sanctuary, thermal cover and feeding (Reinecke et al. 1989). The high seed production of moist soil plants and their value as waterfowl foods have been known since at least the 1940's (Low and Bellrose 1944). However, managing seasonally flooded wetland impoundments or "moist soil units" only became a widely accepted practice after many years of research in southeastern Missouri (Fredrickson and Taylor 1982; Fredrickson 1996). Today, more than 20,000 acres of moist soil habitat are managed in more than 300 impoundments on state and federal lands in the LMV (LMVJV 2010).

Moist soil areas have been shown to be beneficial to a broad range of waterfowl (Fredrickson and Heitmeyer 1988, Reinecke et al. 1989, Fredrickson and Taylor 1982, Fredrickson 1996). Moist soil management areas are maintained at an early successional state by frequent disturbance, and water levels are manipulated to promote the growth and availablility of desirable forage for wildlife at the proper time of year. Annual forbs such as smartweed (*Polygonum spp.*), and grasses including fall panicum (*Panicum dichotomiflorum*), sprangletop (*Leptochloa spp.*), walter's millet (*Echinochloa walteri*), and other large-seeded annual grass species are desirable moist soil forage species for waterfowl (Kaminski et al. 2003, Heitmeyer 1988, 2006, Low and Bellrose 1944). Perennial species, both herbaceous and woody, as well as exotic invasives, will increase and outcompete early-successional annuals in the absence of some type of disturbance on these areas. Therefore, management broadly consists of repeated disturbance coupled with carefully timed manipulation of water levels (Strader and Stinson 2005).

Another essential component of waterfowl wintering habitat is sanctuary. Waterfowl need sanctuary from human, predator and mechanical disturbance. Winter is a biological preparatory period during which many ducks and geese pair and perform other life functions (e.g., female of some species [e.g., mallard] undergo a prebasic molt to acquire their breeding season plumage) in readiness for reproduction. Disturbance-free habitat enables some species of waterfowl to prepare biologically for spring migration and reproduction (Reinecke et al. 1989; Strickland and Tullos 2009). Disturbance can interrupt resting and feeding bouts resulting in a loss of energy and lowering body weight (Henry 1980; Heitmeyer and Raveling 1988; Kahl 1991). Paulus (1984) found in Louisiana that increased foraging time by gadwalls was insufficient to counterbalance disturbance factors.

Wood ducks and wintering geese present special cases and deserve individual mention here. Wood ducks spend their entire life cycle in and around forested wetlands (USFWS 2001). A large number winter on Lacassine NWR; additionally, a few breeding pairs are supported each year through a small nest box program. Wood ducks nest in tree cavities within 1 km (preferably 500 m or less) of water; longer distances are associated with lower brood survival (USFWS 2001). Flooded wood duck habitat is ideally shallow with 50-75% cover provided by shrubs or emergent vegetation (Dugger and Fredrickson 1991, USFWS 2001). Nest boxes are readily used, and single, hidden, well-spaced boxes are best (Hepp and Bellrose 1995). Wood ducks forage mostly in flooded timber, and will only use agricultural habitat if forest is not available. Since wood ducks rarely dive or feed from the bottom, they require shallow (< 8 inches) water for feeding (Dugger and Fredrickson 1991).

Wood ducks begin nesting as early as late January on the Gulf Coast, and the incubation period is 30 days or less (Dugger and Fredrickson 1991). They are omnivorous, but their proportion of animal and plant food sources changes through the year reflecting availability of food and nutritional requirements of breeding, moult, and wintering. During the breeding season, foraging habitat must provide energy and protein for the hen during egg-laying and for the developing ducklings. Hens eat mainly (80%) animal food sources during egg-laying, concentrating on invertebrates that are available on the surface of the water and on riparian areas. Drakes increase their intake of animal sources during the spring as well; invertebrates compose up to 1/3 of their diet during this time. During incubation, hens shift to high-energy seeds to meet the metabolic requirements of incubation. Ducklings consume mostly invertebrates and small fish until they are 6 weeks old, and then shift to mostly plant sources as they mature (USGS 2006). During the winter, diet for both sexes shifts to nearly 100% plant sources, and acorns may account for up to 75% of the total intake.

Wintering geese require food and foraging habitat, escape cover, and roosting habitat (Tesky 1993, Kaminsky 1986). In addition, they require a source of grit for gizzard function. Wintering geese preferentially forage in rice fields in the fall after final harvest until availability of rice grains drops off due to consumption and/or decomposition (Hobaugh 1984, Kaminski 1986). Moist soil units provide wild seed and green browse. Geese also forage on seeds of wetland graminoid plants (Hobaugh 1984, Kaminski 1986, Laskowski no date) and utilize green browse and invertebrates in impounded and unimpounded freshwater marsh. Tall marsh vegetation and

vegetation on levees and spoil banks provide escape cover for geese, while moist soil units and impoundments are most often used for roosting. Geese prefer quartz-based grit over calcium carbonate-based grit. Artificial sources are very readily utilized in coastal Louisiana because of the scarcity of preferred silica grit.

LNWR provides habitat with standing water, green browse, grit areas and protection. Forage for geese include: snails, cordgrass, widgeon grass (*Ruppia maritima*.), bulrush, sedge, and spikerush found on LNWR. The soil on LNWR contains little grit; therefore, maintaining artificial grit sites (piles of sand and pebbles) is a benefit to geese. Recent scientific research documented snow geese traveling from Sweet Lake and Thornwell, Louisiana, to use these sites; some documented distances are approximately 36 miles (USFWS 2006).

Although geese sometimes use moist soil impoundments and eat shoots of germinating plants, rhizomes, roots, or tubers, the primary emphasis of moist soil management is to produce seeds that will provide food for ducks. Most research has focused on estimating seed production and studies have shown that, under intensive management, species of barnyard grass (*Echinochloa crusgalli*), sprangletop (*Leptochloa fascicularis*), flatsedge (*Cyperus spp.*), smartweed (*Polygonum* spp.) and panicum (*Panicum* spp.) can produce more than 1,000 lbs./ac of seed (Fredrickson and Taylor 1982). Moist soil impoundments are highly recommended as a means of diversifying habitat (Fredrickson and Taylor 1982; Reinecke et al. 1989) and supplying food with nutrients not generally available in agricultural grains.

3.2.1.2 Mottled Ducks

Preferred habitats include treeless marshes, prairies, and rice fields with the highest densities of nesting mottled ducks found in brackish to fresh coastal marsh (Rorabaugh and Zwank 1983). Mottled ducks are primarily vegetarians and feed in shallow water with depth as an important variable for autumn habitat (Singleton 1953; White and James 1978). However, their diet may be highly varied, and considerable animal mass may be consumed (Singleton 1953). Invertebrates are especially important for young ducklings. Singleton (1953) and Stutzenbaker (1979) found that from hatching to 3 weeks, 80% of the diet of broods consisted of insects, insect larvae, small fish, snails, and amphipods. Ducklings began their transition to plant foods in the fourth week.

Nesting habitat in coastal marshes is characterized by tall, dense stands of grass located on elevated sites above high tide and generally within 150m of water (Rorabaugh and Zwank 1983). They nest on the ground under bushes or in the concealing grasses such as bulrush (*Scirpus spp.*) in or near the marsh (Terres 1980). Engeling (1950) and Singleton (1953) found nests on levees, roadsides, and fallow rice fields with little grazing pressure in rice production areas.

Mottled ducks have a long potential nesting period, from February through mid-July, and as a result frequent re-nesting attempts are common. Typical mottled duck nesting habitats are cordgrass ridges and other elevated sites within coastal marsh complexes, and cattle pasture and rice production areas of the former coastal prairie. Mottled ducks frequently select nest sites

with some overhead cover, but typically abandon sites once they are overgrown with baccharis, willow, or Chinese tallow.

Mottled ducks use a variety of plant species for nesting cover which may include clumps of cordgrass (*Spartina spp.*), saltgrass (*Distichlis spicata*), and false indigo (*Baptisia sphaerocarpa*) where grasses are sparse or short. However, wet soil conditions with an abundance of rushes, bulrush, and cattails lower nesting habitat quality and areas with woody cover in excess of 30% are avoided entirely (Rorabaugh and Zwank 1983).

Adequate brood habitat can seriously affect duckling survival and reproductive success. Hens with newly hatched ducklings prefer a high water to land ratio with emergent and shoreline vegetation that may be used as cover (Rorabaugh and Zwank 1983). Engeling (1950) found that in Texas coastal marshes brood rearing sites which were bordered by cordgrass, saltgrass, and bulrush were the most successful. Flooded rice fields are also used as brood-rearing sites, but the quality of this habitat is disputed.

Louisiana State University (LSU) has a research project studying habitat use, survival, and movement patterns of mottled ducks implanted with radio transmitters. This research is ongoing across the Southwest Louisiana Refuge Complex and is expected to increase knowledge of mottled duck habitat needs in this area.

3.2.2 Colonial Waterbirds

Colonial waterbirds on Lacassine NWR are a taxonomically and ecologically diverse group of animals. However, the suite of species can be considered as a single Resource of Concern because their general habitat requirements are similar, and management actions taken to benefit one species will generally benefit all. Hafner (1997) divides the general habitat requirements of these wading birds into three components: colony site requirements (rookeries), feeding habitat during breeding season, and feeding habitat during nonbreeding season.

Nesting sites, or rookeries, must provide the nesting birds with nest substrates, protection from weather, and security from predation. Rookeries where ground-nesting takes place are therefore usually surrounded by water, but can be protected by dense vegetation instead. In the absence of these components, most colonial wading birds require tall woody vegetation as nest substrate in order to secure the nest from ground-based predators (Hafner 1997). Great blue herons prefer nest sites 7-10 m high in trees, while black-crowned night herons, snowy egrets, little blue herons, and great egrets tend to nest on islands in shrubby vegetaton (Habitat Objectives Workgroup 1991). Protection from wind, rain, and flooding must be adequate for successful nesting to occur. Rookeries also must have nearby food and nest material resources adequate for the number of birds using the rookery (Hafner 1997).

Feeding habitat during the breeding season must provide sustenance for adults as well as chicks, and must be located within some maximum radius of the rookery that allows foraging adults to efficiently capture and transport food to the nest (Gibbs 1991, Hafner 1997). The size of the rookery (number of nesting pairs) is often limited by availability of suitable feeding habitat

within this radius (Hafner 1997). This has been shown for great blue herons (Gibbs 1991) and black-crowned night herons (Fasola and Barbieri 1978) among other species. Fasola and Barbieri (1978) reported that heron rookeries in Italy were spatially arranged to efficiently divide up the available feeding habitat. Gibbs (1991) likewise reported that great blue heron rookeries in Maine were located near optimum locations relative to dispersed, disjunct wetland feeding habitat. Birds are able to exploit different prey and feeding habitats at different times of the day when prey are most available; therefore, habitat diversity within the available radius is an important factor as well (Hafner 1997).

On LNWR, rookery sites are not all active in any given year. Instead, birds alternate among several locations on the refuge. It is therefore important to protect all known rookery areas when management activities are carried out, and to strategically select locations for future rookeries where woody vegetation is allowed to develop.

Nonbreeding season feeding habitat requirements for Gulf Coast wading birds are similar to those during the breeding season, except that white ibises, which forage in saltwater during the nonbreeding season, require freshwater prey for feeding nestlings during the breeding season (Chavez-Ramirez and Slack 1995). Types of habitat used during the nonbreeding season include shallow open water and water margins. Vegetated areas are much less likely to be utilized by wading birds on the Gulf Coast (Chavez-Ramirez and Slack 1995).

Some researchers have reported that multi-species populations of wading birds partition feeding habitat use. Partitioning can occur by water depth, with longer-legged birds able to forage in deeper water (Hafner 1997), by time of day (Post 2008), or size/configuration of open water area (Chavez-Ramirez and Slack 1995). Recent work has questioned the idea that resource partitioning occurs among diurnal wading birds, especially when food resources are not limiting (Post 2008).

3.3 Refuge Contribution to Habitat Requirements

In addition to the 16,882 acres of impounded freshwater marsh (Lacassine Pool) and 14,725 acres of unimpounded marsh habitat, LNWR has approximately 600 acres of moist soil fields and 1,041 acres farmed for rice under cooperative farming agreements. Both moist soil units and crop areas are managed to provide habitat for waterfowl and shorebirds. There are also about 352 acres of forested wetlands on the refuge which are passively managed for forest species. In coastal Louisiana, freshwater marsh has declined 25-50% from its presettlement extent, and the largest areas of this habitat left in southwest Louisiana are all on USFWS and LDWF-managed lands (Lester et al. 2005). Meanwhile, US rice production has shifted away from the Gulf Coast and towards California and the Mississippi Delta. Acreage planted to rice has declined 40% in Louisiana from 1992 to 2007, decreasing from 630,000 acres to 380,000 acres. Much of this acreage has been converted to pasture or is fallow, and therefore is not maintained in flooded conditions useful for waterfowl, either as cropland or moist soil habitat (Baldwin et al. 2011). As these types of habitat become rarer outside the refuge, maintaining and enhancing them on

the refuge becomes more and more important. Acreages of different types of habitat available to Resources of Concern are presented in Table 5.

Table 5. Acres of habitat available on Lacassine NWR for resources of concern.

Resource of Concern	Cropland (1041 ac.)	Forested Wetland (352 ac.)	Moist Soil Units (600 ac.)	Impounded Marsh (16,882 ac.)	Unimpounded Marsh (14,242 ac.)
WATERFOWL					
Wintering Waterfowl, Including Wood Ducks					
Feeding	520	352	600	16,882	14,242
Loafing	520	352	600	16, 882	14,242
Roosting	500	352	0	16, 882	14,242
Mottled Ducks					
Breeding				16, 882	14,242
Feeding	520	0	600	16, 882	14,242
Loafing	520	0	600	16, 882	14,242
Roosting	500	0	100	16, 882	14,242
COLONIAL WATERBIRDS					
Breeding				16, 882	14,242
Feeding				16, 882	14,242
Loafing				16, 882	14,242
Roosting				16, 882	14,242

3.3.1 Waterfowl

Habitat for wintering waterfowl is provided between mid-August and early March. Lacassine NWR provides 352 acres of forested wetland habitat which is used by wood ducks and black-bellied whistling-ducks. Besides large habitat blocks also used by other waterfowl, grit piles are maintained on LNWR to provide this scarce resource to geese which winter on the refuge.

Mottled ducks are a resident species with a range limited to the western Gulf Coast and Florida. The Louisiana Chenier Plain population estimate is about 170,000 birds, making this region one of the most important in the world for this species. Mottled ducks must meet all their life cycle requirements from their year-round home of Gulf Coast marshes and associated agricultural habitats. These habitat requirements vary seasonally. Therefore, special consideration is warranted to ensure that the unique needs of this species are met, especially during the spring and summer. In particular, the refuge provides breeding habitat by encouraging shrubby vegetation (< 30% cover) and cordgrass on levees, spoil banks, and marsh edges.

Forested wetland on LNWR is passively managed; treatments consist mainly of removing exotic invasive plants. Additionally, the refuge provides 6 well maintained artificial nest boxes which are used by wood ducks.

3.3.2 Colonial Waterbirds

Colonial waterbirds use several rookery sites on LNWR each year during the breeding season and use the impounded and unimpounded marsh and moist soil units year-round for feeding, roosting, and loafing. Rookery areas are shown in Figure 11.

3.4 Reconciling Conflicting Habitat Needs

The Lacassine Pool (Units D, G1-3; Figure 4) is the most prominent feature of the refuge and serves as a waterfowl sanctuary and breeding area for resident birds, including mottled ducks, wood ducks, and fulvous whistling ducks. The primary purpose of the refuge and Lacassine Pool is to sustain high-quality habitats necessary for migratory birds, in particular waterfowl. However, managing the pool to provide a high-quality fishery resource is compatible with that primary objective.

The Lacassine Pool is currently divided into four semi-separate units, although they remain connected hydrologically via stoplog structures and screw-gates. Existing spillways and pumps are adequate for draining Lacassine Pool for vegetation management (i.e., prescribed burning of the organic layer).

Organic matter accumulation is a normal process in a freshwater wetland system. Dead plant matter (detritus) accumulates at the bottom of the impoundment each year. Over time, this material build up, and the water-holding capacity of the impoundment diminishes. A primary objective of the refuge is to establish the capability to burn this organic material, improving the values of Lacassine Pool for waterfowl, and extending the life of the wetland, all the while maintaining the fishery resource in its current state.

Some conflicts are inevitable between waterfowl and fishing programs due to differing water level requirements. Periodic drawdowns are required for maintenance of freshwater marsh conditions conducive to waterfowl habitat (see section 5.1). By rotating this activitity among the four subunits of the Lacassine Pool (Units D, G1, G2, and G3), fishing should be available to anglers on an annual basis without interruption on at least 10,000 acres in any given year, except during extended drought conditions.

3.5 Other Species With Complementary Needs

While habitat objectives and strategies will be established based primarily on the habitat needs of the above identified Resources of Concern, refuges can and should be managed through a strategic habitat management approach that includes other species which represent ecosystem complexity and diversity and extends to the broader landscape in which the refuge lies. The following species (Table 6) have habitat needs that are largely complementary to those of the Resources of Concern, and are expected to benefit from management designed primarily to meet the needs of the Resources of Concern. On Lacassine NWR, these include the following groups: shorebirds, marsh birds, fisheries, alligators, and 3 species of special concern which utilize habitats on the refuge.

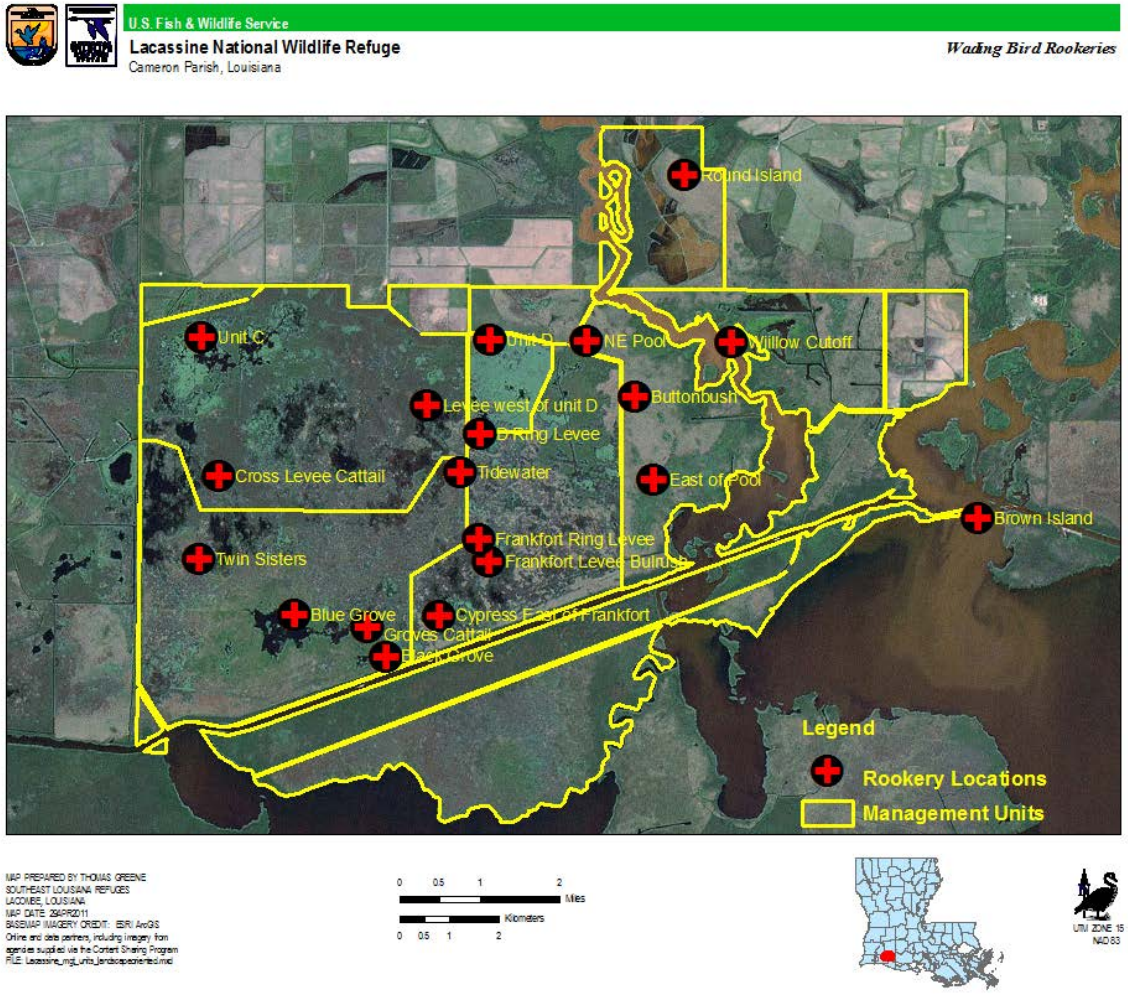

Figure 11. Rookery areas on Lacassine NWR

Table 6. Species which have complementary habitat needs to Resources of Concern (ROC) on Lacassine NWR

Common Name	Moist Soil Units	Impounded Freshwater Units	Unimpounded Freshwater Units	Agricultural Units
SHOREBIRDS				
American Avocet		x	x	
American Golden-Plover	x			x
American White Pelican		x	x	
American Woodcock	x			x
Black Tern		x	x	
Black-necked Stilt	x	x	x	x
Buff-breasted Sandpiper	x			x
Caspian Tern			x	
Common Snipe	x	x	x	x
Dunlin	x	x	x	x
Forster's Tern	x	x	x	x
Glossy Ibis	x	x	x	x
Greater Yellowlegs	x	x	x	x
Gull-billed Tern			x	
Herring Gull			x	
Killdeer	x	x	x	x
Laughing Gull	x	x	x	x
Least Sandpiper	x	x	x	x

Common Name	Moist Soil Units	Impounded Freshwater Units	Unimpounded Freshwater Units	Agricultural Units
Lesser Yellowlegs	x	x	x	x
Long-billed Dowitcher	x	x	x	x
Pectoral Sandpiper	x	x	x	x
Ring-billed Gull	x	x	x	x
Royal Tern			x	
Ruddy Turnstone	x	x	x	x
Semipalmated Plover	x			x
Semipalmated Sandpiper	x	x	x	x
Short-billed Dowitcher	x	x	x	x
Solitary Sandpiper	x	x	x	x
Spotted Sandpiper	x	x	x	x
Stilt Sandpiper	x	x	x	x
Western Sandpiper	x	x	x	x
Whimbrel	x			x
Willet		x	x	
Wilson's Plover	x			x
MARSH BIRDS				
American Coot	x	x	x	x
Belted Kingfisher	x	x	x	x
Black Rail	x			x
Clapper Rail		x	x	

Common Name	Moist Soil Units	Impounded Freshwater Units	Unimpounded Freshwater Units	Agricultural Units
Common Moorhen	x	x	x	x
King Rail	x	x	x	x
Pied-billed Grebe	x	x	x	x
Purple Gallinule	x	x	x	x
Sora	x	x	x	x
Virginia Rail	x	x	x	x
Yellow Rail	x			x
FISHERIES				
Alligator Gar		x	x	
Banded Pygmy Sunfish		x	x	
Black Bullhead		x	x	
Black Crappie		x	x	
Blue Catfish		x	x	
Bluegill		x	x	
Bowfin		x	x	
Channel Catfish		x	x	
Gizzard Shad			x	
Green Sunfish		x	x	
Largemouth Bass		x	x	
Longnose Gar		x	x	
Redear Sunfish		x	x	
Spotted Gar		x	x	

Common Name	Moist Soil Units	Impounded Freshwater Units	Unimpounded Freshwater Units	Agricultural Units
Striped Mullet		x	x	
Threadfin Shad		x	x	
Warmouth		x	x	
White Mullet		x	x	
ALLIGATORS				
American Alligator		x	x	
SPECIES OF SPECIAL CONCERN				
Bald Eagle		x	x	
Paddlefish			x	
Alligator Snapping Turtle			x	

3.6 Habitat of Special Interest

Coastal prairie once covered 3.5 million ha (8.6 million acres) of the coastal plain of Louisiana and Texas; today, it is almost all gone, with only tiny fragments remaining along railroad rights-of-way and in cemeteries. Like the tallgrass prairies of the Midwest, Texas, and Oklahoma, coastal prairie was dominated by bluestems, notably *Schizachyrium scoparium*, *S. tenerum*, and *Andropogon gerardii*, as well as switchgrass (*Panicum virgatum*), yellow indiangrass (*Sorghastrum nutans*), eastern gammagrass (*Tripsacum dactyloides*), brownseed paspalum (*Paspalum plicatulum*), and other warm-season, perennial, C4 grasses. It is extremely biodiverse, with over 500 species of vascular plants, including many endemics, and once supported abundant wildlife, including some species which are now extirpated from the region, like American bison (*Bison bison*), or nearly so, like Attwater's Prairie Chicken (*Tympanuchus cupido attwateri*).

Like other North American grasslands, coastal prairie is fire-dependent, and will succeed to woody vegetation if fires are suppressed. Soils which developed under these prairies are among the most fertile on the continent, and are therefore in great demand for agriculture. Additionally, robust human population growth during the 20th Century led to the urbanization of much of the Gulf Coast region. Finally, the introduction of exotic plant species such as Chinese tallowtree

has further threatened the existence of coastal prairie. Together, these factors have resulted in the near-complete destruction of this critically imperiled ecosystem.

Lacassine NWR has partnered with the Cajun Prairie Habitat Preservation Society (http://www.cajunprairie.org/) to begin restoring the coastal prairie ecosystem by planting native prairie species on 334 acres of coastal prairie soils (Figure 5, Table 2) which had been under rice cultivation for many decades. Artificial restoration of structural componenents of the prairie ecosystem, along with the resumption of fire as an ecological process, has resulted in an area of restored coastal prairie which will one day closely mimic existing prairie remnants and serve as a nucleus for further restoration in the region.

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4.0 HABITAT GOALS AND OBJECTIVES

This habitat management plan is a step-down plan tiered to the CCP; goals and objectives herein have been restated for clarity by combining similar objectives and/or dividing complex objectives from the CCP. More detail, including specific numeric objectives, has been added to more clearly define the original objectives.

4.1 Impounded Freshwater Marsh Habitat Goal

Manage Lacassine Pool (Units D and G1-3) to conserve and enhance impounded freshwater habitat to provide favorable conditions for wintering and resident waterfowl, waterbirds, and native aquatic species while providing, to the extent that it is compatible with that goal, opportunities for compatible wildlife-dependent recreation.

Discussion: During 2002, a Wildlife and Habitat Review was completed. This team of biologists, managers, foresters, and non-Service managers/biologists evaluated current management practices and provided recommendations about future habitat and water management (USFWS 2003). The team recommended the continued management of Lacassine Pool as a freshwater impoundment with the primary focus on waterfowl and aquatic birds. Dewatering and prescribed fire, along with chemical control of vegetation, were recommended for reaching a suggested 50:50 ratio of open water to vegetation mix.

With the recent completion of the terraces dividing Unit G into three large subunits (Appendix F), and the results of the drought and prescribed fires in 2011 (see section 2.4.1.3) it is now time for management to begin addressing the lingering problems associated with the Lacassine Pool. The first step will be to eliminate the yearly accretion rates and address surface fuel reduction through the removal of growing plant materials prior to November of each year. Prescribed fire is a readily available management tool that can be used to produce the needed results. Once the elevation of the organic layer is stabilized, more drastic management actions will need to take place to gain the recommended open water to vegetation ratio. As demonstrated within Unit D, the combination of dewatering and prescribed fire can effectively achieve this end. Prescribed fire has been a consistent tool to remove heavy fuels and to aid in setting back natural succession. When applied under the appropriate environmental conditions, fire, both with and without dewatering, should work to help control accretion. For fire to have the best and most effective impact on the Lacassine Pool, burning operations must be performed during summer months and after dewatering; past prescribed fires occurred primarily during the winter months and at periods of high water. A draft fire prescription for the Lacassine Pool is being written.

4.1.1 Objective 4.1.1

Manage Units G1, G2, and G3 of the Lacassine Pool to achieve, through the 15-year planning period covered by this HMP and beginning in the year after the first unit is drawn down and burned, a mosaic palustrine emergent/aquatic system with the following characteristics:

- an approximate emergent vegetation to open water ratio of 50:50 (averaged across subunits; recently dewatered/burned subunits will have more open water, while those which have gone longer since being so treated will have more emergent vegetation);
- At least 50% of the emergent vegetation consists of plants of high waterfowl food value including sedges such as *Cyperus* spp. and *Eleocharis* spp., and large-seeded grasses of the genera *Panicum* and *Echinochloa*, while maidencane (*Panicum hemitomon*) and cattails (*Typha spp.*) are maintained at less than 50% of the emergent plant cover;
- 50-60% of the open water is occupied by submerged aquatic vegetation including water shield (*Brasenia schreberi*), white water lily (*Nymphaea odorata*), and American lotus (*Nelumbo lutea*);
- exotic invasive aquatic plants (water hyacinth (*Eichhornia crassipes*), common salvinia (*Salvinia minima*), giant salvinia (*Salvinia molesta*) hydrilla (*Hydrilla verticillata*), and alligator weed (*Alternanthera philoxeroides*) are controlled so that they cover no more than 20% of the open water,

and to maintain the following seasonal water levels:

- 1.30 feet (NAVD 88) from March 15 to October 15 to promote emergent herbaceous and submerged aquatic vegetation, and
- between 0.30 and 0.80 feet between October 16 and March 14 to facilitate waterfowl feeding.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Aquatic Vegetation cover • Emergent Wetland Vegetation Composition • Woody Vegetation cover	• Quadrat/transect sampling method (spring/summer/fall) • Periodic acquisition and analysis of remotely sensed data
Wildlife Response Variables	**Probable Methods**
• Waterfowl species composition and abundance • Rookery use; colonial wading bird abundance	• Aerial winter surveys (3x yr) • Ground fall/winter surveys (3x yr) • Ongoing waterfowl research (various projects) • Rookery surveys

Resources of Concern: waterfowl, colonial waterbirds

CCP Reference: Objective A-1, B-1, B-2, B-5-11

Rationale: The Lacassine Pool (Units G1, G2, G3, as well as Unit D, treated separately below), serves primarily as a sanctuary for waterfowl. Its proper management and enhancement contribute to the original purpose of the refuge and are its highest priorities. The primary emphasis of pool management will therefore be on providing high quality habitat for aquatic birds. Compatible public uses that do not detract from the critical role of this unit for

waterfowl and other wetland-dependent birds will be accommodated if at all possible. At times, however, management actions under this plan that involve drawdowns and burning may conflict with public uses. This means, for example, that during a prolonged, severe drought such as that experienced during 2011, when it became impossible to maintain water levels in the pool, the entire pool will dry down. Managers will take advantage of these opportunities, as they did in 2011, to apply prescribed fire in the pool to set back organic matter accumulation.

Invasive species such as giant and common salvinia, hydrilla, water hyacinth, and alligator weed hinder production of better waterfowl foods. These invasive species will be controlled by herbicides, draw downs and/or prescribed fire.

4.1.2 Objective 4.1.2

Manage Unit D of the Lacassine Pool as a special part of the Lacassine Pool, separate from Units G1, G2, and G3, but with similar habitat goals, to achieve, through the 15-year planning period covered by this HMP and beginning in the year after Unit D is drawn down and burned, a mosaic palustrine emergent/aquatic system with the following characteristics:

- an approximate emergent vegetation to open water ratio of 50:50 (changing over time; when recently dewatered/burned the unit will have more open water, while later in the cycle it will have more emergent vegetation);
- At least 50% of the emergent vegetation consists of plants of high waterfowl food value including sedges such as *Cyperus* spp. and *Eleocharis* spp., and large-seeded grasses of the genera *Panicum* and *Echinochloa*, while maidencane (*Panicum hemitomon*) and cattails (*Typha spp.*) are maintained at less than 50% of the emergent plant cover;
- 50-60% of the open water occupied by submerged aquatic vegetation including water shield (*Brasenia schreberi*), white water lily (*Nymphaea odorata*), and American lotus (*Nelumbo lutea*);
- exotic invasive aquatic plants (water hyacinth (*Eichhornia crassipes*), common salvinia (*Salvinia minima*), giant salvinia (*Salvinia molesta*) hydrilla (*Hydrilla verticillata*), and alligator weed (*Alternanthera philoxeroides*) are controlled so that they cover no more than 20% of the open water.
- the unit will serve as an experimental area to test management actions which are proposed for Units G1, G2, and G3 prior to implementing them on the larger units.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Aquatic Vegetation cover • Emergent Wetland Vegetation Composition • Woody Vegetation cover	• Quadrat/transect sampling method (spring/summer/fall)
Wildlife Response Variables	**Probable Methods**

• Waterfowl species composition and abundance • Migratory bird species composition and abundance • Rookery use; colonial wading bird abundance	• Aerial winter surveys (3x yr) • Ground fall/winter surveys (3x yr) • Ongoing waterfowl research (various projects) • Rookery surveys

Resources of Concern: waterfowl, colonial waterbirds

CCP Reference: Objective A-1, B-1, B-2, B-5-11

Rationale: The Lacassine Pool (Unit D), serves primarily as a sanctuary for waterfowl. Its proper management and enhancement contribute to the original purpose of the refuge and are its highest priorities. The primary emphasis of pool management will therefore be on providing high quality habitat for aquatic birds. Experimental management actions whose effects are not completely known must be field-tested before they are taken at full scale. Unit D provides a relatively small, yet similar environment to test actions which could be applied to Units G1, G2, and G3. The most recent example of an action tested in Unit D is the dewatering/burning of impounded freshwater marsh to reduce organic matter accumulation and control the ratio of emergent vegetation to open water. Compatible public uses that do not detract from the critical role of this unit for waterfowl and other wetland-dependent birds will be accommodated if at all possible. At times, however, management actions under this plan that involve drawdowns and burning may conflict with public uses.

Invasive species such as giant and common salvinia, hydrilla, water hyacinth, and alligator weed hinder production of better waterfowl foods. These invasive species will be controlled by herbicides, draw downs and/or prescribed fire.

4.2 Unimpounded Freshwater Marsh Habitat Goal

Restore, maintain, and manage unimpounded freshwater marsh to provide high quality habitat for waterfowl, waterbirds, and other aquatic animals.

Discussion: Unimpounded freshwater marsh habitat complements and supplements habitat provided in Lacassine Pool. Restoring and maintaining these habitats will improve water quality in water flowing down Lacassine Bayou and improve habitat quality for Resources of Concern and other trust species, and enhance biological integrity, diversity and health. Construction of terraces for restoration of freshwater marsh would create additional habitat diversity including emergent vegetation and deep water refugia for fish and waterfowl.

4.2.1 Objective 4.2.1

In unimpounded Freshwater Marsh Units B, E1, E2, F1, F2, F3, H, I, and J**,** manage 14,242 acres of unimpounded marsh to achieve each year through the 15-year planning period covered by this HMP, a mosaic palustrine emergent/aquatic system with the following characteristics:

- an approximate emergent vegetation to open water ratio of 50:50;
- At least 50% of the emergent vegetation consists of plants of high waterfowl food value including sedges such as *Cyperus* spp. and *Eleocharis* spp., and large-seeded grasses of the genera *Panicum* and *Echinochloa*, while maidencane (*Panicum hemitomon*) and cattails (*Typha spp.*) are maintained at less than 50% of the emergent plant cover;
- 50-60% of the open water occupied by submerged aquatic vegetation including water shield (*Brasenia schreberi*), white water lily (*Nymphaea odorata*), and American lotus (*Nelumbo lutea*);
- exotic invasive aquatic plants (water hyacinth (*Eichhornia crassipes*), common salvinia (*Salvinia minima*), giant salvinia (*Salvinia molesta*) hydrilla (*Hydrilla verticillata*), and alligator weed (*Alternanthera philoxeroides*) are controlled so that they cover no more than 20% of the open water.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Aquatic Vegetation cover • Emergent Wetland Vegetation Composition • Woody Vegetation cover	• Quadrat/transect sampling method (spring/summer/fall) • Periodic acquisition and analysis of remotely sensed data
Wildlife Response Variables	**Probable Methods**
• Waterfowl species composition and abundance • Rookery use; colonial wading bird abundance	• Aerial winter surveys (3x yr) • Ground fall/winter surveys (3x yr) • Ongoing waterfowl research (various projects) • Rookery surveys

Resources of Concern: waterfowl, colonial waterbirds

CCP Reference: Objective A-2

Rationale: The refuge's unimpounded marsh habitat provides habitat for waterfowl and colonial waterbirds. Its proper management and enhancement contribute to the original purpose of the refuge and help fulfill the mission of the NWRS. Restoration and management of unimpounded marsh will therefore be focused on continuing to provide high quality habitat for the identified Resources of Concern.

Invasive species such as giant and common salvinia, hydrilla, water hyacinth, and alligator weed hinder production of better waterfowl foods. These invasive species will be controlled by prescribed fire, and when appropriate and feasible, with the application of herbicides.

4.2.2 Objective 4.2.2

For unimpounded Freshwater Marsh Units B, E1, E2, F1, F2, F3, H, and J, by the end of the planning period covered by this HMP, if found to be feasible, (see 5.2.2.4) and if funding is made available, restore lost marsh habitat adjacent to Lacassine Bayou.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Aquatic Vegetation cover • Emergent Wetland Vegetation Composition	• Quadrat/transect sampling method (spring/summer/fall) • Periodic acquisition and analysis of remotely sensed data
Wildlife Response Variables	**Probable Methods**
• Waterfowl species composition and abundance	• Aerial winter surveys (3x yr) • Ground fall/winter surveys (3x yr)

Resources of Concern: waterfowl, colonial waterbirds

CCP Reference: Objective A-2

Rationale: The refuge's unimpounded marsh habitat provides habitat for waterfowl and colonial waterbirds. Restoring lost marsh acreage contributes to the original purpose of the refuge and helps fulfill the mission of the NWRS. Further, marsh restoration will help protect other habitats and human infrastructure as well.

4.3 Moist Soil Habitat Goal

Provide 600 acres per year from August through March of early-successional wetland ("moist soil") habitat timed to optimize usage by wintering and resident waterfowl and wading birds for feeding, loafing, and roosting.

Discussion: Currently, 600 acres are managed as moist soil habitat in Units A, C, and a small area of B (the 19-acre mitigation field, S-4). Water levels within moist-soil units are manipulated seasonally, and adaptive management is used to fine-tune habitat treatments for maximum effectiveness. Different species of birds have different habitat requirements; dabbling ducks prefer 2 to 12 inches of water, while shorebirds concentrate on mud flats or sheet water where invertebrates can be readily found. Wading birds such as herons and egrets also utilize borrow ditches and shallow water areas. Efforts will be made to balance the needs of these species groups through the season.

4.3.1 Objective 4.3.1

In moist soil areas of Units A, B, and C, using adaptive management principles, each year from 01 August through 31 March provide 600 acres of moist soil habitat in moist soil units with a maximum vegetative cover of 80% consisting of sedges (*Cyperus spp.*), walter's millet (*Echinochloa walteri*), spikerushes (*Eleocharis spp.*), fall panicum (*Panicum dichotomiflorum*), and smartweeds (*Polygonum spp.*), while maintaining cover of coffeebean (*Sesbania exaltata*)

below 50% and maintaining water depths between 2 and 8 inches. This range of depths provides excellent foraging habitat for waterfowl and colonial wading birds.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Aquatic vegetation composition • Emergent wetland vegetation composition and productivity for wildlife • Early successional plant community composition • Woody vegetation	• Quadrat/transect sampling method (spring/summer/fall)
Wildlife Response Variables	**Probable Methods**
• Waterfowl species composition and abundance	• Aerial winter surveys (3x yr.) • Ground fall/winter surveys (3x yr.) • Ongoing waterfowl research (various projects)

Resources of Concern: Waterfowl, colonial waterbirds

CCP Reference: Objective A-3, B-1, B-2, B-4, B-5

Rationale: Moist soil habitat is an important component of habitat for both waterfowl and colonial waterbirds. If properly managed, it can produce a season-long supply of native seed and invertebrates which increase dietary diversity and enhance overall nutrtional quality of the available food for wintering waterfowl. At the same time, these areas also function as foraging habitat for colonial waterbirds and serve as feeding habitat for many other species of birds, including shorebirds and marsh birds.

4.3.2 Objective 4.3.2

Restore infrastructure in Unit C by repairing four breaches in levee system and replacing stoplog structure when funding becomes available.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Levees and WCS are functional	• Inspection, periodic testing
Wildlife Response Variables	**Probable Methods**
• Waterfowl species composition and abundance	• Aerial winter surveys (3x yr.) • Ground fall/winter surveys (3x yr.)e

Resources of Concern: Waterfowl, colonial waterbirds

CCP Reference: Objective A-3, A-6, B-1, B-2, B-4, B-5

Rationale: Water control is an integral part of moist soil management. Repairing the levee system and replacing the current, faulty stoplog structure will enable proper management of this unit and allow managers to have better control of water levels so that moist soil management areas can be productive.

4.4 Coastal Prairie Habitat Goal

Work with partners to maintain and restore 334 acres of coastal prairie habitat and conserve prairie plant seed sources at the Duralde Prairie Unit for the benefit of grassland birds and to contribute to the priorities of the Texas Gulf Coast Ecosystem and the Lower Mississippi River Ecosystem.

Discussion: The coastal prairie is a tallgrass prairie ecosystem that once encompassed an estimated 3.5 million hectares (8.6 million acres). Today only a tiny fraction remains. Conserving this critically endangered ecosystem is a high priority for the Service. Like Midwestern prairies, the coastal prairie is dominated by grasses such as little bluestem, switchgrass, Indiangrass, and big bluestem, with over 500 species of grasses, sedges, and wildflowers. However, coastal prairie is distinct in several ways, including the presence of species that are not found in the Midwestern prairies (see Appendix C for a reference list of Coastal Prairie species).

Grassland birds have exhibited a sharper decline in tallgrass prairie during the past 25 years than any other group of North American birds. In Louisiana, old fields and pastures that once provided grassland bird habitat are being replaced with forests of the exotic, invasive Chinese tallowtree. Restoring prairie habitat will benefit many grassland bird species, including Henslow's (*Ammodramus henslowi*), grasshopper (*Ammodramus savannarum*), savannah (*Passerculus sandwichensis*), and Le Conte's (*Ammodramus leconteii*) sparrows; eastern meadowlark (*Sternella magna*); loggerhead shrike (*Lanius ludovicianus*); dickcissel (*Spiza americana*); yellow (*Coturnicops noveboracensis*) and black (*Laterallus jamaicensis*) rails; bobolink (*Dolichonyx oryzivorus*); short-eared owl (*Asio flammeus*); and northern harrier (*Circus cyaneus*).

4.4.1 Objective 4.4.1

In the Duralde Prairie unit, working with partners, achieve and maintain 90% (394) of the 438 reference native herbaceous prairie plant species (Appendix C, Table C2) across 334 acres by 2026. Currently, the prairie has about 250 species of vascular plants (C. Allen, pers. comm.), or about 57% of the 438 native herbs listed by Allen et al. (2001). Interim targets are: 70% (307 species) by 2016, 80% (350 species) by 2021.

Adaptive Management Monitoring Elements	
Habitat Response Variables	Probable Methods
• Grass & herbaceous vegetation composition	• Quadrat/transect sampling method (spring/summer/fall)
Wildlife Response Variables	**Probable Methods**
• Grassland bird species composition and abundance •	• Aerial winter surveys (3x yr.) • Ground fall/winter surveys (3x yr.)

Resources of Concern: Waterfowl

CCP Reference: Objective A-4

Rationale: Coastal prairie vegetation serves as nesting areas for mottled ducks and as feeding areas for wintering geese, especially after a growing-season burn has removed the rough and released fresh regrowth. Many other species with complementary needs use coastal prairie habitat, and maintaining this habitat contributes to overall biodiversity on the refuge.

4.4.2 Objective 4.4.2

In the Duralde Prairie unit, maintain, by use of fire, herbicides, and adaptive management processes, no more than 2% cover of woody plants across 334 acres of restored prairie habitat through 2026.

Adaptive Management Monitoring Elements	
Habitat Response Variables	Probable Methods
• Woody plant cover	• Quadrat/transect sampling method (summer)
Wildlife Response Variables	**Probable Methods**
• Grassland bird species composition and abundance • Wintering waterfowl composition and abundance	• Aerial winter surveys (3x yr.) • Ground fall/winter surveys (3x yr.)

Resources of Concern: Waterfowl

CCP Reference: Objective A-4

Rationale: Tallgrass prairie is a fire-dependent ecosystem; without fire, prairie will be replaced by woody vegetation. On the Gulf Coast, native woody plants such as eastern baccharis, sugarberry, and waxmyrtle will replace herbaceous vegetation. In addition, the invasive exotic Chinese tallow will invade and replace prairie vegetation, forming a near-monospecific stand which has very little ecological or wildlife value. In cases where this has already occurred, herbicide application and/or other methods may be required to return the system to a condition in which it will carry fire. There is a sizable body of literature on prairie restoration, concentrating on Midwestern prairies in North America (see for example Packard and Mutel 1997). However, management challenges faced on the Gulf Coast, particularly exotic plant species and seed source issues, differ from those in the Midwest, so adaptive management will be a critical component of any prairie restoration effort.

4.5 Cropland Habitat Goal

Maintain 500-550 acres in Units B and F annually in cooperatively farmed crops, such as rice, millets, and winter wheat, to provide foraging, loafing, and protection habitat for wintering waterfowl during September through March. Preferred crops are rice and Chiwapa millet.

Discussion: Unit B (P&H Tract) is a 724-acre area, which includes 511 acres of rice impoundments that have been managed since 1990 by a cooperative farmer. Rice is planted in a field every other year, alternating with fallow. The farmer harvests a percentage, which fluctuates, and leaves the rest of the crop for waterfowl. Wheat or perennial ryegrass is planted as green browse for wintering geese.

The refuge acquired the 530-acre cropland portion of Unit F3 (Coto Plot) in 1996; since then, it has been cooperatively farmed similar to Unit B. On average, approximately half of the tract is planted in rice every year, alternating with fallow.

4.5.1 Objective 4.5.1

In Units B and F3, work with cooperative farmers to cultivate 520 acres of rice or chiwapa millet each year to provide a minimum of 68,120 mallard-use-days of wintering waterfowl foraging habitat annually from second (ratoon) crop rice from October to March, with 4 to 8 inches of water, and 200 to 300 acres of shorebird habitat from September to March, with sheet water on fallow fields.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Rice (or millet) present in desired quantities during wintering season for waterfowl	• Estimates of crop yield
Wildlife Response Variables	**Probable Methods**
• Use by wintering waterfowl	• Aerial or ground surveys in winter

Resource of Concern: Wintering waterfowl

CCP Reference: Objective A-5

Rationale: Cultivated grains such as rice and millet provide a source of carbohydrates which wintering waterfowl use to build energy reserves for migration and breeding. Rice acreage has declined in southwestern Louisiana (Baldwin et al. 2011), so this resource has become scarcer and more valuable in the last several years, increasing its importance on the refuge. To fulfill Gulf Coast Joint Venture objectives for habitat, the refuge must produce reliable high quality foraging habitat on an annual basis. A component of this habitat will be unharvested flooded grains.

4.5.2 Objective 4.5.2

In Unit F3, beginning in 2011, provide 1960 acres of inviolate sanctuary for waterfowl each year between October 15 and March 15 by closing the unit to visitor access and hunting.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**

• N/A	• N/A
Wildlife Response Variables	**Probable Methods**
• Use by wintering waterfowl	• Aerial or ground surveys in winter

Resource of Concern: Wintering waterfowl

CCP Reference: , Objective B-1, A-5

Rationale: As discussed in section 3.2.1.1 above, waterfowl need inviolate sanctuary to prepare for migration and breeding. Providing this habitat component in an unimpounded portion of the refuge which includes cultivated and fallow cropland and unimpounded freshwater marsh, complementing the impounded freshwater habitat in Lacassine Pool, increases the habitat diversity of inviolate sanctuary available to wintering waterfowl.

4.6 Forested Wetland [Bottomland Hardwood/Swamp] Habitat Goal

Protect 352 acres of existing bottomland hardwood swamp habitat and upland hardwood habitat on the refuge, specifically cypress-tupelo stands in Upper Lacassine Bayou, Brown Island, Blue and Black Groves within Lacassine Pool, Lacassine Point, the Headquarters Pond, and the mature live oaks in the refuge headquarters area.

Discussion: Limited bottomland hardwood forest (352 acres) occurs on the refuge, primarily in the riparian areas along the Mermentau River and Lacassine Bayou. There may be opportunities for forest restoration on the existing refuge, and for acquisition of additional bottomland hardwood forests within the refuge's acquisition boundary. Protection of forested corridors provides essential foraging and resting habitat for migrating land birds.

4.6.1 Objective 4.6.1

In bottomland hardwood habitat areas of units J, E2, and F2, maintain Chinese tallowtree and other exotic plants below 15% of the total cover in 352 acres of existing bottomland hardwood forest and swamp through use of chemical and mechanical treatments.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Cover of tallowtree and other invasive exotic plants	• transects or plots
Wildlife Response Variables	**Probable Methods**
• N/A	• N/A

Resource of Concern: Waterfowl (wood ducks)

CCP Reference: Objective A-7, A-10

Rationale: Invasive exotic plants such as tallowtree threaten the biological integrity of habitats, outcompeting and replacing plants with greater value to wildlife and reducing biodiversity.

While eradication is not possible for the majority of these species, it is feasible to maintain them at levels which minimize their impacts.

4.7 Lacassine Wilderness Goal

Restore and maintain the wilderness character and biological integrity of the Lacassine Wilderness by continuing to monitor habitat condition, maintaining a fire regime that approximates a natural interval (3-4 years), and taking necessary steps to control invasive plants.

Discussion: Unit I, a 3,345 acre tract south of the Gulf Intracoastal Waterway, was formally designated by Congress as Wilderness in 1976 under Public Law 94-557, and is protected by the provisions of the 1964 Wilderness Act, whose purpose is to "secure for the American people of present and future generations the benefits of an enduring resource of wilderness."

Management of wilderness areas within the National Wildlife Refuge System is governed by the Act, by the designating legislation, and by policies set forth by the Department of the Interior and the Fish and Wildlife Service. Priorities for wilderness areas within the NWRS include:

- preserving wilderness values as mandated by the Wilderness Act (610 FW 1)
- designing wildlife population management strategies to support refuge purposes, including Wilderness Act purposes
- controlling invasive species, pests, or diseases when we have demonstrated that they have degraded or there is a high probability they will degrade the biological integrity, diversity, environmental health, or wilderness character of a wilderness area (610 FW 1**,** 2.16 and 2.19)

A wilderness area, according to the Wilderness Act, is an:

> area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value (Wilderness Act Sec. 2(c)).

The most important management issue in Lacassine Wilderness is the infestation of exotic invasive plants, especially tallowtree. The primary tool to control tallowtree in the wilderness is prescribed fire; funding constraints have limited application of prescribed fire in the past. Fire will continue to be the primary tool for this purpose; however, herbicides may be used in cases where fire is not effective or available.

Other concerns to be addressed at Lacassine Wilderness are: permanent changes of freshwater habitats, monitoring effects on wilderness character, and opportunities for environmental education, interpretation, and outreach (610 FW 1.12B).

4.7.1 Objective 4.7.1

In Unit I, reduce acreage infested by Chinese tallowtrees by 500 acres by 2015 and maintain at <100 acres after 2015, and control any giant salvinia when found in order to keep this species below threshold level for detrimental ecological effects, maintaining coverage of all aquatic invasive species to no more than 200 acres total.

Adaptive Management Monitoring Elements	
Habitat Response Variables	**Probable Methods**
• Cover of tallowtree and other invasive exotic plants	• transects or plots
Wildlife Response Variables	**Probable Methods**
• waterfowl populations	• aerial surveys

Resource of Concern: Waterfowl, colonial waterbirds

CCP Reference: Objective A-8, A-10

Rationale: Invasive exotic plants such as tallowtree threaten the biological integrity of habitats, outcompeting and replacing plants with greater value to wildlife and reducing biodiversity. Invasive exotic plants also degrade the wilderness character of the wilderness area. While eradication is not possible for the majority of these species, it is feasible to maintain them at levels which minimize their impacts.

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5.0 HABITAT MANAGEMENT STRATEGIES

The following management strategies will be employed to satisfy the habitat objectives stated in Section 4. Habitat Goals and Objectives. Management strategies are described by habitat type.

5.1 Impounded Freshwater Marsh Habitat Management Strategies

Units D, G1, G2, G3 (16,000 acres, Lacassine Pool)

5.1.1 Potential Strategies

Lacassine Pool is, to some extent, an artificial system, maintained fresher and wetter than it otherwise would be without the levees and water control structures. A range of strategies for managing Lacassine Pool is possible. Water levels could be maintained at relatively constant levels which would fluctuate only as a result of precipitation and evaporation. Under this scenario, the marsh vegetation would continue to increase, and open water areas would tend to decrease. Vegetation management strategies such as herbicide and mechanical treatments could be used to slow the accumulation of biomass and prevent the closing of open water areas. Alternatively, water levels could be manipulated more actively, with periodic dry-downs and burns, to actively reduce biomass accumulation and prevent or reverse the shift from open water to marsh. This approach could be taken for the entire pool, or could be applied sequentially to the individual units in a rotation which would maintain higher spatial habitat diversity across the pool. For all of the above strategies, it would be necessary to continue to maintain and upgrade the water control structures, including levees and spillways. Finally, a more passive approach to managing Lacassine Pool would be to open the water control structures and allow the pool to reach the same level as unimpounded areas around it, that is to say, at the level maintained by the US Army Corps of Engineers at the Catfish Locks.

5.1.2 Management Strategy Prescription

The following prescription was selected as the best alternative to meet the objectives stated in 4.1 above: maintain and operate water control structures to manipulate water levels in individual units on a rotation, and incorporate prescribed fire to reduce biomass accumulation. Individual strategic elements of this prescription follow.

5.1.2.1 Spillway and levee maintenance

Repair and maintain 70 miles of spillways and levees annually. Maintaining levees and water control structures is essential to retain the capacity to manage water on the refuge. Managing water levels is the most important way that managers direct habitat responses on Lacassine NWR; without these structures, management capability of the refuge would be severely restricted. Levees and water control structures are subject to wear and tear from normal use, to erosion and damage by wildlife, and to catastrophic failure during storms. Levee maintenance and repair is accomplished with equipment including mowers, excavators, dozers, and backhoes. Water contol structures are repaired and replaced as needed using contract or partner (oil

companies, Ducks Unlimited) equipment and labor. Maintaining the levees and water control structures in good condition will result in better control of water levels, which in turn will allow managers to fill and draw down units on schedule to treat vegetation, burn, and conduct other management activities. This strategy will enable managers to reduce the amount of vegetative cover and detritus in Lacassine Pool and increase the amount of open water, resulting in improvement of habitat for waterfowl and fisheries.

Maintenance will consist of the following steps:

- After all significant storm events, but in any event, at least annually, inspect all levees and spillways for damage or deterioration.
- Repair breaches, erosion, leaks, or other deficiencies in levees and spillways using available resources and funding.

Expected effects of this strategy:

- Flooding and drawdown of subunits will be facilitated.
- Low to moderate intensity storms may have less impact on the pool because the levees and spillways will be well maintained and more able to resist storm surge.

5.1.2.2 Normal spillway operations

Operate the spillway structures to accommodate a pool level that benefits migratory birds and takes into consideration fish and other wildlife. This strategy consists of:

- Between March 15 and October 15, when water levels exceed 1.3 ft (NAVD-88), and water levels outside the pool are lower, open spillways to allow water to flow out until water level is 1.3 ft.
- Between March 15 and October 15, when water levels fall below 1.3 ft. (NAVD-88) and water levels outside the pool are higher, open the spillways to allow water to flow into the pool until the level is 1.3 ft.
- If water level in the pool differs from 1.3 ft, but water level outside the pool is not conducive to gravity-flow adjustment in the desired direction (i.e. the pool is too high, but water outside the pool is even higher than that inside, or the water inside the pool is too low, but water levels outside the pool are even lower), then adjustments will not be possible, and the spillways will remain closed.
- Between October 16 and March 14 of each year, when water level in the pool falls below 0.3 ft. (NAVD-88) and water levels outside the pool are higher, open spillways to allow water to flow in until water level inside the pool rises to 0.8 ft. or to the same elevation as the water levels outside the pool, whichever is less.
- Between October 16 and March 14 of each year, when water level in the pool rises above 0.8 ft. (NAVD-88) and water levels outside the pool are lower, open spillways to allow water to flow out of the pool until the level is 0.3 ft., or at the same elevation as water outside the pool, whichever is higher.

- If, between October 16 and March 14 of each year, the water level inside the pool exceeds 0.8 ft. or falls below 0.3 ft., and the water level outside the pool is not conducive to gravity flow adjustment in the desired direction, then adjustments will not be possible, and the spillways will remain closed.

Expected effects of this strategy:

- During normal years, water levels will be maintained at or near target levels for most of the year, promoting desirable vegetation growth (emergent marsh vegetation and submerged aquatic vegetation) and waterfowl feeding during the winter.
- During exceptionally wet or dry years, water levels in the pool will vary from target levels more frequently; however, during dry years, the pool will retain more water than surrounding unimpounded marsh, providing much-needed habitat during critical periods.
- Maintaining the pool as an impounded freshwater marsh has been shown to cause increased accumulation of organic matter compared with unimpounded marsh, which undergoes natural drying cycles (Bryant, 1996).

5.1.2.3 Periodic drawdown and prescribed fire

Depending upon availability of resources, environmental conditions (i.e., such as when drought conditions are most favorable), but no more frequently than every 5 years for any one subunit, individual sub-units will be completely drawn down to a target level of -1.80 feet (NAVD 88) to allow for oxidation and to conduct prescribed burns to set back natural succession and dispose of accumulated dead plant material. Favorable drought conditions normally occur during periods of low rainfall, and often coincide with multi-year El Niño Southern Oscillation cycles (NOAA no date). Note that a level of -1.8 ft. can only be achieved by closing the water control structures during a drought and allowing the pool to dry down by evaporation, since the target level is below sea level. Prescribed burning will be applied during the summer months whenever possible to control invasive brush and tree species. No more than two sub-units may be under treatment within a 5-year period and only one in any given year.

This oxidation and burning is necessary to remove organic material that is building up at a rate 5 times greater than that for natural marsh, with an accretion rate of 32 cm. in 31 years (Bryant 1996). Without this action the pool would eventually fill in and convert to a more terrestrial habitat.

Specifically, this strategy consists of the following steps:

- When favorable conditions occur, a maximum of one of the four Lacassine Pool subunits (G1, G2, G3, D) will be drained by opening spillways and allowing the water to flow out and/or pumping water from the target subunit to one of the other subunits within Lacassine Pool.
- Low water level inside the pool will be maintained by leaving the spillways open as long as the outside water level is lower; the manager may elect to close the spillways in the

event that water level outside the pool rises due to precipitation events that do not directly affect water level inside the pool (i.e. rainfall upstream) to prevent water flowing into the pool.

- Low water level will be maintained for up to 36 months within the subunit to allow for biological oxidation of organic matter.
- If conditions within the drawn-down subunit permit, (dry organic soil horizon, favorable surface fuel and weather conditions), prescribed fire may be applied to the unit with the objective of removing accumulated organic matter (muck) and increasing the proportion of the marsh which will be covered by open water. Preferred season for burning is during the growing season to take advantage of the higher impact on woody plants during that time; however, prescriptions may be written for any season in which favorable conditions can be expected and primary objective (removal of organic matter) can be achieved.
- All prescribed fire will be applied in accordance with the Fire Management Plan and under an approved prescription.
- Once a unit has undergone the desired amount of biological oxidation, or has been drawn down for a maximum of 36 months, or has been burned, whichever occurs first, the unit will be reflooded by opening spillways, provided outside water levels permit. Normal spillway operations (see 5.1.2.2) will resume.
- In the event that a new or modified treatment is proposed, managers may implement it first on an experimental/demonstration basis on Unit D.

Prioritization and timing rules:

- A maximum of two subunits will be so treated during any 5 year period.
- Only one subunit will undergo drawdown treatment during any given year.
- No subunit will be treated more frequently than every 5 years.
- Subunits will be prioritized according to organic matter accumulation and loss of open water habitat.

Application of these steps and rules over the 15-year planning period covered by this Habitat Management Plan would theoretically result in a maximum of 3 drawdowns for any one of the 4 subunits, and a maximum of 6 drawdown treatments (total) across the 4 subunits. Actual frequency will depend on climatic conditions and need for treatment, based on organic matter accumulation and loss of open water habitat, as determined by monitoring (section 5.1.2.4). Note that in 2011, a prolonged drought dried down the entire Lacassine Pool. Managers took the opportunity provided by this climatic event to apply prescribed fire to much of the pool. Flexible application of these principles will continue in the future in order to optimize habitat quality and quantity and fulfill the refuge purposes.

Expected effects of this strategy:

- It is expected that periodic drawdowns, with or without prescribed burning, will reduce accumulations of organic matter in the pool, maintaining desired balance between emergent marsh vegetation and open water.

- Prescribed fire will accelerate removal of organic matter from the pool and maintain woody vegetation at low levels.
- Adverse effects of ground fires may include:
    - smoke issues in nearby population centers
    - removal of too much organic matter, resulting in large areas of open water

5.1.2.4 Monitoring

Monitor changes in Lacassine Pool with an emphasis on identifying aquatic plant types, ratios of open water to vegetation coverage, and comparisons of vegetation/water ratio trends over a 5-year time period. Determine vegetation/water ratio changes associated with years following major hurricane events and any introduction of higher salinity waters. Monitoring is necessary for successful adaptive management. Quantifying the effects of management actions allows managers to assess the success of actions and to change them if they are not producing the desired effect. Since the management of Lacassine Pool (Units D, G1, G2, and G3) is focused on balancing marsh vegetation and open water and on promoting desirable species while discouraging undesirable species, collecting data on these variables is necessary. Furthermore, management actions may need to be adjusted in response to uncontrolled natural events such as hurricanes, so measuring their effects is also important.

Specifically, monitoring will include the following elements:

- Annual line transects will be used to measure proportions of emergent marsh, submerged aquatic and woody vegetation, and open water cover.
- Vertical accumulation of organic matter will be tracked by use of fixed steel posts or other reasonable methods.
- Sampling design and intensity will be selected to ensure statistically valid estimates.
- Woody plant cover will be estimated by transect or by acquisition and analysis of remotely sensed data on a three-year cycle.
- Aerial winter waterfowl surveys (3x yr)
- Ground fall/winter waterfowl surveys (3x yr)
- Rookery surveys—colonial wading birds (annual)
- Periodic acquisition and analysis of remotely sensed data

Expected effects of this strategy:

- Monitoring will provide data on the effects of management actions which will serve as the primary input for adaptive management.

5.1.2.5 Chemical management of invasive plants

Control invasive exotic vegetation with herbicides as needed to achieve Objective 4.1.1 and 4.1.2 and maintain open water at a ratio of 50:50 with marsh vegetation in Lacassine Pool. Even with proper maintenance of marsh vegetation with water level manipulation and fire, exotic weeds such as water hyacinth, hydrilla, giant salvinia, and alligator weed can quickly cover formerly

open water areas and degrade habitat. Periodic use of herbicides will be required to keep these pest species under control.

Location – Units G1, G2, G3, and D.

Timing – Periodic, ongoing as described above.

Frequency – Annual except for drawdown and prescribed fire.

Specific aspects of this strategy include:

- Map new infestations of water hyacinth, hydrilla, giant salvinia, alligator weed, and tallowtree by GPS as discovered.
- Tallowtree, hydrilla, giant salvinia, water hyacinth, and alligator weed will be treated with appropriate, approved chemicals as need exists and funding is made available.
- Chemical pesticides will be used to supplement, rather than as a substitute for, invasive plant control of other types. In most cases, the most narrowly specific pesticide available will be used, unless hazard or persistence issues preclude that choice (7 RM 14). All herbicides will be approved through the Pesticide Use Proposal process and will follow Integrated Pest Management Policy (569 FW 1). An up-to-date list of approved herbicides is kept on file at the refuge complex office.

Expected effects of this strategy are:

- Invasive exotic aquatic plants will be maintained at less than 20% cover of open water areas.

5.2 Unimpounded Freshwater Marsh Management Strategies

(Units E2, F1, F2, H, I, J (14,700 acres)

5.2.1 Potential Strategies

Unimpounded marsh on Lacassine NWR borders Lacassine Bayou and Willow Cutoff, and consists mainly of units E2, F1, F2, H, I, and J, with parts of E1 and F3. A number of strategies for managing unimpounded freshwater marsh to achieve the objectives described in section 4.2 are possible, ranging from passive management without attempting to restore or arrest the conversion of marsh to open water areas to active management strategies involving engineering projects designed to restore marsh and improve habitat. Additional management requirements and constraints apply to Unit I, which is a designated Wilderness Area. See Section 5.7 for additional strategies which apply to this unit. Passive management, or a continuation of current management direction, would result in the continued loss of marsh vegetation along the margin of Lacassine Bayou and within the marsh as storm events, wave action, oil and gas access canals, boat traffic, and saltwater intrusion conspire to erode fragile marsh soils and convert vegetated areas to open water. A number of management actions can be taken to slow or reverse the loss of wetland, including installation of water control structures to reduce saltwater intrusion,

construction of terraces in open water areas, and beneficial use of dredge spoil. Water control structures have been used on nearby Cameron Prarie NWR for decades to control saltwater intrusion through Calcasieu Ship Channel into the East Cove unit of the refuge. These structures are expensive and would probably need to be constructed in partnership with other agencies. Terraces are linear berms constructed from existing sediment in open water areas by excavating and filling. They are constructed perpendicular to prevailing wind direction, and serve to break up wave action by reducing the fetch length and producing quiet water areas on the lee side (Rozas and Minello 2001). Reducing the fetch length reduces wave intensity, which in turn decreases erosion. Deeper water areas adjacent to the terraces (where the material for the terrace was removed) trap sediments and serve as habitat for submerged aquatic vegetation. Terracing has been shown to increase habitat quality for shorebirds, aerialists, and dabbling foragers (O'Connell 2006) and for important fishery species (Rozas and Minello 2001). Beneficial use of dredge spoil is the application of dredge spoil in open water areas to restore marsh. Beneficial use of this material not only restores marsh areas but also reduces the need to dispose of dredge material in in spoil banks or other, less desirable ways. Dredge spoil obtained from the Calcasieu Ship Channel has been successfully used on nearby Sabine NWR for marsh restoration. There, spoil is pumped through a pipeline and deposited into open water areas enclosed by levees. Deposited spoil is quickly colonized by *Spartina patens* without recourse to artificial regeneration. To address the loss of marsh along the margin of Lacassine Bayou, which is caused by wave action from wind and boat wakes, the shore of the bayou could be hardened by placing riprap or other shoreline armoring material or a method like "living shorelines" (Lutz 2005).

In any case, successful control of invasive exotic plants (objective 1, section 4.2.1) will involve some kind of active management. Prescribed fire can be applied when water levels are low. Fire is used to set back succession and control woody invasives, primarily tallowtree. Prescribed fire would be restricted to surface fires; ground fire would be undesirable because it would contribute to loss of emergent marsh habitat. Herbicide application is another feasible strategy for keeping invasive exotic plants under control in these units. Herbicides can be selectively applied when exotic infestations are localized, or in some cases, selective chemicals (e.g. broadleaf plant herbicides) can be used over the top of resistant, desirable vegetation.

As with other restoration and management actions, proper monitoring should be a component of the management of the unimpounded marsh units on Lacassine NWR. Monitoring allows managers to create a record of habitat conditions over time and relate them to management actions taken on the units. Monitoring can be accomplished in a number of ways, either by personnel on the ground with a variety of plot and transect designs or by aerial photography, which gives a "big picture" look at conditions without providing as much detail as ground-based surveys. Information collected in either of these two ways can be supplemented with water sampling, records of fish and game take, and wildlife census data.

Because all of the restoration options have not yet been evaluated for feasibility for achieving the conditions described in 4.2.2, it will be necessary to conduct a feasibility study for the various options available to managers of LNWR. The study should evaluate all possible options for

marsh restoration and preventing wetland loss, including methods which have been used on nearby areas such as water control structures, beneficial use of dredge spoil, and construction of terraces.

5.2.2 Management Strategy Prescription

5.2.2.1 Prescribed fire

Continue to burn unimpounded marsh units on a 3-year cycle as conditions allow. Units should be burned when water is mostly off the unit but soils are still too wet to ignite, to avoid undesirable ground fires. Objective of the burns is to top-kill woody plants including baccharis and waxmyrtle, topkill woody invasives including Chinese tallowtree, and open up space for large-seeded annual plants to establish.

Specifics of this strategy are:

- Prescribed fire will be applied on an approximate 3 year return interval with the primary objective to set back woody plants including native species as well as tallowtree.
- Prescribed burns will be conducted under conditions conducive to surface fuel consumption and to avoid ground fuel (muck) consumption.
- Growing season fire will be preferred because it has the greatest impact on woody plants

All prescribed fire will be applied in accordance with the Fire Management Plan and under an approved prescription.

Expected effects of this strategy include:

- Tallowtree will be maintained below levels at which it impacts habitat quality (<10%);
- Native woody plants (waxmyrtle, baccharis) will be maintained so that total woody plant cover is below 30% cover to maintain suitability for breeding by mottled duck (Rorabaugh and Zwank 1983).

5.2.2.2 Invasive plant control

Use approved herbicides as needed to control giant salvinia, water hyacinth, hydrilla, alligator weed, and tallowtree. Units should be evaluated on an annual basis for presence of these plants, and treatment should be applied as needed to keep populations below levels which would negatively impact habitat quality for waterfowl or colonial waterbirds. At a minimum, this means that waterways are mostly open water (>90%) and tallowtree stems are small enough and far enough apart so as not to significantly reduce marsh productivity.

Specific aspects of this strategy include:

- Map new infestations of water hyacinth, giant salvinia, and tallowtree by GPS as discovered.

- Tallowtree, hydrilla, giant salvinia, water hyacinth, and alligator weed will be treated with appropriate, approved chemicals as need exists and funding is made available.
- Chemical pesticides will be used to supplement, rather than as a substitute for, invasive plant control of other types. In most cases, the most narrowly specific pesticide available will be used, unless hazard or persistence issues preclude that choice (7 RM 14). All herbicides will be approved through the Pesticide Use Proposal process and will follow Integrated Pest Management Policy (569 FW 1). An up-to-date list of approved herbicides is kept on file at the refuge complex office.

Expected effects of this strategy are:

- Invasive exotic aquatic plants will be maintained at less than 20% cover of open water areas.
- Herbicides can impact non-target organisms, typically non-target plants. Non-target impacts will be considered when selecting herbicides and application methods for control of invasive exotic plants.

5.2.2.3 Monitoring

Monitor vegetative changes via remotely sensed data. Maintain a GIS database of marsh habitat extent and type over time to document changes which occur on the refuge.

Specifically, monitoring will include the following elements:

- Periodic aerial photography will be used to estimate proportions of emergent marsh, submerged aquatic vegetation, and open water cover.
- Aerial winter waterfowl surveys (3x yr)
- Ground fall/winter waterfowl surveys (3x yr)
- Rookery surveys—colonial wading birds (annual)
- Quadrat/transect sampling method (spring/summer/fall), marsh and prairie vegetation
- Periodic acquisition and analysis of remotely sensed data

Expected effects of this strategy:

- Monitoring will provide data on the effects of management actions which will serve as the primary input for adaptive management.

5.2.2.4 Feasibility study for marsh restoration

Prepare a feasibility study by 2017 and, if appropriate, a restoration plan for the marshes adjacent to Lacassine Bayou (Willow Cutoff), based on hydrologic modeling and using one of the potential restoration strategies listed in 5.2.1 above as a means to improve water quality, restore marshes, and increase submerged aquatic vegetation.

Location – Units E-2, F-1, F-2, F-3, H, and J.

Timing – By 2017, prepare a marsh restoration and protection plan (including prescribed fire frequency and seasonality) which would address erosion problems, water quality, and needed restoration methods and materials.

Intensity--Lacassine Bayou restoration would potentially entail the installation of approximately 1,500 feet of riprap along the eastern side of Lacassine Bayou near Willow Cutoff.

Addresses Objectives 4.2.1, 4.2.2, and 4.2.3

5.3 Moist Soil Management Strategies

Units A, B, and C (600 acres)

5.3.1 Potential Strategies

Potential strategies to create regular disturbance to produce the conditions described in Objective 4.3 on these areas include mechanical methods such as water buffaloing, disking, and mowing, as well as chemical treatments applied to reduce the cover of undesirable woody plants and perennial herbs.

Figure 12. Water Buffalo (Lawson Aerators)

A water buffalo (Figure 12) is an apparatus used in flooded conditions to knock down vegetation. It consists of a heavy pipe mounted on a frame which rolls freely when pulled behind a tractor. Shovel like projections on the pipe penetrate the soil with a chopping effect (CPNWR Narrative 1993). The water buffalo creates a mosaic pattern of vegetation and open moist soil, which benefits waterfowl as well as many other species of birds.

In drier years, mowing and disking have been successful in producing desired annuals in moist soil units. Herbicide applications, although technically feasible have had minimal effect on woody plants and invasive vegetation due to the lack of consistent financial resources to treat areas on an annual schedule. Prescribed fire, while a means of causing disturbance, has not been a viable option on LNWR due to wet conditions and lack of fuels capable of carrying fire.

Hydrology is the most important tool in moist soil management. Draw-down and flood timing is crucial in producing diverse stands of desirable moist soil vegetation. The combination of water manipulation and disturbance will produce annuals, which sustain migrating waterfowl throughout the winter (Low and Bellrose 1944). The moist soil vegetation also serves as nurseries for invertebrates that are consumed by waterfowl preparing for the return migration north and by many species with complementary needs, notably shorebirds.

Manipulation of water levels depends on well-maintained, functioning water control structures, including levees and stop-log structures. Maintaining these improvements must be a primary task of management on LNWR in order to retain the necessary level of control over water levels to successfully manage early-successional wetland areas.

Management should be directed at gradual flooding and draining of impoundments at appropriate times during the spring and fall migration to create optimal foraging conditions for extended periods of time. Managed moist soil units should be flooded from August through March for

early migrating waterfowl such as blue-winged teal, pintail, and shorebirds. Units should be dewatered by late March (Strader and Stinson 2005). Water depth should be maintained at depths of ≤ 10 inches (Fredrickson and Heitmeyer 1991). Ideal depths in moist soil units are 6" – 8" to favor dabbling ducks, with sheetwater (<6") in other areas to support migrating geese and shorebirds. Water buffaloing or burning and flooding rice stubble increases Pintail use by providing open water <10 inches deep with abundant grain in the sediment (Fredrickson and Heitmeyer 1991).

Monitoring and documentation of actions and results is a key component of adaptive management in any context. Therefore, it is necessary to plan, monitor, and document plant and wildlife responses to moist soil management actions by unit. To do this, it will be necessary to Iinstall water level gauges on all water control structures by 2012.

5.3.2 Strategy Prescription

- Provide shallow early successional wetlands with sheet water from mid-July through September for migrating shorebirds in Field S-4 of Unit B, Unit A, and/or Unit C. From September through March, provide up to 8 inches of water and a minimum of 80% of vegetation cover for wintering migratory waterfowl.
- Manage all moist soil fields to maximize production of annual plants recognized as preferred waterfowl habitat. Use various management tools, including manipulating water levels and soil moisture, discing, burning, mowing, water buffaloing, and selective herbicide application. Disking and mowing will be used in dry years; water buffaloing will be used under wet conditions. All of these actions will result in setting back succession to annuals, which are desirable for waterfowl food production.
- Rework all levees in unit C, replace the water control structure with a Sea Breeze water control structure.
- Monitor and document plant and wildlife responses in all moist soil fields, and document management actions and unmet management needs for the following year in Annual Work Plans.

Location – Units A, C, and field S-4 in Unit B.

Timing – Drawdowns will be completed by mid-April, and plowing should be done by late spring or early summer. Mosaic water buffaloing will be done after flooding in August or September. Herbicide spraying will be done during the growing season as needed.

Frequency - Annually

Intensity – Treatments will be done as needed to maintain a ground coverage of at least 80 % of preferred waterfowl habitat and produce a seed base from preferred waterfowl plant species (Strader and Stinson, 2005).

Addresses Objectives 4.3.1 and 4.3.2

Specifics of this strategy include:

- Mow or disk 600 acres of Unit B (Field S-4), Unit A, and Unit C every year between 15APR and 15JUN.
- If necessary, herbicide application will take place during the growing season while the unit is not flooded. See section 5.1.2.5 for note on herbicide use.
- Tallowtree, baccharis, and waxmyrtle will be treated with appropriate, approved herbicides as need exists and funding is made available.
- Chemical pesticides will be used to supplement, rather than as a substitute for, invasive plant control of other types. In most cases, the most narrowly specific pesticide available will be used, unless hazard or persistence issues preclude that choice (7 RM 14). All herbicides will be approved through the Pesticide Use Proposal process and will follow Integrated Pest Management Policy (569 FW 1). An up-to-date list of approved herbicides is kept on file at the refuge complex office.
- Flood 600 acres of Unit B (Field S-4), Unit A, and Unit C every year between 01AUG and 30SEP to a depth of 2 to 8 inches and maintain flooding until spring drawdown.
- Water-buffalo as needed in August or September after flooding. Water buffalo treatment will be used to create 50% vegetation/50% open water when vegetation cover is higher than desired
- Draw down 600 acres of Unit B (Field S-4), Unit A, and Unit C every year between 01MAR and 01JUL.

Expected effects of this strategy:

- 600 acres of early-successional wetland will be maintained for wintering waterfowl annually on Lacassine NWR

5.4 Coastal Prairie Management Strategies

Unit Duralde Prairie (334 acres)

5.4.1 Potential Strategies

The wetland prairie ecosystem on the Lacassine NWR Duralde Prairie tract is unique to southwest Louisiana and an important part of our natural heritage. Only 1% of the original coastal prairie remains intact, and it is disappearing at alarming rates. Consequently, prairie flora and fauna are rare, and many are endangered. Ecological processes acting in prairie ecosystems are complex and are the subject of ongoing research. Prairie restoration, like the restoration of any ecosystem, involves the re-integration or re-creation of the structural components of the ecosystem with its critical processes. In grasslands, this means making sure that at least dominant grass species and more important forb species are present, and removing or decreasing species which do not belong in a prairie system, such as shrubs, trees, and exotics. It also means restoring fire to its preeminent place as an ecosystem process. Each of these will be discussed below. Potential strategies for replacing plant species which are absent include direct seeding,

either with commercially available seed or with seed harvested from nearby intact prairie, and planting of nursery-grown seedlings. As with other components of the management of LNWR, monitoring will be an important part of the prescription so that effective adaptive management can be done. Management of the Duralde Prairie unit is accomplished in partnership under a cooperative land management agreement with the Cajun Prairie Habitat Preservation Society.

5.4.1.1 Restoring prairie plants

Direct seeding. The most cost-effective method of restoring large areas of native grassland is usually to sow seed of the desired species onto prepared seedbeds at the appropriate time of year (winter, in the case of southwestern Louisiana). Since native plants vary over relatively small geographic and even topographic distances, seed from nearby sources, and similar sites if possible, should always be used. Provenance of commercially available prairie grass seed is often distant from the Gulf Coast, and the resulting plants, though they may be the proper species, will not necessarily thrive if planted there. Therefore, the best way to obtain seed is to harvest it from nearby intact native prairie, if that is available. The following caveats should be observed when collecting seed from wild sources:

- Make sure that undesirable species, especially invasive exotics, are not present in the seed production area, or at least are not in fruit at the time of seed collection.
- Collect seed at different times of the year to ensure that as many (desirable) species as possible are included in the mix.
- Fresh seed is better; seed of some species do not store well.

If local wild seed are not available, some prairie species are commercially available. However, efforts should be made to use provenances within 250 miles (100 miles is best) of the restoration site (USFWS and USGS 1999).

Planting seedlings. Seedlings of some native prairie species are commercially available from nurseries, and seedlings can also be contract-grown from locally produced seed. These seedlings are typically grown in containers ("plugs") designed for winter planting. Planting seedlings is more expensive than sowing seed, but if done properly is more reliable and will result in a more uniform stand. Of course, provenance requirements are the same for plugs as for seed.

5.4.1.2 Removing undesirable plants

Herbicide application. Undesirable plants can be removed by application of herbicides. This method is particularly useful on sites where prairie plants have not yet been restored, although selective application can be done in established prairie as well.

Mechanical removal. Undesirable plants, especially woody plants, can be mechanically removed from restoration sites or from existing prairie, either by manual or mechanized methods. Woody plants which are cut will usually resprout, requiring follow-up treatment for greatest efficacy. Cutting can be combined with selective herbicide application (e.g. "cut-stump application") for better results.

Fire. Fire, properly timed, will kill or top-kill susceptible plants and, over time, result in their decline in a prairie system. Tallowtree and eastern baccharis are top-killed by fire, and burning during the growing season under dry conditions can increase the effectiveness of fire at removing these two species (Grace et al. 2005). Fire is discussed more completely in the next section.

5.4.1.3 Restoring fire as an ecological process

Tallgrass prairie, including coastal prairie, is a fire-dependent system. Restoring fire is crucial to keep grasslands from succeeding to woody systems or becoming dominated by exotic species such as tallowtree. The prairies of the Louisiana and Texas Gulf Coast evolved under a natural regime of fires which were set by lightning and probably burned over very large areas (Grace et al. 2005). Humans have interacted with these systems, and in particular, manipulated the fire regime, for many millennia, and continue to do so today. Native Americans used fire as their primary land management tool, and they had a profound effect on the ecology of North America, including the grasslands of the Gulf Coast (Pyne 1982). Habitat fragmentation now requires that these "natural" fire regimes be mimicked by prescribed burning if prairie vegetation is to be maintained. There has been much discussion of, and research on, what the best fire return interval is for restoring and maintaining various types of prairie; however, a general consensus is that fire should be applied at least every 3-5 years, and as often as annually (e.g. Heisler et al. 2003, Marx et al. 2008), and there is evidence that the timing (both seasonal and year-to-year) and intensity should vary from application to application (Hamilton 2007).

5.4.2 Strategy Prescription

The Duralde Prairie unit is managed under a Cooperative Land Management Agreement between the USFWS and the Cajun Prairie Habitat Preservation Society (Appendix G).

- Burn the prairie during early-to-mid-growing season with an average fire return interval of three years.Apply prescribed fire in an adaptive management context, varying weather conditions, season, intensity, and frequency of burns as indicated by outcomes of previous treatments. The goal is to restore prairie structure and function to the unit by mimicking a natural fire regime. Fire return interval should average approximately 3 years, and season of burn should mirror lightning occurrence; i.e. early-to-mid growing season.
- Annual monitoring is needed to document success and any needed management for the following year. Monitor changes in vegetation on an annual basis to inform decisions about management actions. Monitoring should include measurements of herbaceous diversity and cover of desirable and undesirable species. Work with partners to establish a long-term monitoring plan using standardized protocol(s) (e.g., Project Prairie Bird) to measure grassland bird use and adapt management to achieve high-quality prairie habitat.
- Work with partners through a Cooperative Land Management Agreement (Appendix G) to transplant from prairie remnants.
- Work with partners through a Cooperative Land Management Agreement (Appendix G) to mow and apply herbicides to pest species.

- Work with partners through a Cooperative Land Management Agreement (Appendix G) to make several small prairie plantings, each from a different prairie remnant and each isolated genetically from one another (i.e., at least one mile between sites), to serve as diverse seed sources.

Location – Duralde Prairie unit.

Timing – Burns should occur during early-mid growing season. Herbicide spraying will occur during the growing season and transplanting should occur during late fall. Timing can and should be adjusted in light of new information (adaptive management).

Frequency –Burning will occur with an average fire return interval of three years. Treatment of weeds with herbicides will occur as needed, and transplanting of prairie species will occur whenever possible.

Intensity – Burns should only occur when 1-hour fuel moistures are between 7 and 10%.

Addresses Objective 4.4.1 and 4.4.2

Specifics of this strategy are contained in the Vidrine Prairie Restoration Management Plan, which is attached as part of Appendix G.

Expected effects of this strategy are contained in the Vidrine Prairie Restoration Management Plan, which is attached as part of Appendix G.

Strategies in this plan employed on the Duralde Prairie Unit include:

- Prescribed fire
- Mowing if prescribed fire is not possible
- Herbicide application to control woody plants
- Seed collection and dispersal
- Transplanting of prarie species from reference sites
- Monitoring of vegetation with transects and/or quadrat sampling methods
- Monitoring of prairie bird species

Details of these strategies are discussed in Appendix G.

5.5 Cropland Management Strategies

Units B, F3 (1,041 acres)

Cropland is an important component of waterfowl habitat in the Gulf Coast Prairie Landscape. Cereal grains, especially rice and millet, provide energy for waterfowl arriving from the breeding grounds in the fall. Lacassine NWR has 1,041 acres of cropland which is currently cooperatively farmed, and is mostly in rice with the balance in millet. Each year, approximately half of the farmland acreage is fallow, while the other half is farmed.

5.5.1 Potential Strategies

As described in Section 3.2.1, agricultural crops can significantly contribute to the nutrition and fitness of wintering waterfowl, a resource of concern on Lacassine NWR. Cooperative farming is an important component of the refuge meeting its waterfowl foraging habitat objective. Cooperative farming has been and will continue to be a cost-effective mechanism to provide the high-quality "hot foods" required by wintering waterfowl. Management of a cooperative farming program reduces dependence on refuge staff and equipment.

Rice, grain sorghum (milo), and maize (corn) are the top choices as grain crops for ducks in the Mississippi Alluvial Valley. Rice is particularly resistant to decomposition under flooded conditions. Grain sorghum and maize also provide high-energy resources for waterfowl and can generally be kept above the water surface, but problems arise from depredation prior to flooding, as well as seed decomposition after flooding.

Management Units B and F3, with croplands totaling 1,041 acres, will be farmed on a rotational basis with fallow field management (see section 5.5.2). Approximately one half of the acreage (520 ac) would be farmed one year and the other half the next year; keeping the idle half as fallow fields. This ensures that the management unit is disked every two years to reduce undesirable vegetation. Cooperative farming will be used unless it becomes unavailable, at which time force account farming will be considered as a substitute.

5.5.2 Strategy Prescription

- Maintain a farm agreement in accordance with Region 4 farming policy and procedure which requires the farmer to leave a percentage of the first and second crop unharvested, providing a quality food source for wintering waterfowl.
- Management of fallow rice fields should be similar to that for moist soil units to provide improved foraging habitat for wintering waterfowl. Fallow fields should be managed to provide improved habitat for wintering waterfowl by allowing plant seed maturation before discing or water buffaloing. See the section on moist soil management units (5.3) for details of practices. When managing fallow cropland for shorebirds, alter drawdown schedules to provide shallow water/mudflats from mid-August through October.
- If cooperative farming is lost as an available management option, contract farming or force account farming should be considered.

Location – Units B and F3.

Timing – Harvesting of the first rice crop must occur before mid August to allow maturation of the ratoon (second) crop. All field drains must be plugged following first crop harvest to hold rain water. If there is insufficient rainfall, water level will be adjusted by pumping.

Frequency -- Annually

Intensity – Goal is to provide 131 mallard use days per acre from rice crops (Stafford et al, 2005).

Addresses Objective 4.5.1

Specifics for this strategy:

- 1,041 acres of cropland in units B and F3 will be planted to rice on a one-year-crop, one-year-fallow rotation under a cooperative farming agreement.
- Harvest of first crop of rice must occur before August 15 to ensure maturation of ratoon crop, which is left in the field.
- After first crop is harvested, field will be flooded between 2 and 8 inches deep, either by precipitation or pumping from wells, and kept flooded through winter.
- This method will produce approximately 131 mallard-use-days per acre, or a total of about 68,120 mallard-use-days over the 520 acres cropped each year.
- Fallow acreage will be treated similar to moist soil management units (see section 5.3 for details).

Expected effects of this strategy:

- Lacassine NWR will produce 68,120 mallard-use-days of high-energy food for wintering waterfowl every year.
- 520 acres of fallow fields will provide a diverse mix of early-successional plants to provide high quality nutrition for wintering waterfowl.

5.6 Forested Wetland Habitat Management Strategies

5.6.1 Potential Strategies

Forested wetland on Lacassine NWR is passively managed to provide habitat for wood ducks and other wildlife which utilize forested habitats. Because of the small amount of habitat on the refuge and the fact that most of the area would be inoperable for forest management equipment, traditional forest management is not an option. Controlling exotic invasive plants is therefore the only management action taken in these areas. Options for control include herbicide and mechanical removal. Mechanical control of woody vegetation can be accomplished by use of a tractor-mounted mulching head or a mower. Woody stems may be selectively treated with herbicide by basal spray, hack-and-squirt, or cut-stump treatment. Aerial application of herbicides may be used when less selectivity is needed (e.g. large area of open water infested with salvinia or water hyacinth, or areas of heavy tallowtree cover).

5.6.2 Strategy Prescription

Invasive Control: Control Chinese tallowtree and other invasive exotic plant species with herbicide and mechanical treatments (mowing, mulching).

Addresses Objective 4.6.1

Specifics of this strategy:

- Tallowtree will be treated with an approved herbicide as needed.
- Chemical pesticides will be used to supplement, rather than as a substitute for, invasive plant control of other types. In most cases, the most narrowly specific pesticide available will be used, unless hazard or persistence issues preclude that choice (7 RM 14). All herbicides will be approved through the Pesticide Use Proposal process and will follow Integrated Pest Management Policy (569 FW 1). An up-to-date list of approved herbicides is kept on file at the refuge complex office.

Expected effects of this strategy:

- Tallowtree and other exotics will not proliferate to the point that they have a significant detrimental effect on forested wetland habitat on Lacassine NWR.

5.7 Wilderness Area Management Strategies

Lacassine Wilderness (Unit I) consists of 3,345 acres of unimpounded freshwater marsh. Management strategies for this habitat type are covered in Section 5.2. Additional management actions and constraints arising from the wilderness status of this unit are described here.

5.7.1 Potential Strategies

Management actions which are implemented in wilderness areas in order to accomplish refuge objectives and to comply with the Wilderness Act, the designating legislation, and with DOI and USFWS policy (610 FW) will follow a decision process, and each decision will be recorded. Records will be archived in the Refuge's administrative record. Projects will be assessed first for their suitability within the Lacassine Wilderness and, for projects determined to be suitable, the selection of the minimum tool or technique to use in the completion of the project will be made based on this process ("Minimum Requirement" Concept 610 FW 1.18).

5.7.1.1 Planning

A wilderness management plan was prepared for the refuge in 1986 (USFWS 1986). This plan needs to be updated in order to address recent issues including the invasion of exotic weed species. This planning effort should take the form of a Wilderness Stewardship Plan as described in the refuge Comprehensive Conservation Plan (USFWS 2007) (610 FW 3.8).

5.7.1.2 Visitor Access

Special provisions for management and visitor access to Lacassine Wilderness are based on the following from the 1964 Wilderness Act (PL 88-577): "Within wilderness areas designated by this Act the use of aircraft or motorboats, where these uses have already become established, may be permitted to continue subject to such restrictions as the Secretary of Agriculture deems desirable. In addition, such measure may be taken as may be necessary in the control of fire, insects, and diseases, subject to such conditions as the Secretary deems desirable." At the time the designating legislation (PL 94-557) was passed in 1976, the Congressional Record included the following language:

> Because of the limited access, public use remains relatively low with about 11,000 annual visitation recorded. Most visitors use the wildlife refuge for fishing and waterfowl hunting purposes. Use of motorboats for fishing and transportation to waterfowl hunting locations are traditional uses in the wilderness portion of the wildlife refuge. Such use occurs in navigable waters technically not in the wilderness. Further, the Wilderness Act (Sec. 4(d)(1)) recognizes that previously existing motorboat use may continue [sic.] and Sec. 6 of H.R. 15446 adopts this specific provision. Hunting and fishing activities are not precluded by wilderness designation.

However, at the time of this writing (October, 2011), the navigable waterways referred to in the Congressional Record language have closed up with marsh vegetation, and therefore no motorboat access is allowed in the wilderness.

In order to protect habitat, species, and wilderness values, it may be necessary to close portions of the wilderness area to visitors. If areas are closed, signs may be posted to that effect. The Wilderness Stewardship Plan should include provisions for area closures.

5.7.1.3 Threatened and Endangered Species

The refuge will meet the requirements of the Endangered Species Act and or any recovery plan affecting listed species. Any refuge operations in, or visitor use of, Lacassine Wilderness will support and observe the requirements of the ESA. An Intra-service Section 7 Biological Evaluation of potential impacts of management on listed species from the refuge Comprehensive Conservation Plan was conducted in 2006 (USFWS 2007). No impacts to species or critical habitat were found at that time for bald eagle, Louisiana black bear, or American alligator.

5.7.1.4 Exotic Species

Exotic invasive species are major threats on many National Wildlife Refuge wilderness areas (Cole and Landres 1996, Tempel et al. 2004). In the Lacassine Wilderness, the most important of these species are Chinese tallowtree and floating aquatic plants including salvinia and water hyacinth. Reasonable efforts will be made to control exotic invasive plant and animal species in the wilderness so that they do not reduce the wilderness character of the unit or degrade the habitat value of the unit for the Resources of Concern. A number of tools are available for this purpose.

- Fire—Warm-season fire can be used to set back, and eventually kill, woody invasives, notably tallowtree (Grace et al. 2005). Management options in the wilderness area are limited, but fire is a natural part of this ecosystem and is a viable tool for managing tallowtree.
- Herbicide—Aquatic invasives like giant salvinia and water hyacinth can be controlled with herbicide. Herbicide use in a wilderness area requires analysis of the necessity of the action to comply with the 1964 Wilderness Act (610 FW 1.19).
- Mechanical/hand Removal—Certain exotic plants can be managed by mechanical removal. For example, water hyacinth can be removed with hand tools or boat-mounted equipment (Cervone 2003).
- Trapping—Should exotic animals, particularly feral swine and nutria, become management problems in the wilderness area, trapping can be conducted to reduce their numbers and impacts.

5.7.1.5 Monitoring

Resource monitoring, particularly, the effects of habitat changes will be done annually using an established procedure (610 FW 2.28). Monitoring is the foundation of adaptive management; without good data on the effects of past management actions, rational decisions on future actions cannot be made. Monitoring in the wilderness area will be addressed in the Wilderness

Stewardship Plan as described in the refuge CCP (USFWS 2007). The following general monitoring actions are potential strategies for the Lacassine Wilderness:

- Habitat condition—Aerial surveys can be conducted to detect changes in habitat condition, particularly changes in extent of open water and emergent marsh vegetation and large-scale changes in plant communities.
- Use by migratory birds—Aerial surveys can be used to monitor use by waterfowl and other migratory and resident birds.
- Presence of exotic species—Exotic plant species can be detected aerially in many cases, although ground-based surveys may be necessary for detailed data.
- Human use—Human use of the wilderness area should be monitored in order to manage its impact on wilderness character and habitat quality.

5.7.2 Strategy Prescription

- Wilderness Stewardship Plan—To manage with a minimum of intrusion, preserve the character, and to prevent a loss of wilderness values, prepare a Wilderness Stewardship Plan by 2014 (610 FW 3).
- Prescribed Fire—Apply growing season fires on a 3-year return interval in unit I (Wilderness Area) to reduce the encroachment of exotic plant species.
- Chemical control of invasive exotic plants—Use herbicides or other management tools to reduce cover of aquatic invasives including water hyacinth and giant salvinia to less than 200 acres. Exotic species will be actively contained and suppressed and where possible extirpated. E xotic plants which show increasing cover trends over a 5 year period under the above fire regime will be considered for chemical or mechanical (hand) control, subject to the procedures described above in section 5.7.1. All herbicide use will follow approved FWS procedures.
- Monitoring—Conduct aerial surveys of unimpounded marsh in unit I (Wilderness Area) at least once every two years to visually monitor and record habitat changes and migratory bird presence within the Wilderness Area. Variables to be monitored include: presence of people, bird colonies, areas with invasive exotic species, and endangered and threatened species. Areas where these variables are measured will be mapped with GPS and photographed, and a standard record of site observations will be made. Indicators to be evaluated will be size of area, vegetation condition, and bird colony condition. Baseline and threshold conditions for action will be established in the Wilderness Stewardship Plan as described in 610 FW 3.8.

Addresses Objective 4.7.1

Effects of this strategy are expected to be:

- The Lacassine Wilderness will maintain its wilderness character and provide high quality habitat for the refuge's resources of concern.

Appendix A

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Appendix B

Authors and/or Contributors

- Rob “Goose” Gosnell, Complex Wildlife Biologist, author
- Wayne Syron, Wildlife Biologist co-author
- Glenn Harris, Complex Deputy Project Leader, contributor
- Matthew Johnson, Complex Fire Management Officer, contributor
- Richard Meyers, Refuge Manager, contributer
- Thomas A. Greene, Natural Resource Planner, contributor, editor

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Appendix C

Biota

Table C1. Species known or expected on Lacassine National Wildlife Refuge.

ANIMALS	
Common Name	Scientific Name
BIRDS*	
Loons	
Common Loon	*Gavia immer*
Grebes	
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps nigricollis*
Pelicans and their Allies	
American White Pelican	*Pelecanus erythrorhynchos*
Double–crested Cormorant	*Phalacrocorax auritus*
Neotropic Cormorant	*Phalacrocorax brasilianus*
Anhinga	*Anhinga anhinga*
Magnificent Frigatebird	*Fregata magnificens*
Herons, Egrets, and Allies	
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Tricolored Heron	*Egretta tricolor*
Reddish Egret	*Egretta rufescens*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nycticorax violacea*
Ibis, Spoonbill, and Stork	
Glossy Ibis	*Plegadis falcinellus*
White Ibis	*Eudocimus albus*
White-faced Ibis	*Plegadis chihi*

Roseate Spoonbill	*Platalea ajaia*
Wood Stork	*Mycteria americana*
Sandhill Crane	*Grus Canadensis*
Waterfowl	
Fulvous Whistling-Duck	*Dendrocygna bicolor*
Black-bellied Whistling Duck	*Dendrocygna autumnalis*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Ross's Goose	*Chen rossii*
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas crecca*
American Black Duck	*Anas rubripes*
Mottled Duck	*Anas fulvigula*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Canvasback	*Aytha valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Vultures, Hawks, and Allies	
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*

Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Northern Caracara	*Caracara cheriway*
Gallinaceous Birds	
Northern Bobwhite Quail	*Colinus virginianus*
Rails, Gallinules, Coots, and Cranes	
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
Clapper Rail	*Rallus longirostris*
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Purple Gallinule	*Porphyrio martinica*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica Americana*
Shorebirds	
Black-bellied Plover	*Pluvialis squatarola*
American Golden-Plover	*Pluvialis dominica*
Wilson's Plover	*Charadrius wilsonia*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Actitis macularia*
Upland Sandpiper	*Bartramia longicauda*
Whimbrel	*Numenius phaeopus*
Long-billed Curlew	*Numenius americanus*
Marbled Godwit	*Limosa fedoa*
Ruddy Turnstone	*Arenaria interpres*

Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
White-rumped Sandpiper	*Calidris fuscicollis*
Pectoral Sandpiper	*Calidris melanotos*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Calidris himantopus*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Laughing Gull	*Larus atricilla*
Franklin's Gull	*Larus pipixcan*
Bonaparte's Gull	*Larus Philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Gull-billed Tern	*Sterna nilotica*
Caspian Tern	*Sterna caspia*
Royal Tern	*Sterna maxima*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Least Tern	*Sterna antillarum*
Black Tern	*Childonias niger*
Black Skimmer	*Rynchops niger*
Pigeons and Doves	
Mourning Dove	*Zenaida macroura*
White-winged Dove	*Zenaida asiatica*
Cuckoos	
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Groove-billed Ani	*Crotophaga sulcirostris*
Owls	
Barn Owl	*Tyto alba*
Eastern Screech Owl	*Megascops asio*
Great Horned Owl	*Bubo virginianus*

Burrowing Owl	*Athene cunicularia*
Short-eared Owl	*Asio flammeus*
Nightjars	
Common Nighthawk	*Chordeiles minor*
Chuck-will's widow	*Caprimulgus carolinensis*
Whip-poor-will	*Caprimulgus vociferous*
Swifts and Hummingbirds	
Chimney Swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Kingfishers	
Belted Kingfisher	*Megaceryle alcyon*
Woodpeckers	
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Northern Flicker	*Colaptes auratus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Hairy Woodpecker	*Picoides villosus*
Flycatchers	
Olive-sided Flycatcher	*Contopus cooperi*
Eastern Wood-Pewee	*Contopus virens*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Acadian Flycatcher	*Empidonax virescens*
Eastern Phoebe	*Sayornis phoebe*
Vermilion Flycatcher	*Pyrocephalus rubinus*
Great Crested Flycatcher	*Myiarchus crinitus*
Western Kingbird	*Tyrannus verticalis*
Eastern Kingbird	*Tyrannus tyrannus*
Scissor-tailed Flycatcher	*Tyrannus forficatus*
Martins and Swallows	
Purple Martin	*Progne subis*
Tree Swallow	*Iridoproche bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Cliff Swallow	*Petrochelidon pyrrhonota*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Jays and Crows	
Blue Jay	*Cyanocitta cristata*

Fish Crow	*Corvus ossifragus*
Nuthatches	
Red-breasted Nuthatch	*Sitta Canadensis*
Creepers	
Brown Creeper	*Certhia americana*
Wrens	
Carolina Wren	*Thryothorus ludovicianus*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
House Wren	*Troglodytes aedon*
Carolina Chickadee	*Poecile carolinensis*
Kinglets and Gnatcatchers	
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Bluebirds	*Thrushes and Robins*
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Gray-cheeked Thrush	*Catharus minimus*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Thrashers	
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Northern Mockingbird	*Mimus polyglottos*
Pipits	
American Pitpit	*Anthus rubescens*
Waxwings	
Cedar Waxwing	*Bombycilla cedrorum*
Starling	
European Starling	*Sturnus vulgaris*
Shrike	
Loggerhead Shrike	*Lanius ludovicianus*
Vireos	
White-eyed Vireo	*Vireo griseus*

Blue-headed Vireo	*Vireo solitarius*
Yellow-throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Philadelphia Vireo	*Vireo philadelphicus*
Warblers	
Blue-winged Warbler	*Vermivora pinus*
Golden-winged Warbler	*Vermivora chrysoptera*
Tennessee Warbler	*Vermivora peregrine*
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Yellow-throated Warbler	*Dendroica dominica*
Prairie Warbler	*Dendroica discolor*
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea*
Blackpole Warbler	*Dendroica striata*
Cerulean Warbler	*Dendroica cerulea*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Prothonotary Warbler	*Protonotaria citrea*
Worm-eating Warbler	*Helmitheros vermivorus*
Ovenbird	*Seiurus aurocapilla*
Northern Waterthrush	*Seiurus noveboracensis*
Louisiana Waterthrush	*Seiurus motacilla*
Kentucky Warbler	*Oporornis formosus*
Mourning Warbler	*Oporonis philadelphia*
Hooded Warbler	*Wilsonia citrina*
Canada Warbler	*Wilsonia canadensis*
Yellow-breasted Chat	*Icteria virens*
Northern Parula	*Parula americana*

Common Yellowthroat	*Geothlypos trichas*
Wilson's Warbler	*Wilsonia pusilla*
Tanagers	
Summer Tanager	*Piranga rubra*
Scarlet Tanager	*Piranga olivacea*
Western Tanager	*Piranga ludoviciana*
New World Finches	
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Blue Grosbeak	*Passerina caerulea*
Indigo Bunting	*Passerina cyanea*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza Americana*
Sparrows	
Eastern Towhee	*Pipilo erythrophthalmus*
Field Sparrow	*Spizella pusilla*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Savannah Sparrow	*Passerculus sandwichensis*
LeConte's Sparrow	*Ammodramus leconteii*
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza Georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
White-crowned Sparrow	*Zonatrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
Chipping Sparrow	*Spizella passerina*
Blackbirds, Grackles, Cowbirds, and Orioles	
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Rusty Blackbird	*Euphagus carolinus*
Boat-tailed Grackle	*Quiscalus major*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*

Orchard Oriole	*Icterus spurius*
Altamira Oriole	*lcterus galulris*
Bobolink	*Dolichonyx oryzivorus*
Great-tailed Grackle	*Quiscalus mexicanus*
Old World Finches	
Purple Finch	*Carpodacus purpureus*
American Goldfinch	*Carduelis tristis*
Weaver Finches	
House Sparrow	*Passer domesticus*
MAMMALS	
Marsupials	
Virginia Opossum	*Didelphis marsupialis*
Edentates	
Nine-banded armadillo	*Dasypus novemcinctus*
Insectivores	
Least Shrew	*Cryptotis parva*
Bats	
Red Bat	*Lasiurus borealis*
Seminole Bat	*Lasiurus seminolus*
Yellow Bat	*Lasiurus ega*
Carnivores	
Coyote	*Canis latrans*
Gray Fox	*Urocyon cinereoargenteus*
Red Fox	*Vulpes vulpes*
Raccoon	*Procyon lotor*
Mink	*Mustela vison*
Striped Skunk	*Mephitis mephitis*
River Otter	*Lutra canadensis*
Bobcat	*Lynx rufus*
Ungulates	
White-tailed Deer	*Odocoileus virginianus*
Feral swine	*Sus scrofa*
Rodents	
Marsh Rice Rat	*Orysomys palustris*
Fulvous Harvest Mouse	*Reithrodontomys fulvescens*
Hispid Cotton Rat	*Sigmodon hispidus*
Muskrat	*Ondatra zibethicus*
House Mouse	*Mus musculus*

Black Rat	*Rattus rattus*
Norway Rat	*Rattus norvegicus*
Nutria	*Myocastor coypus*
Fox Squirrel	*Sciurus niger*
Lagomorphs	
Swamp Rabbit	*Sylvilagus aquaticus*
Eastern Cottontail	*Sylvilagus floridanus*
REPTILES AND AMPHIBIANS	
Alligator	
American Alligator	*Alligator mississippiensis*
Lizards	
Green Anole	*Anolis carolinensis*
Broadhead Skink	*Eumeces laticeps*
Ground Skink	*Scinella lateralis*
Five-lined Skink	*Eumeces fasciatus*
Slender Glass Lizard	*Ophisaurus attenuates*
Turtles	
Snapping Turtle	*Chelydra serpentina*
Alligator Snapping Turtle	*Macroclemys temminckii*
Mississippi Mud Turtle	*Kinosternon subrubrum hippocrepis*
Common Slider	*Trachemys scripta*
Spiny Softshell Turtle	*Apalone spinifera*
Chicken Turtle	*Deirochelys reticularia*
Eastern Box Turtle	*Terrapene carolina carolina*
Stinkpot Turtle	*Sternotherus odoratus*
Snakes	
Southern Water Snake	*Nerodia fasciata*
Mississippi Green Water Snake	*Nerodia cyclopion*
Diamondback Water Snake	*Nerodia rhombifer*
Brown Snake	*Storeria dekayi*
Western Ribbon Snake	*Thamnophis proximus proximus*
Glossy Crayfish Snake	*Regina rigida*
Eastern Hognose Snake	*Heterodon platirhinos*
Mud Snake	*Farancia abacura*
Racer	*Coluber constrictor*
Rat Snake	*Drymobius elaphe*
Common Kingsnake	*Lampropeltis getulus*
Southern Copperhead	*Agkinstodon contortrix contortrix*

Cottonmouth	*Agkinstodon piscivorus*
Pigmy Rattlesnake	*Sistrurus miliarius*
Yellow-bellied Water Snake	*Nerodia erythrogaster flavigaster*
Rough Green Snake	*Opheodrys aestivus*
Graham's Crayfish Snake	*Regina grahamii*
Salamanders	
Three-toed Amphiuma	*Amphiuma tridactylum*
Frogs and Toads	
Gulf Coast Toad	*Bufo valliceps valliceps*
Northern Cricket Frog	*Acris crepitans crepitans*
Green Treefrog	*Hyla cinera*
Eastern Narrow-mouthed Toad	*Gastrophryne carolinensis*
Bullfrog	*Rana catesbeiana*
Pig Frog	*Rana grylio*
Southern Leopard Frog	*Rana utricularia*
Squirrel Tree Frog	*Hyla squirella*
Woodhouse Toad	*Bufo woodhousii woodhousii*
CRUSTACEA	
Crustaceans	
White River Crayfish	*Procambarus acutus*
Red Swamp Crayfish	*Procambarus clarkii*
Isopods and Amphipods	
Wood-boring Isopod	*Limnoria tripunctata*
Rock Louse	*Ligia exotica*
Smooth-backed Isopod	*Sphaeroma quadridentatum*
Fish Louse	*Cymothous spp.*
Wharf Roach	*Ligia spp.*
Beach Flea	*Orchestia grillus*
Marsh Hopper	*Talorchestia spp.*
FISH	
Gars	
Spotted Gar	*Lepisosteus oculatus*
Longnose Gar	*Lepisosteus osseus*
Alligator Gar	*Lepisosteus spatula*
Bowfins	
Bowfin	*Amia calva*
Herrings	
Gizzard Shad	*Dorosoma cepedianum*

Threadfin Shad	*Dorosoma petenense*
Lizardfishes	
Inshore Lizardfish	*Synodus foetens*
Carps	
Common Carp	*Cyprinus carpio*
Golden Shiner	*Notemigonus crysoleucas*
Suckers	
Bigmouth Buffalo	*Ictiobus cyprinellus*
Freshwater Catfishes	
Blue Catfish	*Ictalurus furcatus*
Black Bullhead	*Ictalurus melas*
Yellow Bullhead	*Ictalurus natalis*
Channel Catfish	*Ictalurus punctatus*
Sunfishes	
Banded Pygmy Sunfish	*Elassoma zonatum*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Redear Sunfish	*Lepomis punctatus*
Bantam Sunfish	*Lepomis symmetricus*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
White Crappie	*Pomoxis annularis*
Black Crappie	*Pomoxis nigromaculatus*
Drums	
Freshwater Drum	*Aplodinotus grunniens*
Spot	*Leiostomus xanthurus*
Mullets	
Striped Mullet	*Mugil cephalus*
White Mullet	*Mugil curema*

PLANTS		
FAMILY	COMMON NAME	SCIENTIFIC NAME
Charophytes		
Characeae	Muskgrass	*Chara spp.*
Ferns		
Azollaceae	Mosquito-Fern	*Azolla caroliniana*
Salviniaceae	Common Salvinia	*Salvinia minima*

Salviniaceae	Giant salvinia	*Salvinia molesta*
Conifers		
Cupressaceae	Baldcypress	*Taxodium distichum*
Flowering Plants: Dicots		
Apiaceae	Pennywort	*Hydrocotyle spp*
Asteraceae	Giant Ragweed	*Ambrosia trifida*
Asteraceae	Baccharis	*Baccharis halimifolia*
Asteraceae	Dog Fennel	*Eupatorium capillifolium*
Asteraceae	Sumpweed	*Iva annua*
Asteraceae	Marsh Elder	*Iva frutescens*
Amaranthaceae	Alligator Weed	*Alternanthera philoxeroides*
Euphorbiaceae	Chinese Tallow	*Triadica sebifera*
Fabaceae	False indigo	*Amorpha fruticosa*
Fabaceae	Beggar's tick	*Bidens laevis*
Fabaceae	Coffee Bean	*Sesbania drummondii*
Fabaceae	Rattlebox coffeebean	*Sesbania drummondii*
Fabaceae	Coffeeweed	*Sesbania macrocarpa*
Asclepiadaceae	Milkweeds	*Asclepias spp.*
Haloragaceae	Parrot Feather	*Myriophyllum aquaticum*
Haloragaceae	Eurasian Watermilfoil	*Myriophyllum spicatum*
Verbenaceae	Frogfruit	*Phyla nodiflora*
Verbenaceae	Brazilian Vervain	*Verbena brasiliensis*
Malvaceae	Saltmarsh Mallow	*Kosteletzkya virginica*
Sterculiaceae	Chocolate Weed	*Melochia corchorifolia*
Myricaceae	Waxmyrtle	*Morella cerifera*
Onagraceae	Floating Water Primrose	*Ludwigia peploides*
Cabombaceae	Water Shield	*Brasenia schreberi*
Cabombaceae	Fanwort	*Cabomba caroliniana*
Ceratophyllaceae	Coontail	*Ceratophyllum demersum*
Nelumbonaceae	American Lotus	*Nelumbo lutea*
Nymphaeaceae	Spadderdock	*Nuphar lutea*
Nymphaeaceae	Blue Water Lily	*Nymphaea elegans*
Nymphaeaceae	Banana Water Lily	*Nymphaea mexicana*
Nymphaeaceae	White Water Lily	*Nymphaea odorata*
Polygonaceae	Water Pepper	*Polygonum hydropiperoides*
Polygonaceae	Smartweed	*Polygonum spp.*
Polygonaceae	Curly-leaf Dock	*Rumex crispus*
Rosaceae	Macartney Rose	*Rosa bracteata*

Rubiaceae	Buttonbush	*Cephalanthus occidentalis*
Salicaceae	Black Willow	*Salix nigra*
Rutaceae	Toothache Tree	*Zanthoxylum clava-herculis*
Lentibulariaceae	Common Bladderwort	*Utricularia macrorhiza*
Scrophulariaceae	Coastal Water-Hyssop	*Bacopa monnieri*
Convolvulaceae	Saltmarsh Morning Glory	*Ipomoea sagittata*
Ochnaceae	Bird's Eye Bush	*Ochna serrrulata*
Ulmaceae	Hackberry	*Celtis laevigata*
Flowering Plants: Monocots		
Alismataceae	Bulltongue	*Sagittaria lancifolia*
Araceae	Water Lettuce	*Pistia stratiotes*
Lemnaceae	Duckweed	*Lemna minor*
Cyperaceae	Sawgrass	*Cladium jamaicense*
Cyperaceae	Flatsedges	*Cyperus spp.*
Cyperaceae	Green Flatsedge	*Cyperus virens*
Cyperaceae	Dwarf Spikerush	*Eleocharis parvula*
Cyperaceae	Four Corner Grass	*Eleocharis quadrangulata*
Cyperaceae	Squarestem Spikerush	*Eleocharis quadrangulata*
Cyperaceae	Spikerushes	*Eleocharis spp.*
Cyperaceae	Grasslike Fimbry	*Fimbristylis miliacea*
Cyperaceae	White-topped Sedge	*Rhynchospora colorata*
Cyperaceae	Horned Beakrush	*Rhynchospora corniculata*
Cyperaceae	Bullwhip	*Schoenoplectus californicus*
Cyperaceae	Softstem Bullwhip	*Schoenoplectus tabernaemontani*
Cyperaceae	Three-cornered Grass	*Scirpus olneyi*
Cyperaceae	Bulrush	*Scirpus spp.*
Poaceae	Bushy Bluestem	*Andropogon glomeratus*
Poaceae	Jungle Rice	*Echinochloa colona*
Poaceae	Barnyard Grass	*Echinochloa crusgalli*
Poaceae	Walter's Millet	*Echinochloa walteri*
Poaceae	Sprangletop	*Leptochloa fascicularis*
Poaceae	Red Rice	*Oryza sativa*
Poaceae	Fall Panicum	*Panicum dichotomiflorum*
Poaceae	Maidencane	*Panicum hemitomon*
Poaceae	Brownseed Paspalum	*Paspalum plicatulum*
Poaceae	Vasey Grass	*Paspalum urvillei*
Poaceae	Seashore Paspalum	*Paspalum vaginatum*
Poaceae	Phragmites	*Phragmites australis*

Poaceae	Marshhay Cordgrass	*Spartina patens*
Poaceae	Eastern gamagrass	*Tripsacum dactyloides*
Poaceae	Wild Rice	*Zizania aquatica*
Poaceae	Giant Cutgrass	*Zizaniopsis miliacea*
Hydrocharitaceae	Hydrilla	*Hydrilla verticillata*
Hydrocharitaceae	Frogbit	*Limnobium spongia*
Juncaceae	Black Needlerush	*Juncus roemerianus*
Iridaceae	Iris	*Iris virginica*
Liliaceae	Southern Swamp Lily	*Crinum americanum*
Liliaceae	False Garlic	*Nothoscordum bivalve*
Pontederiaceae	Water Hyacinth	*Eichhornia crassipes*
Pontederiaceae	Pickerelweed	*Pontederia cordata*
Najadaceae	Southern Naiad	*Najas guadalupensis*
Potamogetonaceae	Sago Pondweed	*Potamogeton pectinatus*
Potamogetonaceae	Thin-leaf Pondweed	*Potamogeton pusillus*
Ruppiaceae	Widgeon-grass	*Ruppia maritima*
Typhaceae	Cattail	*Typha spp*
Marantaceae	Thalia	*Thalia dealbata*

*Source: USFWS (1989).

Table C2. List of vascular plant taxa by major plant group and then by family from coastal prairie remnants in southwestern Louisiana. Source: Allen et al. (2001). Exotic species are marked with an asterisk.

Classification	Genus	Species	Growth Form**
Pteridophytes			
Aspleniaceae			
	Asplenium	*platyneuron*	h
Dennstaedtiaceae			
	Pteridium	*aquilinum*	h
Lygodiaceae			
	**Lygodium*	*japonicum*	h
Gymnosperms			
Pinaceae			
	Pinus	*palustris*	t
	Pinus	*taeda*	t
Taxodiaceae			
	Taxodium	*distichum*	t
Moncotyledons			
Agavaceae			
	Manfreda	*virginica*	h
Commelinaceae			
	Commelina	*erecta*	h
	Tradescantia	*hirsutiflora*	h
	Tradescantia	*virginiana*	h
Cyperaceae			
	Bulbostylis	*capillaris*	h
	Carex	*alata*	h
	Carex	*albolutescens*	h
	Carex	*cherokeensis*	h
	Carex	*complanata*	h
	Carex	*frankii*	h
	Carex	*microdonta*	h
	Carex	*vulpinoidea*	h
	Cladium	*mariscus*	h
	Cyperus	*acuminatus*	h

Classification	Genus	Species	Growth Form**
	Cyperus	*croceus*	h
	Cyperus	*echinatus*	h
	Cyperus	*erythrorhizos*	h
	Cyperus	*haspan*	h
	**Cyperus*	*iria*	h
	Cyperus	*oxylepis*	h
	Cyperus	*pseudovegetus*	h
	Cyperus	*retrorsus*	h
	**Cyperus*	*rotundus*	h
	Cyperus	*strigosus*	h
	Cyperus	*virens*	h
	Eleocharis	*microcarpa*	h
	Eleocharis	*montana*	h
	Eleocharis	*obtusa*	h
	Eleocharis	*quadrangulata*	h
	Eleocharis	*tuberculosa*	h
	Fimbristylis	*autumnalis*	h
	Fimbristylis	*miliacea*	h
	Fimbristylis	*puberula*	h
	Fuirena	*pumila*	h
	Isolepis	*carinata*	h
	Kyllinga	*brevifolia*	h
	Kyllinga	*odorata*	h
	Rhynchospora	*caduca*	h
	Rhynchospora	*cephalantha*	h
	Rhynchospora	*chalarocephala*	h
	Rhynchospora	*colorata*	h
	Rhynchospora	*corniculata*	h
	Rhynchospora	*elliottii*	h
	Rhynchospora	*globularis*	h
	Rhynchospora	*glomerata*	h
	Rhynchospora	*harveyi*	h
	Rhynchospora	*microcarpa*	h
	Rhynchospora	*pusilla*	h

Classification	Genus	Species	Growth Form**
	Rhynchospora	*rariflora*	h
	Scleria	*ciliata*	h
	Scleria	*pauciflora*	h
	Scleria	*reticularis*	h
	Scleria	*verticillata*	h
Iridaceae			
	Herbertia	*lahue*	h
	Iris	*virginica*	h
	Sisyrinchium	*angustifolium*	h
	Sisyrinchium	*atlanticum*	h
	Sisyrinchium	*exile*	h
	Sisyrinchium	*langloisii*	h
Juncaceae			
	Juncus	*brachycarpus*	h
	Juncus	*effusus*	h
	Juncus	*marginatus*	h
	Juncus	*nodatus*	h
	Juncus	*polycephalus*	h
	Juncus	*tenuis*	h
	Juncus	*validus*	h
Liliaceae			
	Aletris	*aurea*	h
	Aletris	*farinosa*	h
	Allium	*canadense*	h
	Allium	*canadense*	h
	Hymenocallis	*liriosme*	h
	Hypoxis	*hirsuta*	h
	Nothoscordum	*bivalve*	h
Orchidaceae			
	Calopogon	*oklahomensis*	h
	Platanthera	*nivea*	h
	Pteroglossaspis	*ecristata*	h
	Spiranthes	*vernalis*	h
Poaceae			

Classification	Genus	Species	Growth Form**
	Agrostis	*hyemalis*	h
	Alopecurus	*carolinianus*	h
	Andropogon	*gerardii*	h
	Andropogon	*glomeratus*	h
	Andropogon	*gyrans*	h
	Andropogon	*ternarius*	h
	Andropogon	*virginicus*	h
	Anthaenantia	*rufa*	h
	Aristida	*longispica*	h
	Aristida	*oligantha*	h
	Aristida	*purpurascens*	h
	Axonopus	*fissifolius*	h
	Bothriochloa	*exaristata*	h
	**Bothriochloa*	*ischaemum*	h
	Bothriochloa	*longipaniculata*	h
	Briza	*minor*	h
	Bromus	*catharticus*	h
	**Chloris*	*canterai*	h
	Coelorachis	*cylindrica*	h
	Coelorachis	*rugosa*	h
	Ctenium	*aromaticum*	h
	**Cynodon*	*dactylon*	h
	Dichanthelium	*aciculare*	h
	Dichanthelium	*acuminatum*	h
	Dichanthelium	*dichotomum*	h
	Dichanthelium	*oligosanthes*	h
	Dichanthelium	*ovale*	h
	Dichanthelium	*scoparium*	h
	Dichanthelium	*sphaerocarpon*	h
	Digitaria	*ciliaris*	h
	Digitaria	*cognata*	h
	Digitaria	*filiformis*	h
	Digitaria	*ischaemum*	h
	Digitaria	*violascens*	h

Classification	Genus	Species	Growth Form**
	Echinochloa	*crus-galli*	h
	Eragrostis	*bahiensis*	h
	Eragrostis	*elliottii*	h
	Eragrostis	*hirsuta*	h
	Eragrostis	*lugens*	h
	Eragrostis	*refracta*	h
	Eragrostis	*spectabilis*	h
	Gymnopogon	*brevifolius*	h
	Leersia	*hexandra*	h
	Limnodea	*arkansana*	h
	**Lolium*	*perenne*	h
	Muhlenbergia	*capillaris*	h
	Panicum	*anceps*	h
	Panicum	*brachyanthum*	h
	Panicum	*hemitomon*	h
	Panicum	*rigidulum*	h
	Panicum	*virgatum*	h
	**Paspalum*	*dilatatum*	h
	Paspalum	*floridanum*	h
	Paspalum	*laeve*	h
	Paspalum	*plicatulum*	h
	Paspalum	*praecox*	h
	Paspalum	*setaceum*	h
	**Paspalum*	*urvillei*	h
	Phalaris	*angusta*	h
	Phalaris	*caroliniana*	h
	Schizachyrium	*scoparium*	h
	Schizachyrium	*tenerum*	h
	Setaria	*parviflora*	h
	Setaria	*pumila*	h
	Sorghastrum	*nutans*	h
	**Sorghum*	*halepense*	h
	Spartina	*spartinae*	h
	Sphenopholis	*obtusata*	h

Classification	Genus	Species	Growth Form**
	Sporobolus	*compositus*	h
	**Sporobolus*	*indicus*	h
	Sporobolus	*junceus*	h
	Sporobolus	*silveanus*	h
	Steinchisma	*hians*	h
	Tridens	*ambiguus*	h
	Tridens	*strictus*	h
	Tripsacum	*dactyloides*	h
	Urochloa	*platyphylla*	h
	Vulpia	*octoflora*	h
Pontederiaceae			
	Pontederia	*cordata*	h
Smilacaceae			
	Smilax	*rotundifolia*	h
Typhaceae			
	Typha	*latifolia*	h
Xyridaceae			
	Xyris	*difformis*	h
	Xyris	*laxifolia*	h
	Xyris	*torta*	h
Dicotyledons			
Acanthaceae			
	Hygrophila	*lacustris*	h
	Justicia	*ovata*	h
	Ruellia	*humilis*	h
Amaranthaceae			
	**Alternanthera*	*philoxeroides*	h
Anacardiaceae			
	Rhus	*copallinum*	s
	Toxicodendron	*radicans*	l
Apiaceae			
	Centella	*erecta*	h
	Chaerophyllum	*tainturieri*	h
	Cicuta	*maculata*	h

Classification	Genus	Species	Growth Form**
	Cynosciadium	*digitatum*	h
	Eryngium	*integrifolium*	h
	Eryngium	*yuccifolium*	h
	Polytaenia	*nuttallii*	h
	Ptilimnium	*capillaceum*	h
	Ptilimnium	*costatum*	h
	Spermolepis	*echinata*	h
Apocynaceae			
	Amsonia	*tabernaemontana*	h
Aquifoliaceae			
	Ilex	*decidua*	s
	Ilex	*vomitoria*	s
Asclepiadaceae			
	Asclepias	*lanceolata*	h
	Asclepias	*longifolia*	h
	Asclepias	*obovata*	h
	Asclepias	*tuberosa*	h
	Asclepias	*verticillata*	h
	Asclepias	*viridiflora*	h
	Asclepias	*viridis*	h
	Cynanchum	*laeve*	h
	Matelea	*gonocarpos*	h
Asteraceae			
	Ambrosia	*artemisiifolia*	h
	Ambrosia	*bidentata*	h
	Ambrosia	*psilostachya*	h
	Ambrosia	*trifida*	h
	Arnoglossum	*plantagineum*	h
	Baccharis	*halimifolia*	s
	Bidens	*aristosa*	h
	Bigelowia	*virgata*	h
	Boltonia	*asteroides*	h
	Boltonia	*diffusa*	h
	Chromolaena	*ivifolia*	h

Classification	Genus	Species	Growth Form**
	Chrysopsis	*mariana*	h
	Cirsium	*horridulum*	h
	Conyza	*canadensis*	h
	Coreopsis	*gladiata*	h
	Coreopsis	*lanceolata*	h
	Coreopsis	*pubescens*	h
	Coreopsis	*tinctoria*	h
	Coreopsis	*tripteris*	h
	Echinacea	*pallida*	h
	Erechtites	*hieraciifolia*	h
	Erigeron	*annuus*	h
	Erigeron	*philadelphicus*	h
	Erigeron	*strigosus*	h
	Eupatorium	*capillifolium*	h
	Eupatorium	*hyssopifolium*	h
	Eupatorium	*leucolepis*	h
	Eupatorium	*perfoliatum*	h
	Eupatorium	*rotundifolium*	h
	Eupatorium	*semiserratum*	h
	Eupatorium	*serotinum*	h
	Eurybia	*hemispherica*	h
	Euthamia	*leptocephala*	h
	Euthamia	*tenuifolia*	h
	Gaillardia	*aestivalis*	h
	Gamochaeta	*purpurea*	h
	**Helenium*	*amarum*	h
	Helenium	*drummondii*	h
	Helenium	*flexuosum*	h
	Helianthus	*angustifolius*	h
	Helianthus	*mollis*	h
	Iva	*annua*	h
	Krigia	*caespitosa*	h
	Krigia	*dandelion*	h
	Krigia	*virginica*	h

Classification	Genus	Species	Growth Form**
	Lactuca	*canadensis*	h
	Lactuca	*floridana*	h
	Liatris	*acidota*	h
	Liatris	*elegans*	h
	Liatris	*pycnostachya*	h
	Liatris	*spicata*	h
	Liatris	*squarrosa*	h
	Mikania	*scandens*	h
	Oligoneuron	*nitidum*	h
	Packera	*glabella*	h
	Packera	*tomentosa*	h
	Pityopsis	*graminifolia*	h
	Pluchea	*camphorata*	h
	Pluchea	*foetida*	h
	Pluchea	*rosea*	h
	Pseudognaphalium	*obtusifolium*	h
	Pterocaulon	*virgatum*	h
	Pyrrhopappus	*carolinianus*	h
	Rudbeckia	*grandiflora*	h
	Rudbeckia	*hirta*	h
	Rudbeckia	*texana*	h
	Silphium	*gracile*	h
	Silphium	*laciniatum*	h
	Solidago	*canadensis*	h
	Solidago	*odora*	h
	Solidago	*rugosa*	h
	Solidago	*sempervirens*	h
	Sonchus	*asper*	h
	Sonchus	*oleraceus*	h
	Symphyotrichum	*dumosum*	h
	Symphyotrichum	*lateriflorum*	h
	Symphyotrichum	*oolentangiense*	h
	Symphyotrichum	*patens*	h
	Symphyotrichum	*pratense*	h

Classification	Genus	Species	Growth Form**
	Vernonia	*gigantea*	h
	Vernonia	*texana*	h
Bignoniaceae			
	Campsis	*radicans*	l
Boraginaceae			
	Myosotis	*verna*	h
Brassicaceae			
	Cardamine	*hirsuta*	h
	Cardamine	*parviflora*	h
	Lepidium	*virginicum*	h
Buddlejaceae			
	Polypremum	*procumbens*	h
Callitrichaceae			
	Callitriche	*heterophylla*	h
Campanulaceae			
	Lobelia	*appendiculata*	h
	Lobelia	*puberula*	h
	Triodanis	*perfoliata*	h
Caprifoliaceae			
	**Lonicera*	*japonica*	h
	Sambucus	*nigra*	s
Caryophyllaceae			
	Cerastium	*glomeratum*	h
	Silene	*antirrhina*	h
Cistaceae			
	Lechea	*mucronata*	h
	Lechea	*tenuifolia*	h
Clusiaceae			
	Hypericum	*crux-andreae*	s
	Hypericum	*drummondii*	h
	Hypericum	*gentianoides*	h
	Hypericum	*gymnanthum*	h
	Hypericum	*hypericoides*	s
	Hypericum	*nudiflorum*	s

Classification	Genus	Species	Growth Form**
Convolvulaceae			
	Dichondra	*carolinensis*	h
	Ipomoea	*lacunosa*	h
	Ipomoea	*sagittata*	h
	Stylisma	*aquatica*	h
Cornaceae			
	Cornus	*drummondii*	s
Cucurbitaceae			
	**Cucumis*	*melo*	h
	Melothria	*pendula*	h
Cuscutaceae			
	Cuscuta	*indecora*	h
Droseraceae			
	Drosera	*brevifolia*	h
Ebenaceae			
	Diospyros	*virginiana*	t
Ericaceae			
	Vaccinium	*arboreum*	s
Euphorbiaceae			
	Acalypha	*gracilens*	h
	Caperonia	*palustris*	h
	Chamaesyce	*humistrata*	h
	Chamaesyce	*maculata*	h
	**Chamaesyce*	*nutans*	h
	Croton	*capitatus*	h
	Croton	*glandulosus*	h
	Croton	*willdenowii*	h
	Euphorbia	*corollata*	h
	Euphorbia	*spathulata*	h
	Tragia	*betonicifolia*	h
	**Triadica*	*sebifera*	t
Fabaceae			
	**Aeschynomene*	*indica*	h
	Baptisia	*alba*	h

Classification	Genus	Species	Growth Form**
	Baptisia	*bracteata*	h
	Baptisia	*bracteata*	h
	Baptisia	*nuttalliana*	h
	Baptisia	*sphaerocarpa*	h
	Centrosema	*virginianum*	h
	Chamaecrista	*fasciculata*	h
	Crotalaria	*sagittalis*	h
	Dalea	*candida*	h
	Desmodium	*ciliare*	h
	Desmodium	*paniculatum*	h
	Desmodium	*sessilifolium*	h
	Galactia	*volubilis*	h
	**Glottidium*	*vesicarium*	h
	**Kummerowia*	*striata*	h
	Lespedeza	*capitata*	h
	Lespedeza	*repens*	h
	Lespedeza	*virginica*	h
	**Medicago*	*lupulina*	h
	**Medicago*	*polymorpha*	h
	**Melilotus*	*indicus*	h
	Mimosa	*microphylla*	h
	Neptunia	*lutea*	h
	Neptunia	*pubescens*	h
	Orbexilum	*pedunculatum*	h
	Orbexilum	*simplex*	h
	Rhynchosia	*minima*	h
	Strophostyles	*umbellata*	h
	Stylosanthes	*biflora*	h
	Tephrosia	*onobrychoides*	h
	Trifolium	*bejariense*	h
	**Trifolium*	*dubium*	h
	**Trifolium*	*resupinatum*	h
	Vicia	*ludoviciana*	h
Fagaceae			

Classification	Genus	Species	Growth Form**
	Castanea	*pumila*	s
	Quercus	*falcata*	t
	Quercus	*incana*	t
	Quercus	*marilandica*	t
	Quercus	*nigra*	t
	Quercus	*stellata*	t
	Quercus	*virginiana*	t
Gentianaceae			
	**Centaurium*	*pulchellum*	h
	Sabatia	*brachiata*	h
	Sabatia	*campestris*	h
	Sabatia	*gentianoides*	h
	Sabatia	*stellaris*	h
Geraniaceae			
	Geranium	*carolinianum*	h
Haloragaceae			
	Proserpinaca	*palustris*	h
Hamamelidaceae			
	Liquidambar	*styraciflua*	t
Hydrophyllaceae			
	Hydrolea	*ovata*	h
Juglandaceae			
	Carya	*illinoinensis*	t
Lamiaceae			
	Hyptis	*alata*	h
	Lamium	*amplexicaule*	h
	Lycopus	*americanus*	h
	Monarda	*fistulosa*	h
	Monarda	*lindheimeri*	h
	Monarda	*punctata*	h
	Physostegia	*intermedia*	h
	Physostegia	*virginiana*	h
	**Prunella*	*vulgaris*	h
	Pycnanthemum	*albescens*	h

Classification	Genus	Species	Growth Form**
	Pycnanthemum	*muticum*	h
	Pycnanthemum	*tenuifolium*	h
	Salvia	*azurea*	h
	Salvia	*lyrata*	h
	Scutellaria	*integrifolia*	h
	Scutellaria	*parvula*	h
	Stachys	*crenata*	h
	**Stachys*	*floridana*	h
	Teucrium	*canadense*	h
Lauraceae			
	Sassafras	*albidum*	t
Lentibulariaceae			
	Pinguicula	*pumila*	h
	Utricularia	*subulata*	h
Linaceae			
	Linum	*medium*	h
	Linum	*sulcatum*	h
Loganiaceae			
	Mitreola	*petiolata*	h
	Mitreola	*sessilifolia*	h
Lythraceae			
	Cuphea	*glutinosa*	h
	Lythrum	*alatum*	h
Malvaceae			
	Callirhoe	*papaver*	h
	Hibiscus	*moscheutos*	h
	Modiola	*caroliniana*	h
	Sida	*rhombifolia*	h
Melastomataceae			
	Rhexia	*mariana*	h
Meliaceae			
	**Melia*	*azedarach*	t
Molluginaceae			
	**Mollugo*	*verticillata*	h

Classification	Genus	Species	Growth Form**
Myricaceae			
	Morella	*cerifera*	s
Nyssaceae			
	Nyssa	*sylvatica*	t
Oleaceae			
	**Ligustrum*	*sinense*	s
Onagraceae			
	Gaura	*lindheimeri*	h
	Gaura	*longiflora*	h
	Ludwigia	*decurrens*	h
	Ludwigia	*glandulosa*	h
	Ludwigia	*hirtella*	h
	Ludwigia	*leptocarpa*	h
	Ludwigia	*linearis*	h
	Ludwigia	*palustris*	h
	Oenothera	*biennis*	h
	Oenothera	*laciniata*	h
	Oenothera	*linifolia*	h
	Oenothera	*pilosella*	h
	Oenothera	*spachiana*	h
	Oenothera	*speciosa*	h
Oxalidaceae			
	Oxalis	*stricta*	h
	Oxalis	*violacea*	h
Passifloraceae			
	Passiflora	*incarnata*	h
Phytolaccaceae			
	Phytolacca	*americana*	h
Plantaginaceae			
	Plantago	*aristata*	h
	Plantago	*heterophylla*	h
	Plantago	*virginica*	h
Polemoniaceae			
	Phlox	*pilosa*	h

Classification	Genus	Species	Growth Form**
Polygalaceae			
	Polygala	*cruciata*	h
	Polygala	*incarnata*	h
	Polygala	*leptocaulis*	h
	Polygala	*mariana*	h
	Polygala	*nana*	h
	Polygala	*ramosa*	h
	Polygala	*sanguinea*	h
	Polygala	*verticillata*	h
Polygonaceae			
	Polygonum	*hydropiperoides*	h
	Rumex	*verticillatus*	h
Portulacaceae			
	Claytonia	*virginica*	h
Primulaceae			
	Anagallis	*arvensis*	h
	Anagallis	*minima*	h
Ranunculaceae			
	Anemone	*caroliniana*	h
	Ranunculus	*fascicularis*	h
	Ranunculus	*laxicaulis*	h
	Ranunculus	*muricatus*	h
	Ranunculus	*pusillus*	h
Rhamnaceae			
	Berchemia	*scandens*	l
	Ceanothus	*americanus*	s
Rosaceae			
	Crataegus	*crus-galli*	s
	Geum	*canadense*	h
	Prunus	*serotina*	t
	Rubus	*argutus*	h
	Rubus	*trivialis*	h
Rubiaceae			
	Cephalanthus	*occidentalis*	s

Classification	Genus	Species	Growth Form**
	Diodia	*teres*	h
	Diodia	*virginiana*	h
	Galium	*aparine*	h
	Galium	*tinctorium*	h
	Galium	*virgatum*	h
	Hedyotis	*nigricans*	h
	Houstonia	*micrantha*	h
	Oldenlandia	*boscii*	h
Rutaceae			
	Zanthoxylum	*clava-herculis*	t
Salicaceae			
	Salix	*nigra*	t
Sapindaceae			
	**Cardiospermum*	*halicacabum*	h
Saxifragaceae			
	Lepuropetalon	*spathulatum*	h
Scrophulariaceae			
	Agalinis	*fasciculata*	h
	Agalinis	*heterophylla*	h
	Agalinis	*oligophylla*	h
	Agalinis	*skinneriana*	h
	Agalinis	*viridis*	h
	Bacopa	*rotundifolia*	h
	Buchnera	*americana*	h
	Gratiola	*neglecta*	h
	Gratiola	*virginiana*	h
	Lindernia	*dubia*	h
	Mecardonia	*acuminata*	h
	Nuttallanthus	*canadensis*	h
	Nuttallanthus	*texanus*	h
	Pedicularis	*canadensis*	h
	Penstemon	*digitalis*	h
	Penstemon	*laxiflorus*	h
	Veronica	*arvensis*	h

Classification	Genus	Species	Growth Form**
	Veronica	*peregrina*	h
Solanaceae			
	Physalis	*angulata*	h
	Physalis	*heterophylla*	h
	Solanum	*americanum*	h
	Solanum	*carolinense*	h
	Solanum	*dimidiatum*	h
	Solanum	*elaeagnifolium*	h
Sterculiaceae			
	**Melochia*	*corchorifolia*	h
Styracaceae			
	Styrax	*americanus*	t
Ulmaceae			
	Celtis	*laevigata*	t
	Ulmus	*americana*	t
Urticaceae			
	Boehmeria	*cylindrica*	h
Valerianaceae			
	Valerianella	*radiata*	h
Verbenaceae			
	Glandularia	*pulchella*	h
	Phyla	*nodiflora*	h
	Verbena	*bonariensis*	h
	Verbena	*brasiliensis*	h
	Verbena	*halei*	h
	Verbena	*litoralis*	h
Violaceae			
	Viola	*lanceolata*	h
	Viola	*sagittata*	h
Vitaceae			
	Ampelopsis	*arborea*	l
	Parthenocissus	*quinquefolia*	l
	Vitis	*cinerea*	l

* Exotic

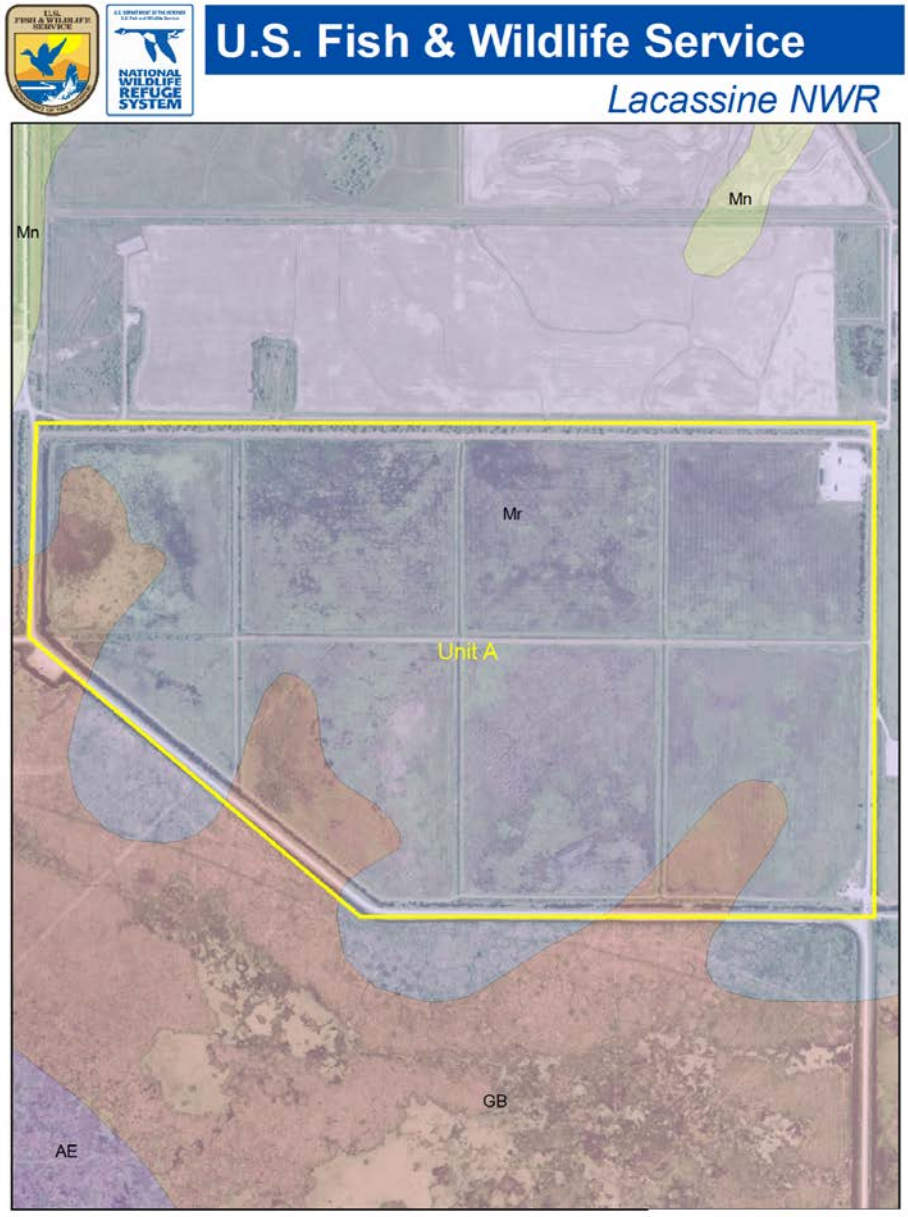
**h=herb; l=liana; s=shrub; t=tree

Appendix D

MANAGEMENT UNIT SOIL MAPS

Key to soil map unit symbols in management unit maps:

Parish	Map Unit Symbol	Soil Series or Complex
Cameron	AE	Allemands muck
Cameron	AN	Aquents, frequently flooded
Cameron	Cw	Crowley-Vidrine silt loams
Cameron	GB	Ged mucky clay
Cameron	Ju	Judice silty clay
Cameron	Kd	Kaplan silt loam
Cameron	LE	Larose muck
Cameron	Mn	Midland silty clay loam
Cameron	Mr	Morey silt loam
Cameron	Mt	Mowata-Vidrine silt loam
Cameron	UD	Udifluvents, 1 to 20 percent slopes
Cameron	W	[Open water]
Evangeline (Duralde Prairie Unit)	Cv	Crowley-Vidrine Complex
Evangeline (Duralde Prairie Unit)	Mt	Mowata silt loam
Evangeline (Duralde Prairie Unit)	MaB	Mamou silt loam, 1 to 3 percent slopes
Jefferson Davis (Easements)	CrA	Crowley-Vidrine silt loam, 0 to 1 percent slopes
Jefferson Davis (Easements)	CrB	Crowley-Vidrine silt loam, 1 to 3 percent slopes
Jefferson Davis (Easements)	LeA	Leton silt loam
Jefferson Davis (Easements)	PnB	Pine Island loam, 1 to 3 percent slopes


U.S. Fish & Wildlife Service
Lacassine NWR
Mn
Mn
Mr
Unit A
GB
AE
Scale: 1:10,358
Miles
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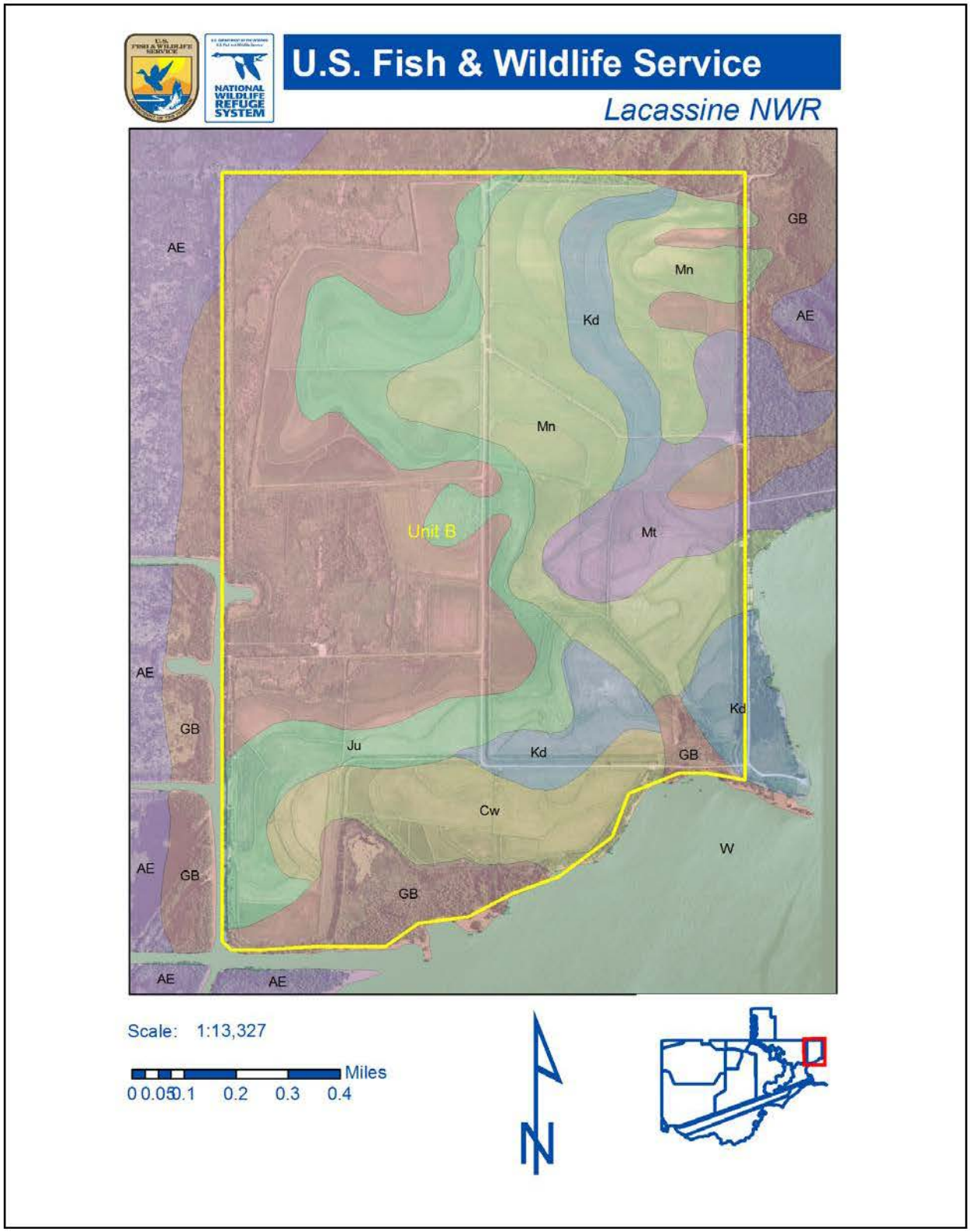
U.S. Fish & Wildlife Service
Lacassine NWR
NATIONAL WILDLIFE REFUGE SYSTEM
AE
GB
Mn
Kd
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Mn
Unit B
Mt
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GB
Kd
Ju
Kd
GB
Cw
W
AE
GB
GB
AE
AE
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Miles
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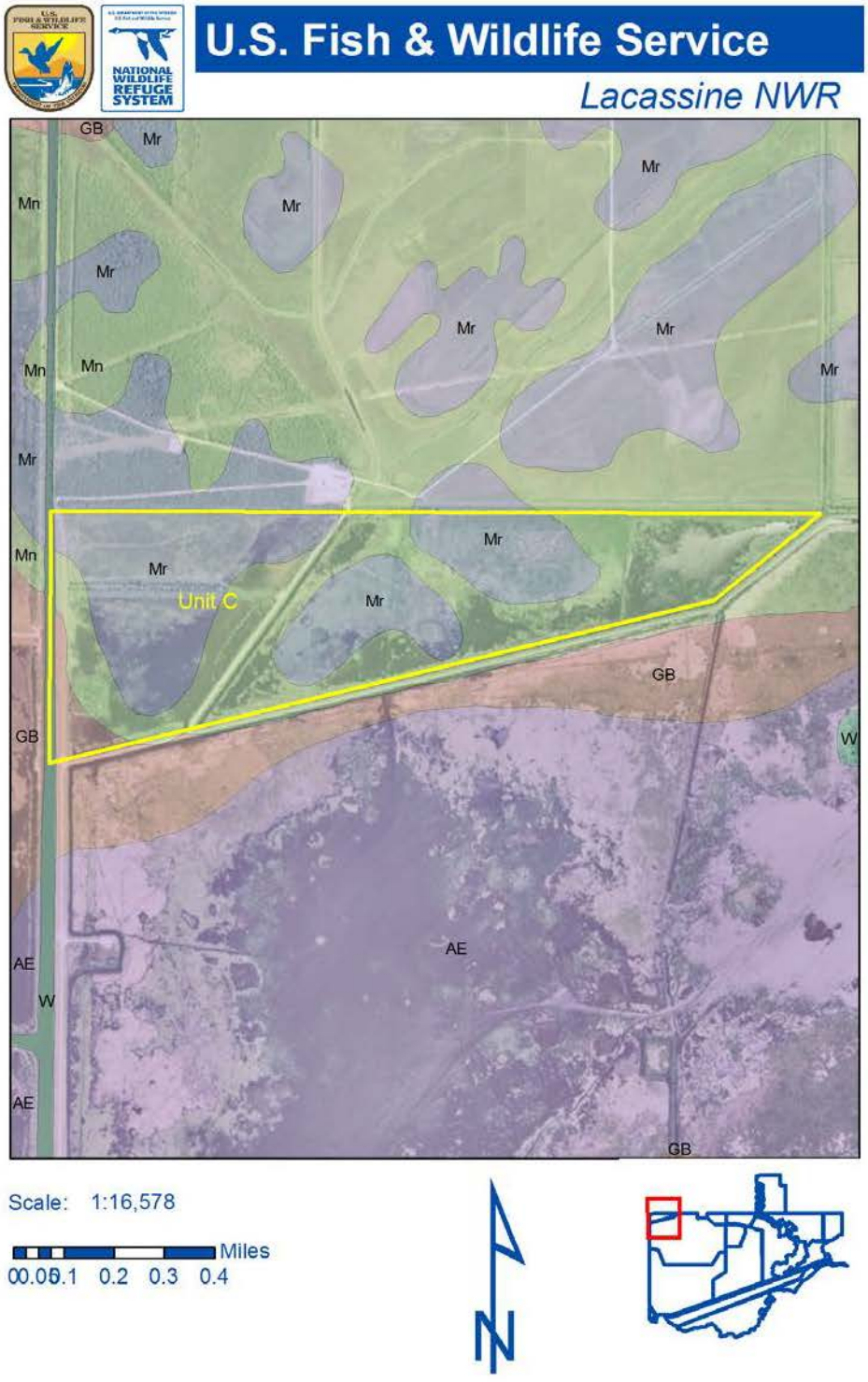
N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Lacassine NWR
NATIONAL WILDLIFE REFUGE SYSTEM
Unit C
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Mn
GB
AE
W
Scale: 1:16,578
Miles
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N


U.S. Fish & Wildlife Service
Lacassine NWR
NATIONAL WILDLIFE REFUGE SYSTEM
Mn
Mr
Mr
Mr
Unit D
AE
GB
AE
Scale: 1:11,508
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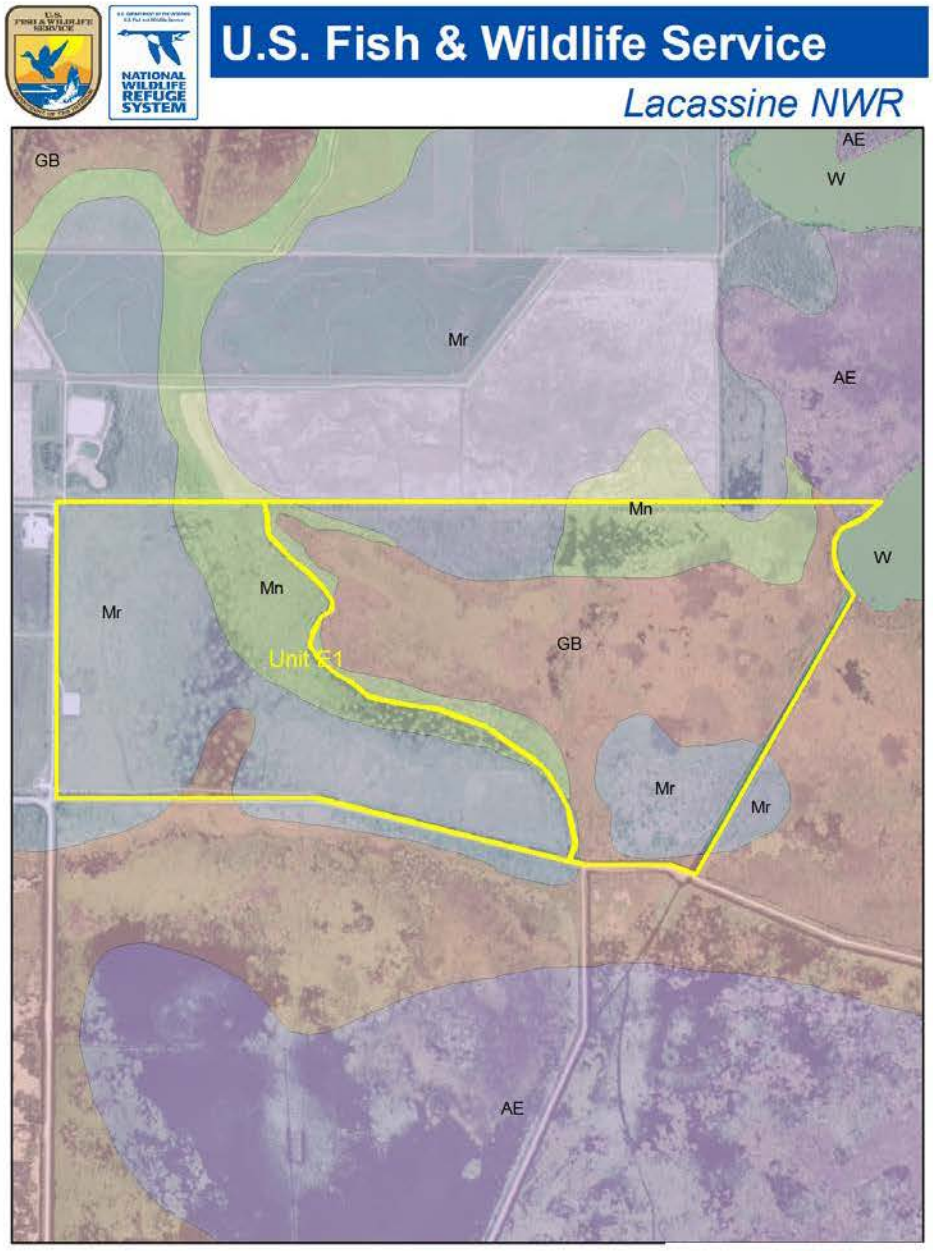
N


U.S. Fish & Wildlife Service
Lacassine NWR
GB
AE
W
Mr
AE
Mn
W
Mr
Mn
GB
Unit 1
Mr
Mr
AE
Scale: 1:17,581
Miles
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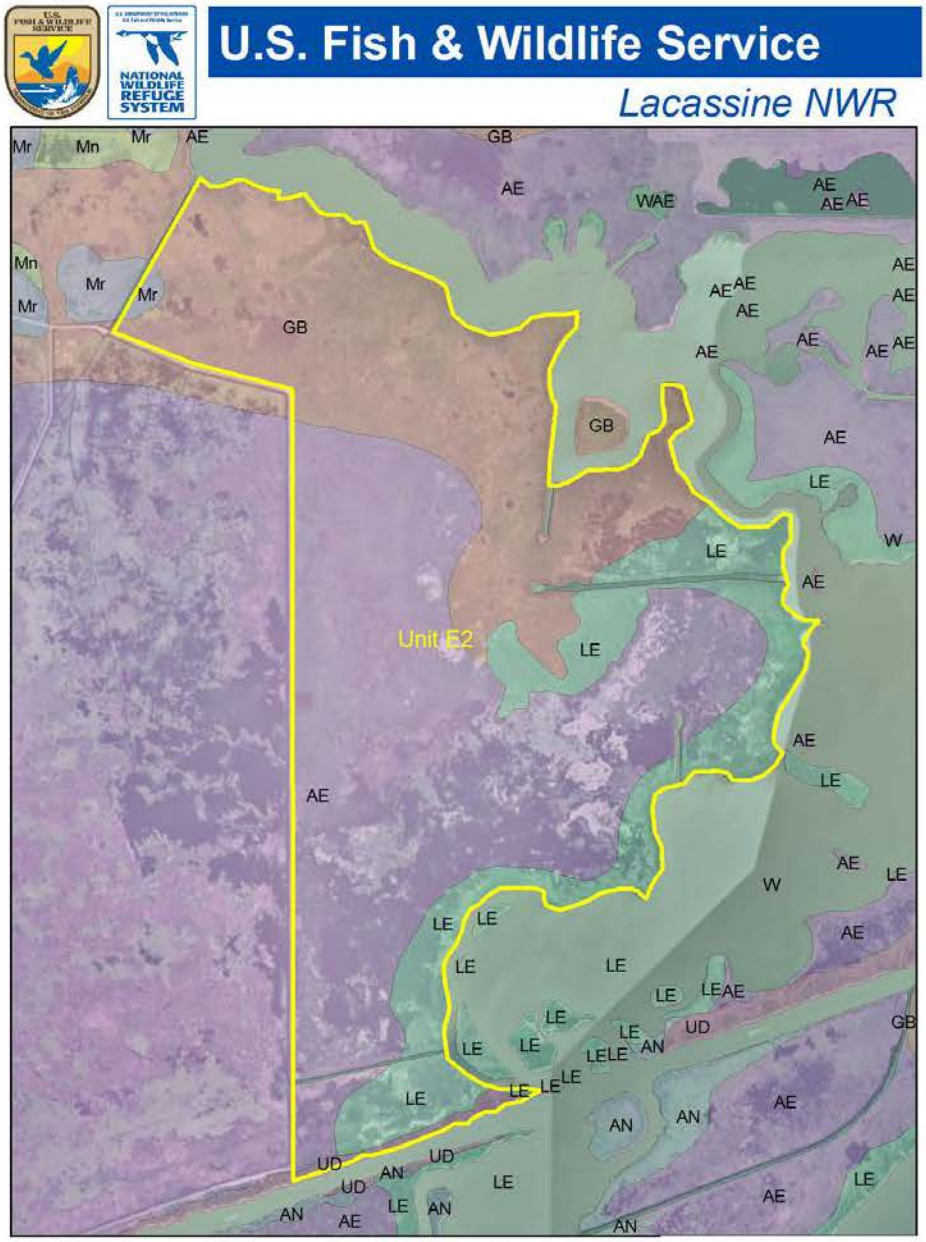
N


U.S. Fish & Wildlife Service
Lacassine NWR
NATIONAL WILDLIFE REFUGE SYSTEM
Unit E2
Scale: 1:31,884
Miles
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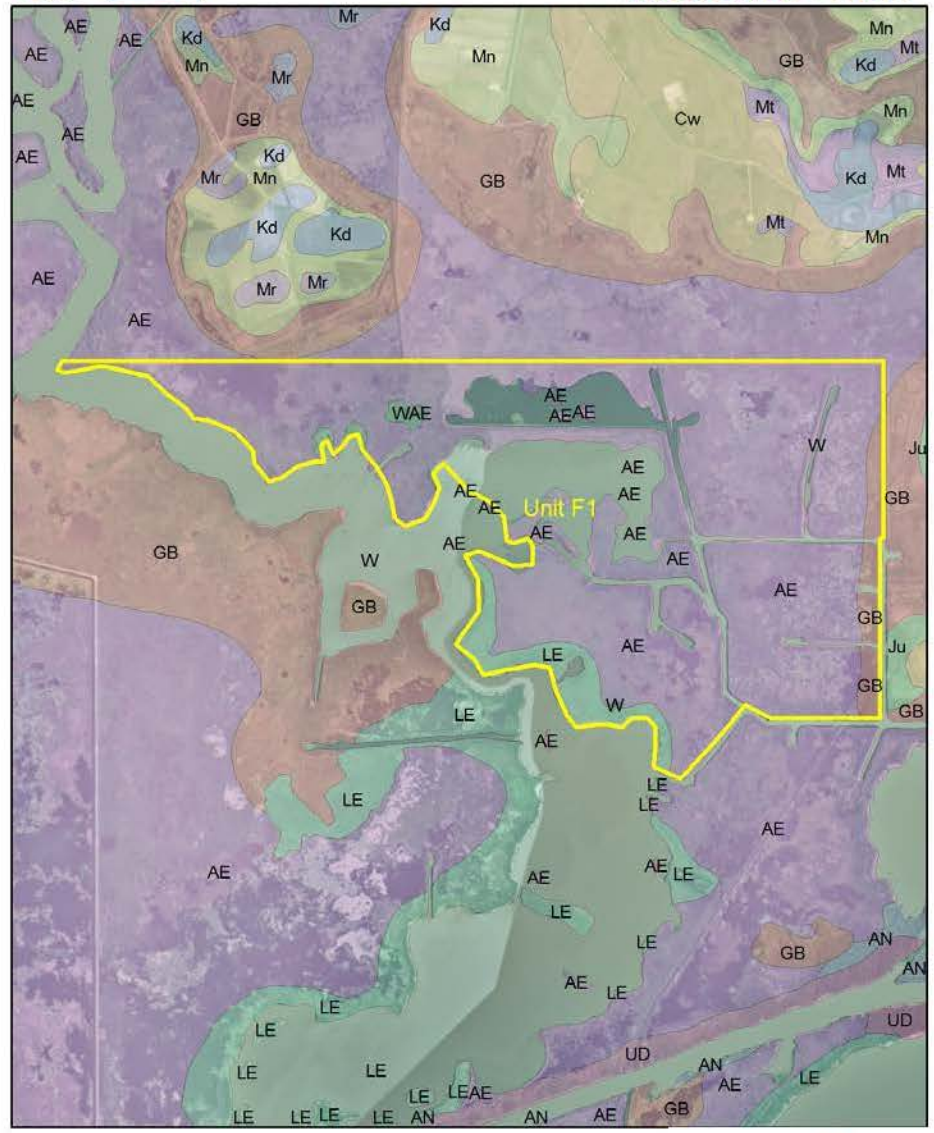
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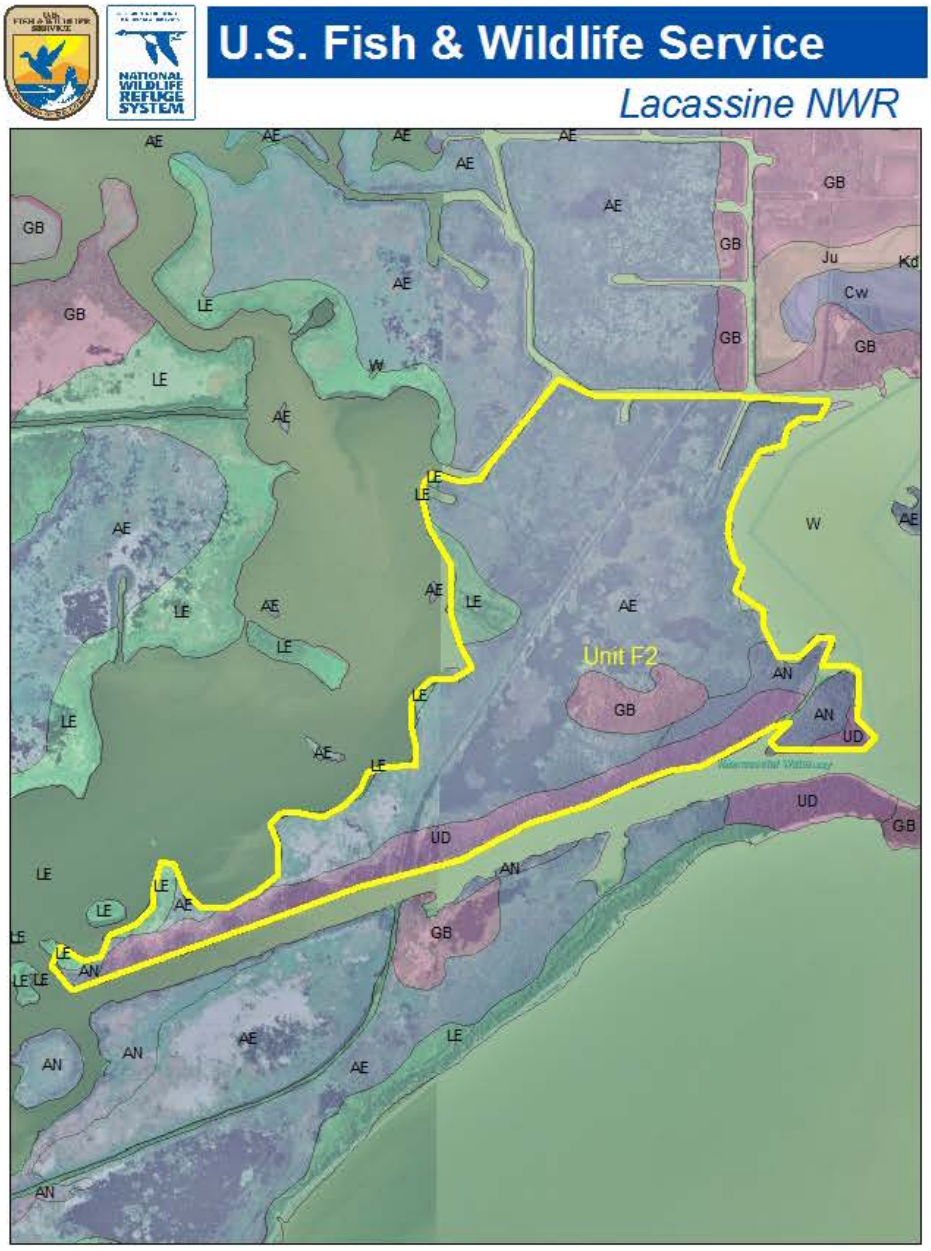
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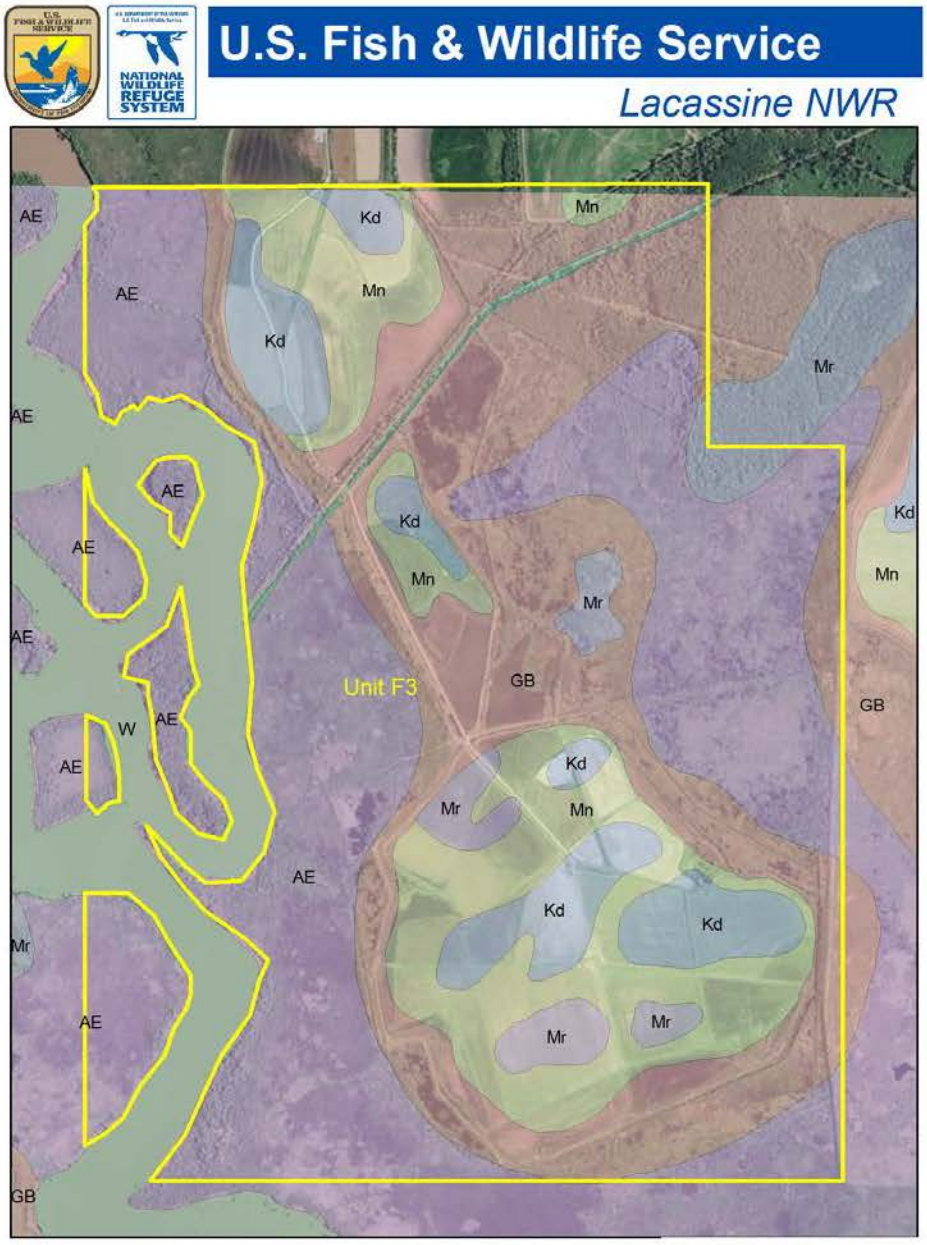
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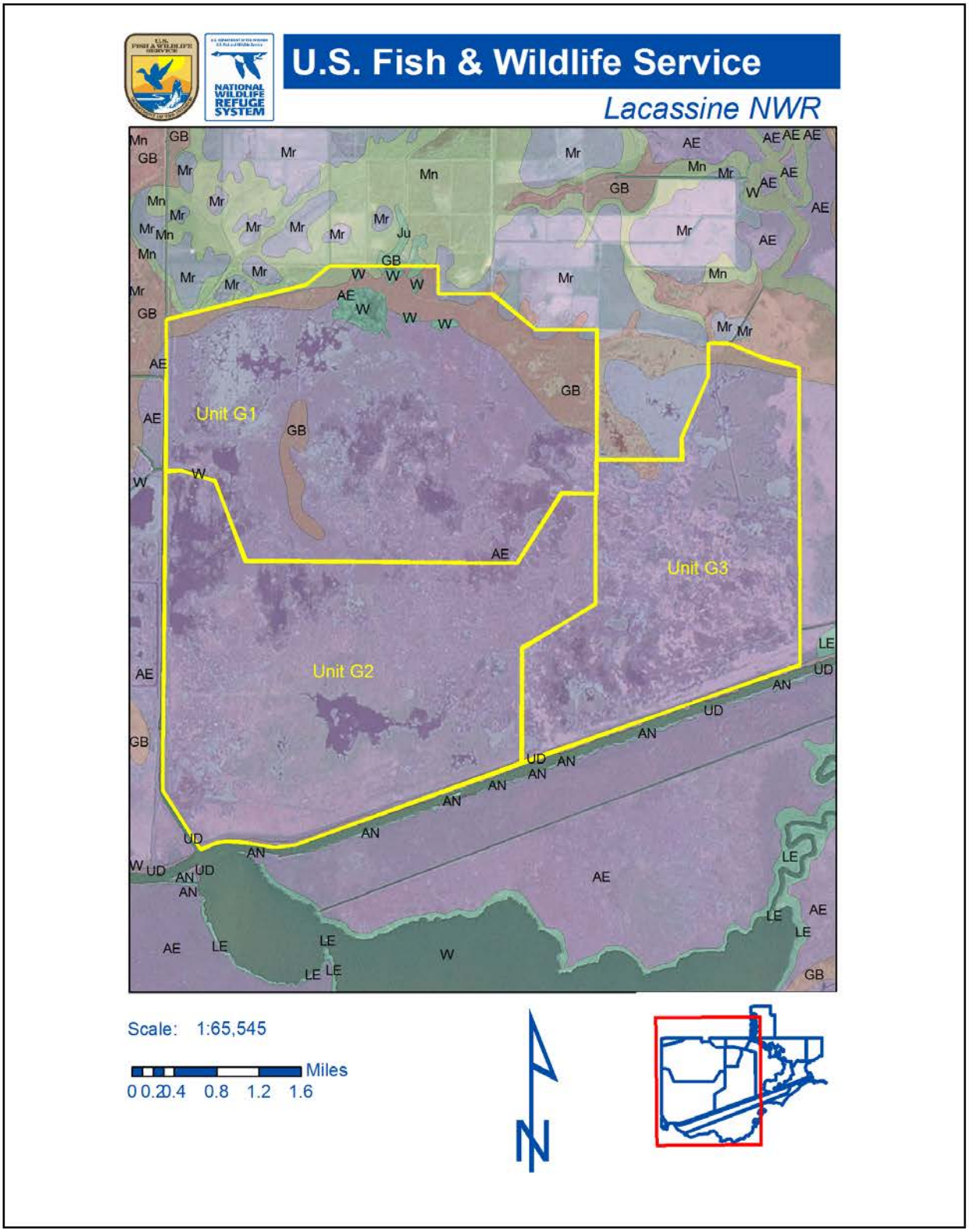
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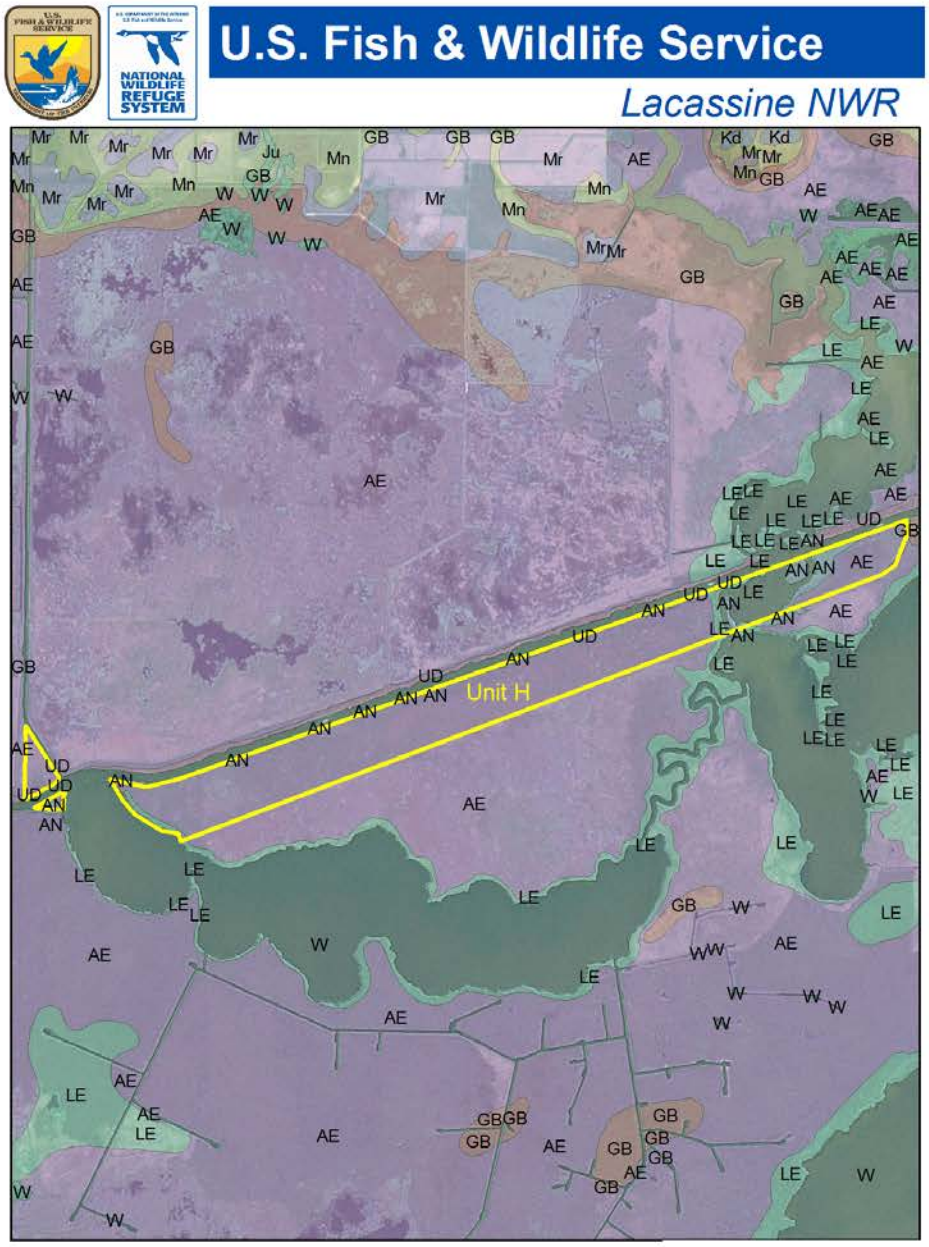
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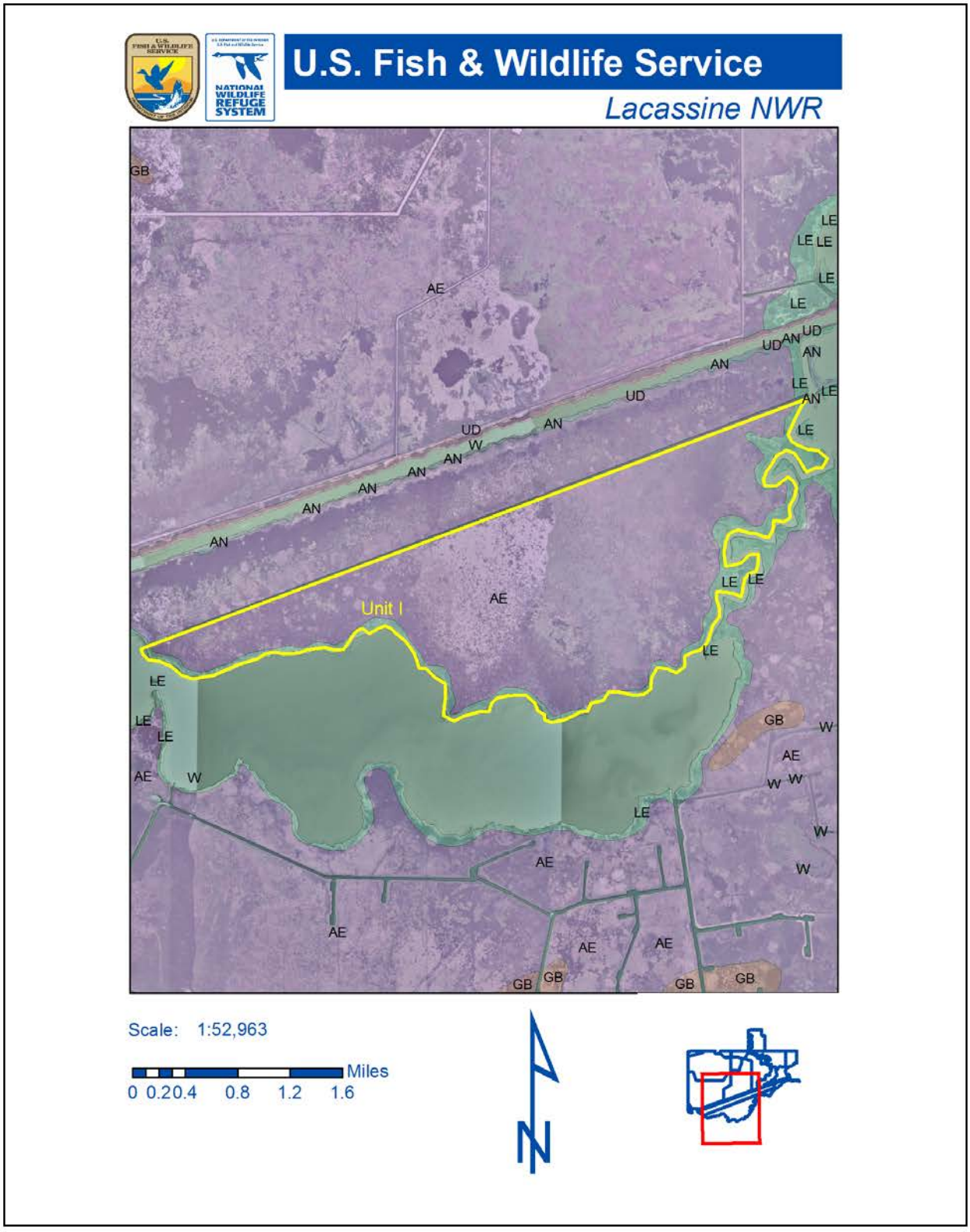
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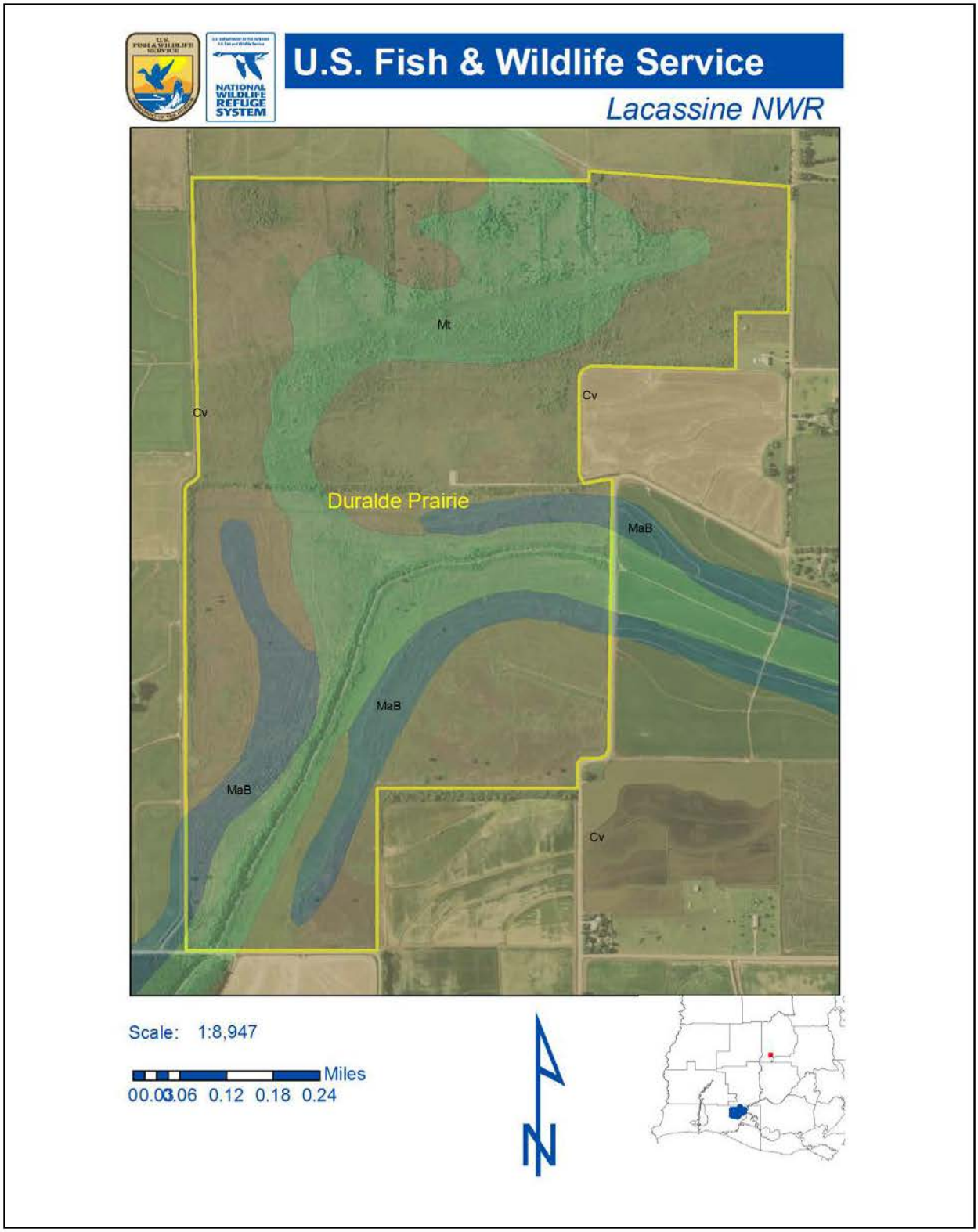
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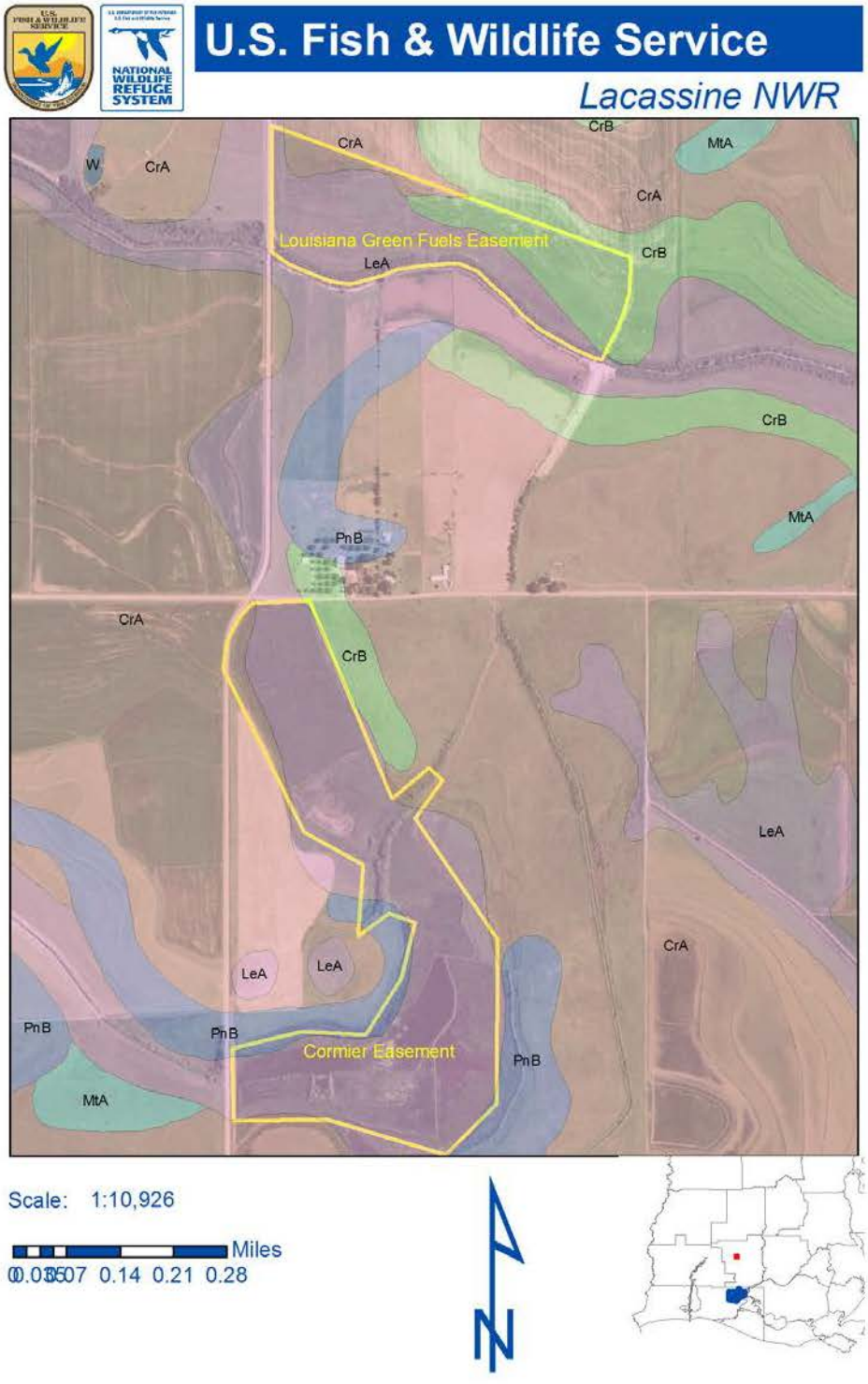
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Appendix E

Climate Change Impacts

Scientific consensus affirms that climate change is occurring and is causing an increase in global average land and ocean temperatures (Bedoya 2008). This warming trend is likely to cause substantial impacts to precipitation levels, sea level, species and ecosystems. The Southeast United States may be one of the most vulnerable regions in the United States to climate change mainly due to its high biodiversity and long, low-lying coastline (Smith 2004; Karl et al. 2009).

In the Southeast region the increase in average temperature is expected to continue with the greatest increases occurring in summer. The magnitude of rise is expected to be between 4.5° and 9° Fahrenheit by 2100 along with an increase in frequency of very hot days (U.S. Global Change Research Program 2009; US Congressional Budget Office 2009). The number of freezing days per year for most of the Southeast has declined by 4 to 7 since the mid-1970's (Karl et al. 2009).

Seasonal precipitation is also changing dramatically in this region. Fall precipitation over most of the region is up about 30 percent with only a small decrease in South Florida (Karl et al. 2009). Summer precipitation has decreased in most areas and during the past three decades there have been several severe droughts. Across the region the amount of precipitation that falls in the form of a heavy downpour is up and could lead to an increased chance of flooding (Karl et al. 2009).

Currently, climate change is not the most important driver of changes in biodiversity; however, it could be the largest driver by the end of the 21st century (Millennium Ecosystem Assessment 2005). Even so, there have already been measurable changes in global biodiversity due to climate change, particularly with regard to changes in species distributions, population sizes, timing of reproduction or migration events, and increases in the frequency of pest and disease outbreaks (Millennium Ecosystem Assessment 2005; Janetos et al. 2008). In the United States, climate change has already impacted terrestrial ecosystems by changing the timing of growing season length, phenology, and species distributions and diversity (Janetos et al. 2008).

As climate change disrupts ecological processes with increasing severity, the Refuge system is likely to experience significant changes in its physical and biological resources. Regional Climate Science Centers are being established by the Department of the Interior. These centers will provide scientific information, tools and techniques needed to manage land, water, wildlife and cultural resources in the face of climate change. The USGS and the DOI centers will also work closely with a network of Landscape Conservation Cooperatives in which federal, state, tribal and other managers and scientists will develop conservation, adaptation and mitigation strategies for dealing with the impacts of climate change (USFWS 2010).

To summarize, climate change effects on Lacassine NWR are likely to include the following:

- Increased temperatures
- Increased fall precipitation

- Increased frequency and severity of growing season drought
- Increasing sea level, coupled with local subsidence

How these changes will affect management of the refuge over time is uncertain; however, some predictions seem safe. Changes in precipitation are likely to affect management of the refuge by changing the amount and timing of fresh water available to flush brackish water from unimpounded marsh, as well as to fill Lacassine Pool. Maintaining sufficient water in Lacassine Pool during dry summers may become more difficult, since the pool is fed only by rainwater and freshwater flow from upstream. Conversely, fire management of Lacassine Pool may become more feasible with frequent droughts. These effects will be exacerbated by higher summer temperatures, which will increase evaporation and transpiration from the pool. Lacassine Pool dried up during the drought of the late 1990s and early 2000s (USFWS 2007) and again in 2010-2011. Increases in fall precipitation, especially if high intensity rainfall events become more common, may result in wider fluctuations in salinity, or longer periods of fresh water residence on brackish marsh.

Warmer temperatures and decreased frequency of freezing temperatures in the winter may result in proliferation of exotic species adapted to warmer climates and will likely cause native species to adjust their ranges or be locally extirpated due to inability of the refuge to meet their habitat needs. Examples of exotic pest species which may benefit from climate change include water hyacinth, common reed, and nutria (US EPA 2008).

Sea level rise will obviously affect low-lying areas of south Louisiana, including Lacassine NWR. Unprotected low-elevation areas will be inundated or converted from freshwater to brackish systems over time. In addition, freshwater aquifers may experience saltwater intrusion, limiting their utility for irrigation. Artificial elevation of marshlands with dredge spoil or other materials can be tried to counteract these effects, though it is not known whether these methods represent more than a short-term solution.

Appendix F

Mitigation Plan for Long-Term Restoration and Management of the Lacassine Pool

Mitigation Plan for Long-Term Restoration and Management of the Lacassine Pool

Lacassine National Wildlife Refuge (NWR)
Lake Arthur, Louisiana
December 2007

Post-Hurricane Rita Photo of the Lacassine Pool Wetlands & the Breached Southwest Perimeter Levee

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Background:

Lacassine NWR was established on December 30, 1937, as Lacassine Migratory Waterfowl Refuge by the following: 1) Executive Order 7780, "...as a Refuge and breeding ground for migratory birds and other wildlife...;" 2) the Migratory Bird Conservation Act, "... for use as an inviolate sanctuary, or any other management purpose, for migratory birds," (USC 715d). Additional lands were added to the refuge under 3) Fish and Wildlife Act of 1956 "...for the development, advancement, management, conservation, and protection of fish and wildlife resources..." [16 USC 742f(a)(4)] and 4) "...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services" [16 USC 742f(b)(1)].

Within the purpose of its establishment, management efforts have focused toward the improvement of habitats under its jurisdiction for the primary benefit of waterfowl and ancillary benefits to wading birds and shorebirds, threatened and endangered species, and other native fish and wildlife. The Lacassine NWR staff engages in habitat restoration, management, and manipulation that includes terrace construction and maintenance, organic layer reduction, drainage, prescribed fire, vegetative planting, and exotic plant control that are beneficial to wildlife.

The focus of this document centers on the 16,000-acre Lacassine Pool (Unit G), also known as the "Pool". This fresh marsh impoundment was completed in the early 1940's and is recognized as a closed aquatic ecosystem. It is adjacent to the Bell City Ditch to the west, the Gulf Intracoastal Waterway (GIWW) to the south, the Lacassine Bayou to the east, and cropland to the north (see Figure 1). Because it is essentially a closed system, there is no tidal influence. Rainfall is the Pool's only water source.

When constructed, the Pool was designed to be managed at approximately four feet above mean sea level (MSL). As a result of the closed system and flat topography, no natural flushing activity exists within the Pool to disperse dead plant material outside of the impoundment. There is minimal capability to manage water levels by gravity flow through the existing three stop-log water-control structures located within the southeast, southwest, and northeast levees. Thus, for over sixty years, dead plant material has continually accumulated on the "marsh floor" and has gradually decreased water depth and volume. The sub-tropical climate and extended growing season produces thousands of tons of dead plant material annually. This "unnatural" process tends to alter the entire aquatic community which in turn impacts the other local wildlife communities.

Over time, a multitude of emergent plant species have thrived, out-competing the more desirable waterfowl plant species. Without some form of intervention, the Pool will continue to fill in, open water areas will completely disappear, and the use of the area by migratory birds will significantly diminish. In addition, the excellent fisheries resource that has developed will be lost and no longer available to future generations.

Many local residents have observed these events happening over the years and have voiced their concerns, dating back as far as 1953. Over the course of time, biologists and scientists have gathered to investigate such concerns and address the management of the Pool.

U.S. Fish and Wildlife Service (FWS) Fisheries Biologist, David Fruge (Fruge 1974), reported in August 1974 in a wildlife management study titled, "The Vegetation of Lacassine Pool:"

> *"The three small, elevated spillways allow a negligible amount of the tremendous annual crop of plant matter to escape from the impoundment. The resultant accumulation of this detritus therefore will cause aggradations of the substrate with consequent lowering of water levels, and continuing emergence of pop-ups, with resultant colonization by emergent species and consequent elimination of open water areas and the associated floating-leafed submergent community. This process was noted in refuge records as far back as 1953."*

Fish and Wildlife Service Biologist, Jacob Valentine (Valentine 1979), reported in November of 1979:

> *"Lacassine Pool has been in existence for about 36 years. The accumulation of organic material laid down by generations of plants is proceeding at a greater rate under impoundment than in the adjacent marshes. Under natural conditions, marshes are subject to drying which reduces the organic material by oxidation. The accumulation of peat-mucks reduces the water holding capacity of the impoundment, and ultimately the vegetation would succeed to a totally emergent plant community."*

By the early 1990s, an overwhelming amount of emergent vegetation had dominated the Pool. In 1993, in an attempt to create more open water areas, the refuge manager raised the Pool's water level about one to one and one-half feet with the intent of causing plant mortality through waterlogging stress. After several years of subsequent monitoring, it was concluded that higher water levels did not reduce vegetation and may have actually promoted the growth of some emergent species such as maidencane *Panicum hemitomon*. In addition, the increased water pressure began to compromise the integrity and stability of the terrace system.

During a wildlife and habitat management review in 2002, a team of veteran natural resource managers and biologists (26 members consisting of private, state, and federal professionals) evaluated the current refuge management practices and provided recommendations regarding future habitat and water management in a report entitled *"Lacassine National Wildlife Refuge Wildlife and Habitat Management (Biological) Review, February 2003"*. The general consensus of the team concluded that, if no remedial actions are undertaken, the water volume will continue to decline and the waterfowl habitats diminish.

Post Hurricane Rita

In October 2006, the Southwest Louisiana Refuge Complex publicly issued a draft rehabilitation plan or a Comprehensive Conservation Plan (CCP) for the Lacassine NWR aimed at reversing the negative impacts associated with the man-made impoundment. The CCP was developed to guide management actions and direction over the next fifteen years. Engineers, managers, and biologists from various entities have formulated strategies as part of the plan. These strategies include the use of improved technology and construction techniques to effectively attain specified goals.

As described in the CCP, the peril of the Pool has been further exacerbated:

> *"On September 24, 2005 Hurricane Rita struck southwest Louisiana with 121 mile-per-hour winds and a storm surge ranging from 15 to 20 feet. The storm surge topped the Lacassine Pool dikes and water control structures carrying saltwater into it and killing vegetation, some fish, and other aquatic organisms. Salinity in Lacassine Pool ranged from 14 ppt to 1.2 ppt during the period September 24, 2005 - March 6, 2006; "[levees] and water conveyance infrastructure were weakened."*

Prior to Hurricane Rita, the Pool was recognized as a wetland in peril because of the long-term build up of dead plant material. The salinity associated with the storm surge killed additional vegetation which only compounded the problem. Refuge managers have known for years that the best way to remedy the problem is through effective and efficient water management capabilities. The CCP recognizes some of the problems associated with effectively managing water in the Pool as follows:

> *"This water level regime is highly dependent upon weather conditions in any given year. A hurricane or tropical depression can completely flood the area for an entire year. A heavy spring rain can do the same. A severe drought can do the complete opposite so refuge managers must be flexible and have the ability to work with the dynamic weather conditions of the area."*

The ultimate significance of water level manipulation capability in the Pool lies in the management of dead plant material. Decomposing plant material uses oxygen from the water that is vital to aquatic species. Having the maximum capability to manage water levels allows for timely dewatering of the units followed by prescribed burning which accelerates the decaying process and results in a more highly oxygenated environment once water is restored to the system.

Hurricane-related infrastructure and water management requires the ability to slow down storm surges where possible and to remove salt water from the area in a timely manner through appropriately placed and constructed levees, terraces, water control structures, and mechanical water pump systems. This capability is essential to restore aquatic plant communities, aquatic organisms, and ancillary wildlife.

In an effort to manage the Pool for both wintering waterfowl and aquatic species (e.g., fish for recreational fishing), it is the goal of this ongoing restoration project to repair and modify as appropriate, water pump systems, levees, and terraces so that refuge managers will have the flexibility to work with the "dynamic weather conditions of the area" and manage the Pool to fulfill the purpose for which the refuge was established.

FWS Enhancement Efforts within Existing Terraced Wetlands

The draft CCP was evaluated and approved through an Environmental Assessment (EA) review in accordance with the National Environmental Policy Act (NEPA). In the CCP, six management goals were developed, each with its own specific objectives and subsequent strategies for achieving those objectives. Through the EA, three alternatives were identified which offered "different approaches or combinations of management objectives and strategies designed to achieve the refuge purpose, vision, and the goals identified in the [CCP]" all of which are aimed at providing "permanent protection and restoration of fish, wildlife, plants, habitats, and other resources at Lacassine Refuge."

Strong support from the public for subdividing the Pool was observed during a public meeting held in May 2006 in Lake Charles, Louisiana in which the draft CCP and EA were discussed. The Louisiana Department of Wildlife and Fisheries (LDWF), who also aided in the development of the plan, in their December 5, 2006 letter regarding the CCP, expressed their concurrence with the FWS on the theory that migratory waterfowl use has likely declined primarily due to the loss of open waters and that subdivision into three additional management units would allow for more direct development and management actions effectively reverse the declining trend. On May 20, 2007, a finding of no significant impact or FONSI was issued.

Under the proposed alternative, a levee or terrace would be constructed within the Lacassine Pool, subdividing it into four units (Unit D plus three additional units). "This action would facilitate the management and lengthen the longevity of the Pool by increasing the ability of refuge staff to dewater it, drawing it down to facilitate oxidation of accumulating sediments and more frequent use of prescribed fire. Thus, management could proceed unit-by-unit on a regular basis without having to impact the value of the entire pool to migratory birds and fisheries all at once." The placement of the cross terrace is one of the strategies designed to aid refuge personnel in accomplishing their objective for managing the impounded freshwater marsh (Lacassine Pool) which, in turn, supports the refuge goal of conserving, restoring, and enhancing diverse habitats to provide favorable conditions for migratory birds and native terrestrial and aquatic species. The other objective strategies include:

(a) Continue repairing and maintaining all spillways and leaking levees.

(b) Operate the spillway structures to accommodate a pool level that benefits migratory birds and takes into consideration fish, other wildlife, and access for recreational fishing.

(c) Conduct prescribed/hazardous fuel removal burns as environmental factors permit. Secure advanced permission from appropriate decision-makers to conduct prescribed burns during severe fire danger periods.

(d) Survey pool elevations to allow for subsidence and the resetting of spillway structure gages and stop logs.

(e) Rehabilitate and maintain a deepwater perimeter ditch around the interior perimeter of Lacassine Pool.

(f) Continue to stock fish as needed and continue to collect fisheries and waterfowl use data.

(g) Conduct a feasibility study focused on the removal of dead plant vegetation that has accumulated over the last 60 years. A private entity would potentially remove the material and sell it on the open market as top soil or peat. The study would also investigate the feasibility of mechanically removing floating aquatic vegetation with the best available technology. The study would determine what the permitting requirements would be and if it could be a financially and environmentally viable project. If the project proves viable, it would be implemented.

(h) Keep the 714-acre Unit D, established as an experimental research unit, separated from Lacassine Pool.

(1) Work with the Louisiana Department of Wildlife and Fisheries and the U.S. Fish and Wildlife Service's fisheries biologists to manage the area as a special waterfowl and fisheries management area.

(2) Explore providing some form of limited horsepower boating access to the area under a time and space management program. If it is determined that this is feasible, implement the access.

(3) Habitat management of this unit will follow the same general management guidelines as identified for Lacassine Pool units, with options to implement experimental treatments that might be applicable for improving management within the unit.

(i) Closely monitor and document the effects of ship traffic on the south dike of the Lacassine Pool, which is adjacent to the Gulf Intracoastal Waterway (GIWW).

(1) Implement an engineering study within five years to determine what preventive action needs to be taken to avoid erosion potentially being caused by vessels using the GIWW.

In October 2006, the FWS started the application process for obtaining the necessary environmental permits required to carry out repair activities associated with damage incurred as a result of Hurricane Rita, as well as refuge enhancement activities necessary to carry out the refuge's CCP goals and objectives. Included in these activities was the construction of the cross terrace designed to subdivide 11,000 acres

of the Lacassine Pool into two smaller, more manageable units. To address wetland alterations resulting from the described action, the FWS has developed and will implement the following:

Mitigation Efforts for Altered Wetlands

A low-level cross terrace, approximately 21,809 feet long, will be made through the center of the 11,000-acre unit of the Pool, subdividing it into two smaller, approximately equal-size units (see drawing CS-1). The purpose of the cross terrace is two-fold - (1) to effectively reduce the size of the unit so that the area becomes more manageable by refuge personnel, and (2) to reduce wind fetch, reduce turbidity, promote submerged aquatic species, and ultimately serve as a tool to restore marsh.

The new terrace will be constructed from east to west spanning from the Tidewater Levee to the Bell City Ditch Levee, respectively. By design, the terrace will be constructed approximately 6 feet high, 52 feet wide along its base, and 16 feet wide along its crest (see drawing CS-2).

Amphibious excavators will be used to construct the terrace by dredging thalwegs or canals on either side of the proposed terrace and using the dredge material from the thalwegs to form the terrace. Each thalweg will be dredged approximately 6 feet deep and 51 feet wide with side slopes of 3(H):1(V) (horizontal feet: vertical feet).

While these thalwegs will function as borrow areas during the construction of the terrace, they will ultimately serve as escape routes or "refuge" areas for some of the local fisheries during droughts or managed draw-downs. These areas may also serve as waterfowl brood areas for mottled ducks *Anas fulvigula*, a species of concern in portions of the Chenier Plain. This practice occurs on other national wildlife refuges such as the Toppenish NWR in Washington where these canals are known to "reduce the chance of leaving isolated pools and provide better passage of fish through wetlands during wetland drawdown process. These thalwegs effectively drain the wetlands and convey water to outlets to prevent stranding and entrainment of juvenile fish."

It is anticipated that it will take approximately 6 months or longer to construct, assuming two excavators are utilized during the entire construction period. The terrace, once formed, will be allowed to settle and dewater for a period of approximately 6 months. At that time, the terrace will be shaped and sown with either Bahia grass seeds at a minimum rate of 5 pounds per acre if seeding is performed during the months of January through July or, if seeding during the months of August through December, with rye grass seeds at a minimum rate of 25 pounds per acre.

As part of the design, two bridges will be constructed within the cross terrace; one along the west end and one along the east end (see drawing CS-1). Each bridge has been designed with boat pass capability, as well as stop log-style water control structures for water management purposes.

In evaluating potentially-altered wetlands resulting from the construction of the cross terrace, several areas have been considered - the total construction acreage and the total potentially-altered wetlands acreage.

Construction Acreage

Terrace - The base of the terrace will be approximately 52 feet along a total construction length of approximately 21,809 linear feet for a total construction area of 26.0 acres.

Thalwegs - Each thalweg will be constructed approximately 51 feet wide along a total length of 21,809 linear feet for a total construction area of 25.5 acres for one thalweg or 51 acres for both thalwegs.

Potentially-Altered Wetlands Acreage

Of the 77.0 acres under construction, an estimated 41% consists of open waters (see Figure 1 and drawing CS-1). Thus, it is anticipated that only approximately 59% or 45.4 acres consists of potentially-altered wetlands.

However, based upon wetland research, as well as the personal experience of refuge personnel, wetland species are known to survive in saturated soils up to 1 vertical foot above the water surface and down to a depth of 4 vertical feet below the water surface. For example, research related to fresh marsh ecosystems in Louisiana illustrates that common species of fresh marsh vegetation such as California bulrush *Scirpus californicus* and cattail *Typha* spp. can survive in water depths to three feet (Materne 2000, Grace 1989).

Such habitat benefits have routinely been and continue to be recognized by regulatory and natural resource management agencies. Previous projects that have been credited with such benefits include the Cameron Creole Mitigation Bank Phases I and II, Sediment Trapping at "The Jaws" (Coastal Wetlands Planning, Protection, and Restoration Act [CWPPRA] Project: TV-15), and Little Vermilion Bay Sediment Trapping (CWPPRA Project: TV-12).

It is also known that seed banks, or rather collections of dormant seeds in soils, are present in nearly all ecosystems and are critical components in the establishment and development of vegetation communities in wetlands (DeBerry and Perry 2000, No. 00-2). Typically, a physical disturbance mechanism must be present in order to transport the seeds from within the seed bank up to the soil surface where they can obtain the proper amounts of water and oxygen, as well as the appropriate temperature range necessary for germination. "Transplanted wetland soils have been shown to increase species diversity and cover on created and restored sites" (DeBerry and Perry 2000, No. 00-4). During alternating periods of flooded and dry conditions, as might be expected along the banks of the thalwegs and the toe of the terrace, germination response varies such that submersed aquatic species are favored during flooded conditions and emergent perennials during dry or drawdown conditions (DeBerry and Perry 2000, No. 00-2).

Considering the above information, it is reasonable to assume that submerged and emergent wetland vegetation will grow along the banks of each thalweg and along the toe of the cross terrace on each side. With side slopes of 3(H):1(V), it is

anticipated that wetlands will re-naturalize in an area of 12 horizontal feet along each thalweg bank and in an area of 3 horizontal feet along the toe of the terrace on either side for a total of 27.0 acres (see drawing CS-2). Since many of the existing wetland species at Lacassine NWR tend to spread quickly by rhizomes and/or seed (e.g., cattail, maidencane, bulrush, and cutgrass), and there is believed to be a strong existing seed bank within the Pool, the FWS anticipates a quick re-vegetation of the banks of the newly created thalwegs and terrace; most likely within 2-5 years. However, the FWS plans on planting an additional 2,340 Bulrush and Cutgrass plants in small plant communities along the cross terrace for a total combined length of approximately 11,900 linear feet (See Figures 2-4). As described in the Virginia Institute of Marine Science's Summer 2000 Wetlands Program Technical Report, No. 00-4, planting of wetland species may influence recruitment of naturally colonizing vegetation from the seed bank (DeBerry and Perry 2000, No. 00-4).

In addition, the FWS, working with partners, is in the process of degrading approximately 1.4 acres of an abandoned oil and gas levee down to marsh level (see Figure 5). The adjacent levee borrow pit will be backfilled and allowed to re-naturalize with wetland vegetation; however, to supplement the process, the FWS will plant approximately 1,500 Bulrush and Cutgrass plants within the degraded areas.

All of these plantings will be completed prior to October 31, 2012. A tabular summary of the anticipated wetland alterations is provided below.

SUMMARY OF ALTERED WETLANDS

DESCRIPTION	LENGTH (linear feet)	WIDTH (feet)	SQUARE FEET	ACREAGE UNDER MODIFICATION	POTENTIALLY ALTERED WETLANDS (AC)[1]
Cross Terrace	21,809	52	1,134,068	26.0	15.3[1]
Thalweg	21,809	51	1,112,259	25.5	15.0[1]
Thalweg	21,809	51	1,112,259	25.5	15.0[1]
				Potentially Altered Wetlands	**45.3[1]**

DESCRIPTION	LENGTH (linear feet)	SATURATED SOIL (feet)	SQUARE FEET	ALTERED WETLANDS TO RE-NATURALIZE (AC)[2]
Cross Terrace	21,809	6	130,854	3.0[2,3]
Thalweg	21,809	24	523,416	12.0[2]
Thalweg	21,809	24	523,416	12.0[2]
Degraded Levee			60,350	1.4[2,4]
			Altered Wetlands to Re-Naturalize & Receive Supplemental Plantings	**28.4[2]**

1. An estimated 41% of the total area under construction occurs in open waters; thus, only 59% of the total 77.0 acres represents altered wetlands.
2. Based upon wetland research and FWS management experience, common wetland species can survive within the soil saturation zone up to 1 vertical foot above and 4 vertical feet below the water surface. Given proposed slopes of 3(H):1(V) along the terrace and each of the thalwegs, common emergent wetland grasses are expected to naturalize along 3 horizontal feet (1 vertical foot above the water surface) at toe of the terrace on each side and 12 horizontal feet along the inside edges of the thalwegs (4 vertical feet below the water surface within the thalweg).
3. Approximately 2,380 Bulrush and Cutgrass plants will be planted in small communities along the terrace toe to enhance wetland habitat.
4. Approximately 1.4 acres of an abandoned oil and gas operations levee will be degraded down to marsh level and planted with approximately 1,500 Bulrush and Cutgrass plants.

As a result of the anticipated re-naturalization, the proposed project effectively alters an estimated 16.9 acres of wetlands, less than 0.2% of the Pool's 11,000 acres of wetlands and marshland being subdivided. The FWS proposes to compensate for these 16.9 acres of altered wetlands by converting almost 20 acres of active agricultural land into emergent marshland. Specifically, a portion of Management Unit B, Field S-4, will be converted into an early successional wetland habitat (see Figures 1 and 5). The site has been carefully selected to blend in with the existing farming program and create a unique edge affect that will be beneficial to wetland dependent wildlife species.

Field S-4 is one of 19 fields found in Unit B and is composed of an estimated 19.3 acres of predominately (~ 90%) seashore paspalum, *Paspalum distichu,* and secondarily, rattlebox, *Sesbania punicea*. Currently, the field is out of crop rotation but scheduled for planting during the upcoming growing season. Field S-4 is bordered on the north, west, and south by irrigation ditches and to the east by both a roadway and a larger irrigation ditch (See Photos 1-5). Existing field drains are actively used by a cooperative farmer

with all flooding and drainage activities being dependent upon one main water pump located in the southeast corner of Unit B.

The FWS will prepare the field for future management as a moist soil/early successional wetland by initially discing the field, constructing a rice-check dam, and installing several water control devices. Once the site has been prepared, the following water management strategies will be applied:

1. The water levels will be raised gradually to a depth of 6 to 12 inches and remain at this level during the early fall and winter until around February.
2. During the early spring, the water levels will gradually be lowered to a point which will allow for the germination of wetland dependent plant species.
3. Soil moisture conditions will be monitored periodically throughout the summer to determine if additional water is needed to enhance or perpetuate moist soil plant growth.
4. The cycle will be repeated annually or on an as-needed basis in order to provide the best habitat possible for wetland-dependent wildlife.

Prescribed burning, chemical treatment, and/or discing may also be performed from time to time in an effort to control the growth of noxious plants. The management strategies employed on this field will be evaluated annually and adjustments made as necessary to achieve and maintain the wetland plant community and water regimes most productive for wetland-dependent wildlife.

While it is understood that this project would alter 16.9 acres of existing wetlands, it is important to reiterate the fact that without the construction of the proposed cross terrace, the entire 11,000-acre portion of the Lacassine Pool would continue to degrade, ultimately leading to a larger, more significant loss of valuable wetlands and marshlands.

In reviewing the pros and cons of this project, it should also be noted that significant wildlife benefits will be derived from the cross terrace and adjacent thalwegs as follows: Between 1998 and 2000, Frank Moore, PhD, and doctoral candidate Jennifer Owen of the University of Southern Mississippi, conducted a study entitled "*Use of Sabine NWR nearcitic-neotropical landbird migrants: Comparison between coastal Chenier and habitat 'islands' within the refuge*". Data was collected along two study sites during annual spring migrations - (1) a man-made refuge terrace and (2) a coastal Chenier offsite. Results indicate that during days of inclement weather, birds are just as likely to use man-made terraces as observed in refuges as they are terraces in the coastal Cheniers along the Gulf of Mexico.

In addition, the proposed thalwegs also offer wetland value which has been substantiated by the FWS. Through historic FWS observations, it has been shown that the open waters of the thalwegs will transition over to a floating aquatic marsh consisting primarily of white water lily, *Nymphaea odoratta,* and water shield, *Brasinia schreberi,* both of which are species valuable to migratory birds and fisheries.

In summary, the FWS proposes the following measures in an effort to fully mitigate for the alteration of 45.3 acres of wetlands resulting from the Service's compliance with its legislative commitment to fulfill the purposes for which the Lacassine NWR was established by attempting to rescue a well documented 11,000-acre wetland in danger.

Mitigation Measures	Wetland Acreage
Altered Wetlands to Re-naturalize & Receive Plantings	27.0
Levee Degraded & Converted to Wetlands	1.4
Agriculture Land Converted to Wetlands	19.3
Total Wetlands Gained through Mitigation Efforts	**47.7**

Upon completion of this restoration project, the FWS will manage the Lacassine Pool by employing the following strategies designed to improve and sustain the lands in support of both fish and wildlife for decades to come.

Proposed Treatment of the Lacassine Pool Management Units

The Lacassine Pool and Unit D will be managed, first and foremost, to support the purpose for which the refuge was created (i.e., to benefit migratory birds, especially waterfowl), but when possible, priority public uses such as fishing will be allowed. Treatments could include operating water control structures to dewater the pool, burning, spraying, and using other means to restore open water and food sources in the pool to attract and benefit many species of waterfowl. Water levels in other units not under initial rehabilitation will be managed in accordance with an adaptive management strategy that is conducive to fulfilling the purposes for which the refuge was established and in compliance with the National Wildlife Refuge System Improvement Act.

Each unit will be treated using the following strategies:

(1) Within a 10- to 15-year cycle, dependent upon availability of resources, environmental conditions (i.e., such as when drought conditions are most favorable), and under conditions described in an adaptive step-down water management plan, individual sub-units will be completely drawn down to allow for oxidation and to conduct prescribed burns to set back natural succession and dispose of accumulated dead plant material. Prescribed burning will continue as needed during the summer months whenever possible. Draw down of the sub-unit may require multiple years to achieve management goals. No more than two sub-units may be under treatment within a 5-year time period.

(2) Obtain advance permission to conduct prescribed burns during severe fire danger conditions. Keep annual records of fire practices and have prescription plans prepared to take advantage of drought periods.

(3) Provide water control structures and water pumping devices, as needed, to maintain the maximum water management capability possible.

(4) Develop an adaptive water management plan for each unit, as it is rehabilitated, that benefits migratory birds and takes into consideration fish, other wildlife, and recreational fishing. The plan should include:

- Development and maintenance of an elevation profile throughout Lacassine Pool to determine depths to mineral soil, depth of organic matter, and pool contours.
- Installation of water level gauges at strategic points in Lacassine Pool to allow recording of pool water elevations and drawdown schedules.
- Review of the water quality sampling plan to re-establish sampling objectives and procedures that will be sensitive to significant changes (i.e., immediate or long-term) inside and outside Lacassine Pool.
- Acquisition and updating of aerial imagery, ground surveys, and sound sampling procedures to track vegetation communities and open water/vegetation ratios and trends at 5-8 year intervals (work with U.S. Geological Survey to type map pool vegetation communities and repeat every 5-8 years).
- Monitor changes in Lacassine Pool by utilizing fine-scale plant/habitat aerial imagery inventory methods to type map habitats, with an emphasis on identifying aquatic-plant types, ratios of open water to vegetation coverage, and comparisons of vegetation/water ratio trends over a 5-year time period.
- Determine vegetation/water ratio changes associated with years following major hurricane events and any introduction of higher salinity waters.

(5) The remaining units awaiting their initial sediment treatment will continue to be open to fishing. Water levels will continue to be managed in a manner that is conducive to migratory birds and, to the extent possible, a fisheries resource and recreational fishing.

(6) Inform the public through refuge brochures (e.g., hunting and fishing) and at kiosks that the primary purpose of the refuge is migratory bird management. The message should state that measures taken to improve migratory bird habitat are also expected to benefit fish populations and anglers by prolonging the life of the Lacassine Pool.

(7) Archive all previous and future management treatments and scientific/biological studies, data relating to management actions/results, vegetation maps, impacts of catastrophic events (e.g., hurricanes and droughts) in one file or binder for future reference.

(8) Continue the historical waterfowl sanctuary status of the Lacassine Pool for migratory birds, especially waterfowl, and limit human disturbances by restricting and closely regulating public use of it and its observation route from October through March; by controlling oil and gas exploration and development; and by locating and protecting rookeries.

(9) Use mechanized equipment wherever practicable to build fish passageways and deep ponds so that fish will have escape routes to deeper water during droughts or cyclic drawdowns.

(10) Restock the fisheries resource as needed.

(11) Provide additional boat launching sites.

Fish and wildlife conservation continues to be a priority in refuge management at the Lacassine NWR. With the 15-year management plan as described in the CCP and the construction of this cross terrace and the associated thalwegs, the refuge will be able to improve the current conditions of the existing wetlands and marshlands found in the Lacassine Pool and develop a healthier, more valuable refuge for all forms of wildlife.

Literature References

DeBerry, Douglas A. and James E. Perry. 2000. *An Introduction to Wetland Seed Banks.* Wetlands Program Technical Report, No. 00-2. School of Marine Science, College of William and Mary. Glouscester Point, Virginia.

DeBerry, Douglas A. and James E. Perry. 2000. *Wetland Seed Banks: Research in Natural and Created Wetlands.* Wetlands Program Technical Report, No. 00-4. School of Marine Science, College of William and Mary. Glouscester Point, Virginia.

Grace, James B. 1989. *Effects of Water Depth on Typha Latifolia and Typha Domingensis.* Department of Botany, Louisiana State University. Baton Rouge, Louisiana. American Journal of Botany 76(5): 762-768.

Materne, Mike. 2000. *Plant Techniques Used for Wetland Restoration Along the Louisiana Coast.* Center for Plant Materials, U. S. Department of Agriculture, Natural Resources Conservation Service.

Rosburg, Thomas. 2001. *Secrets of the seed bank: Tiny clues to a landscape's past and future.* Iowa Natural Heritage Foundation website, www.inhf.org/seedbank2.htm

FIGURE 1 - Lacassine NWR Management Units

FIGURE 2 - West Cross Terrace Plantings

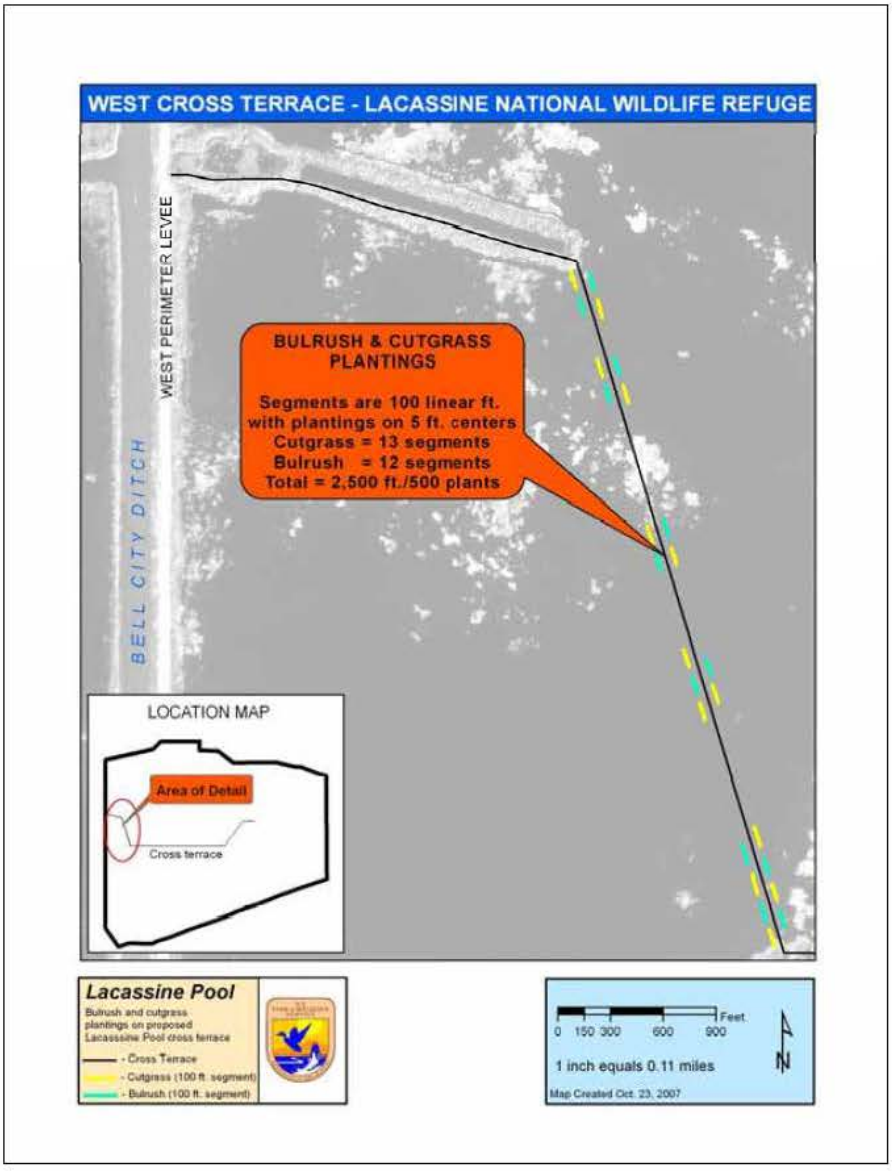


FIGURE 3 - Center Cross Terrace Plantings

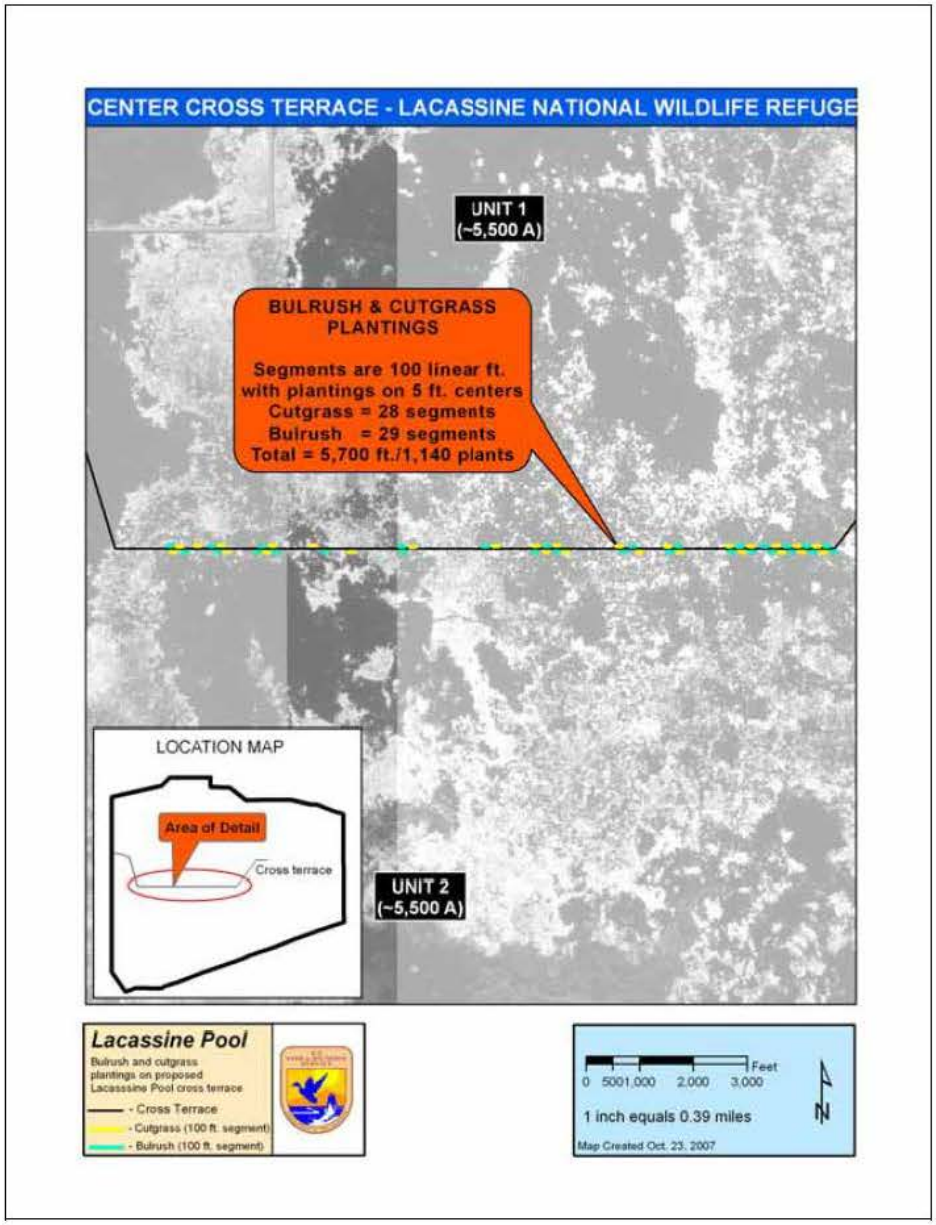


FIGURE 4 - East Cross Terrace Plantings

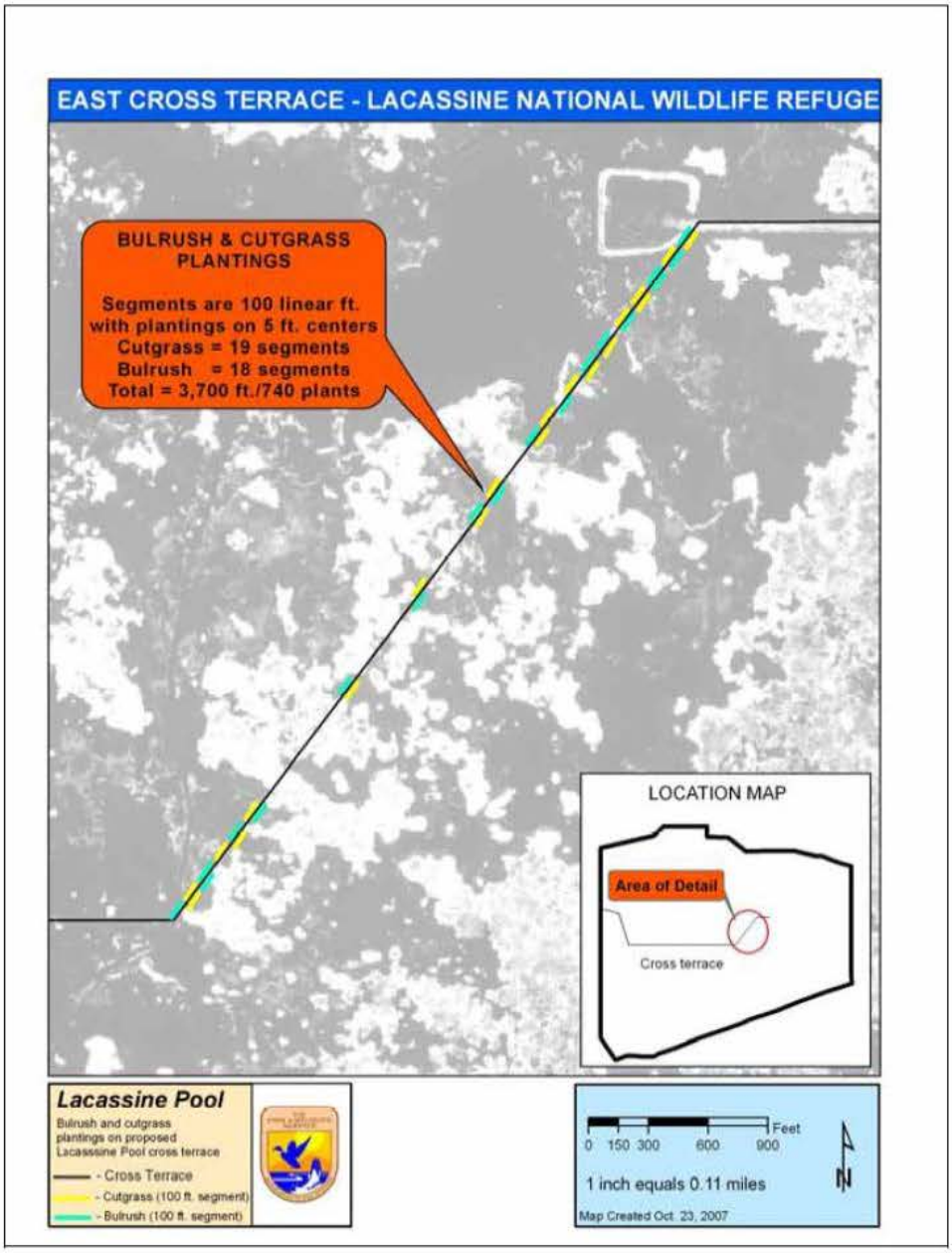


FIGURE 5 - United World Energy Mitigation (degradation of levee)

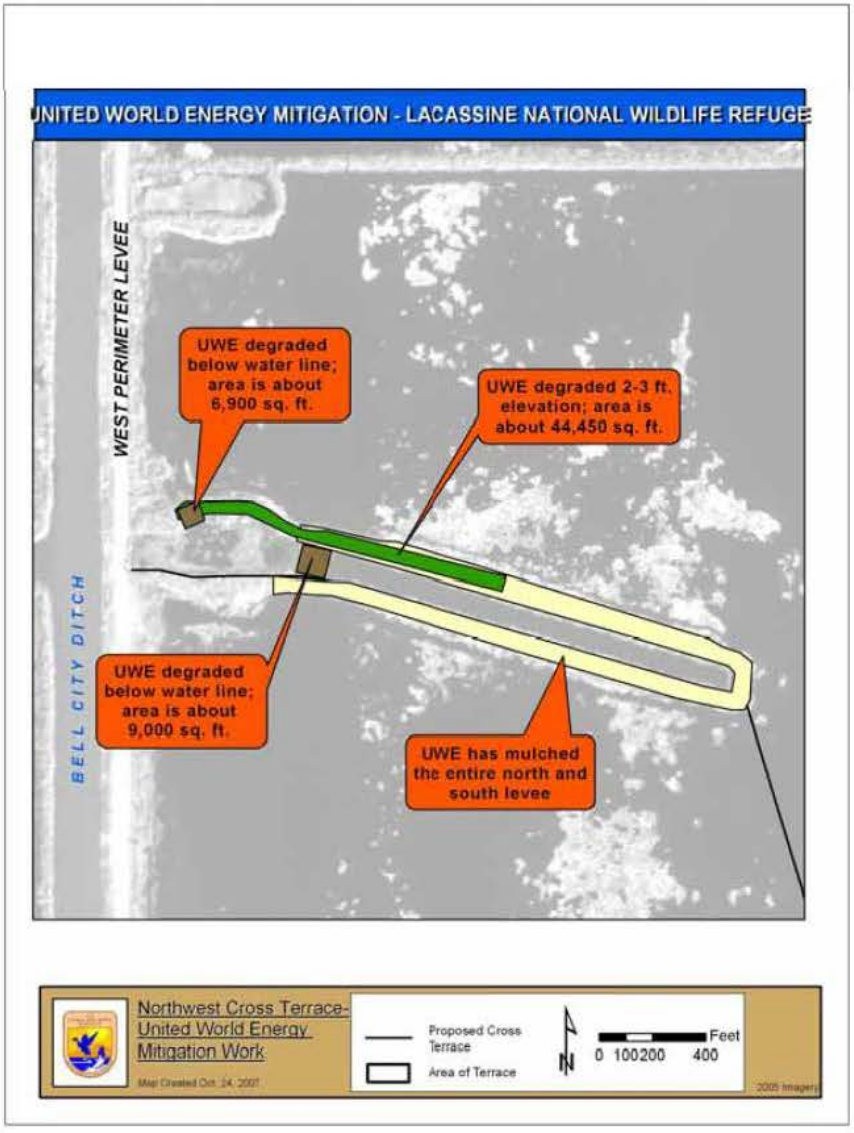


FIGURE 6 - Management Unit B, Field S-4

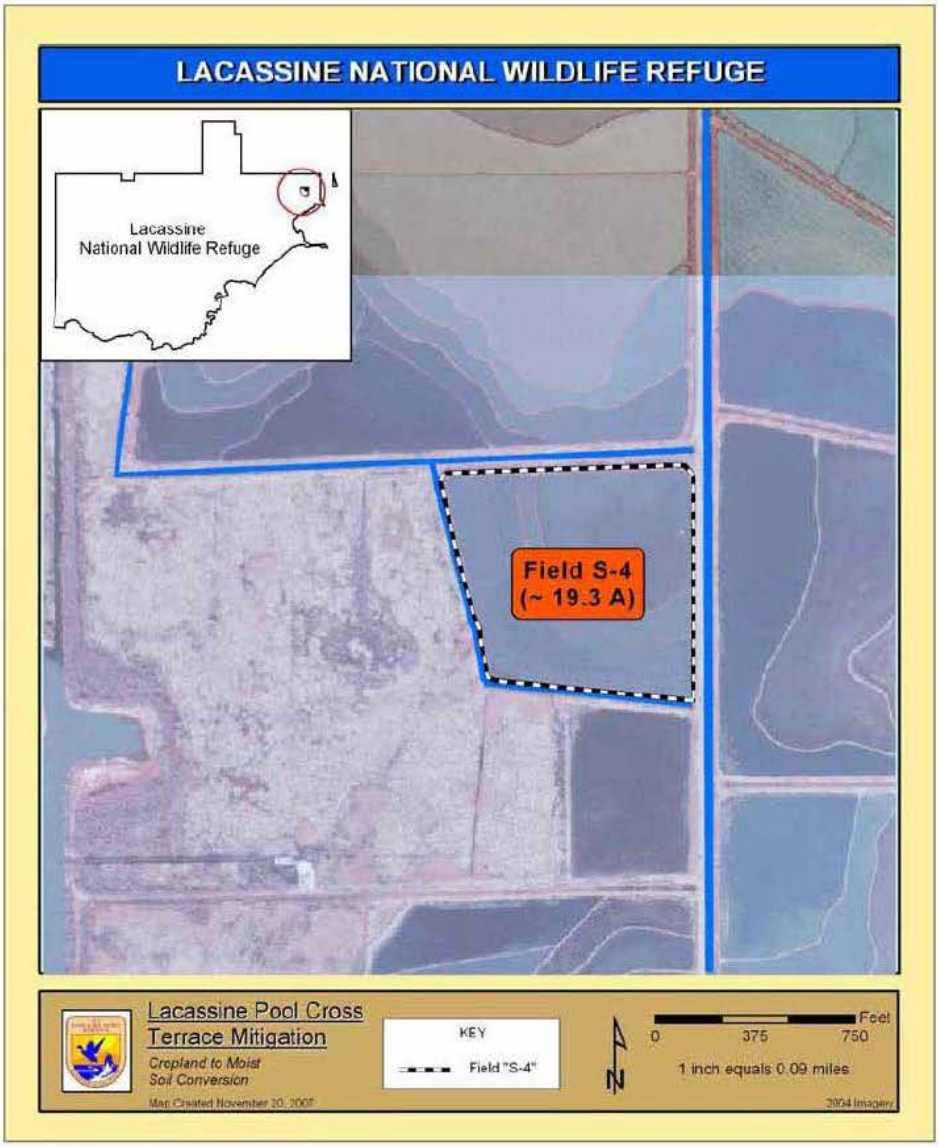


PHOTO 1 - Field S-4: Northwest View from Southeast Corner

PHOTO 2 - Field S-4: West View from Southeast Corner

PHOTO 3 - Field S-4: Southwest View from Northeast Corner

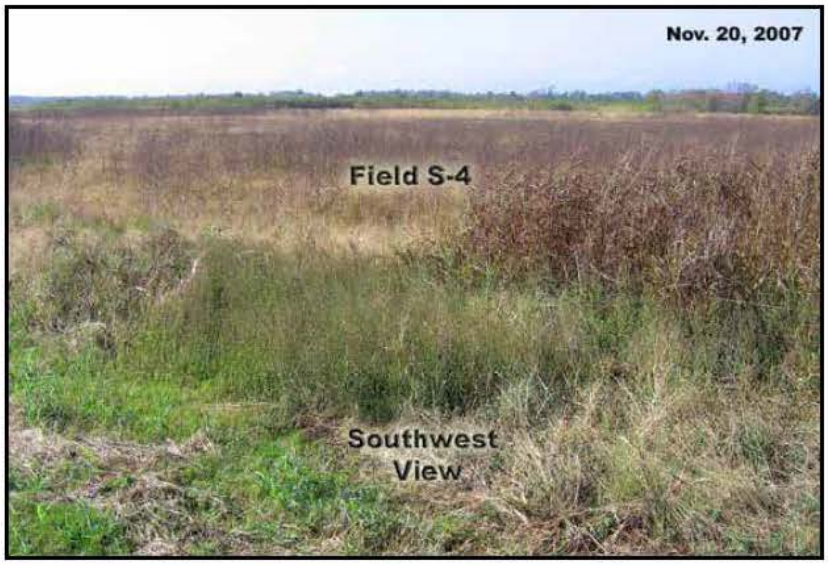


PHOTO 4 - Irrigation and Drainage Ditch East of Field S-4

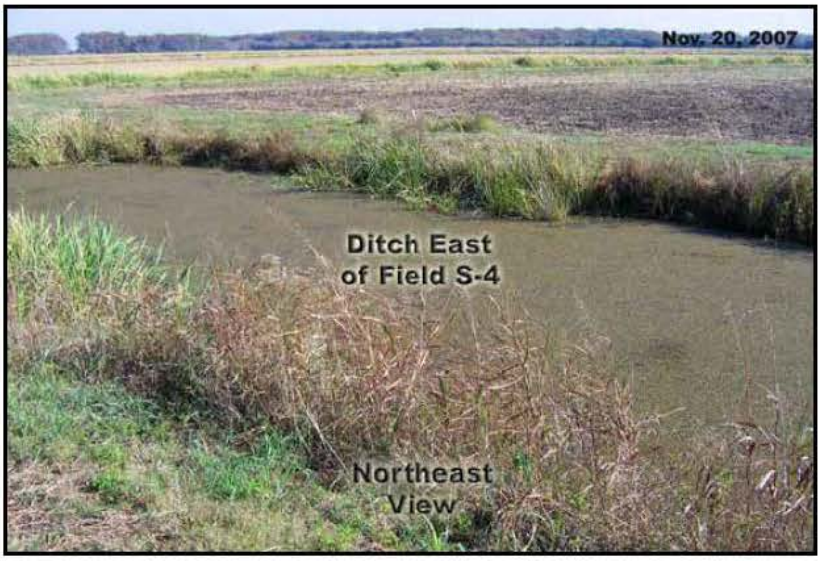
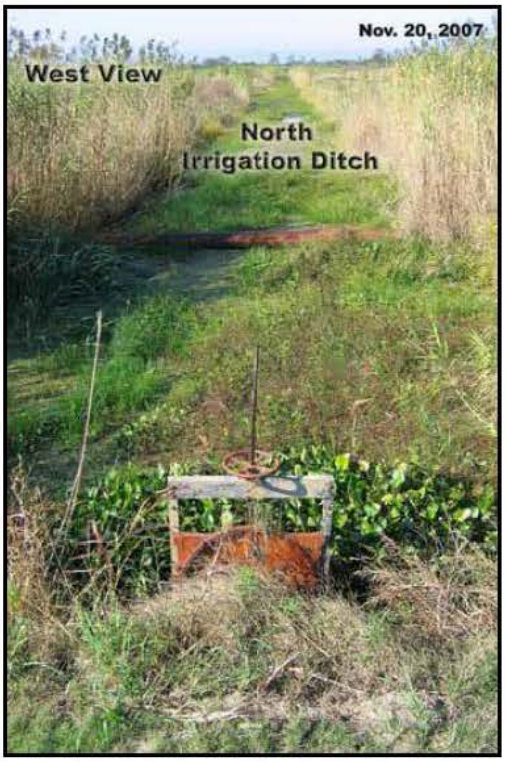
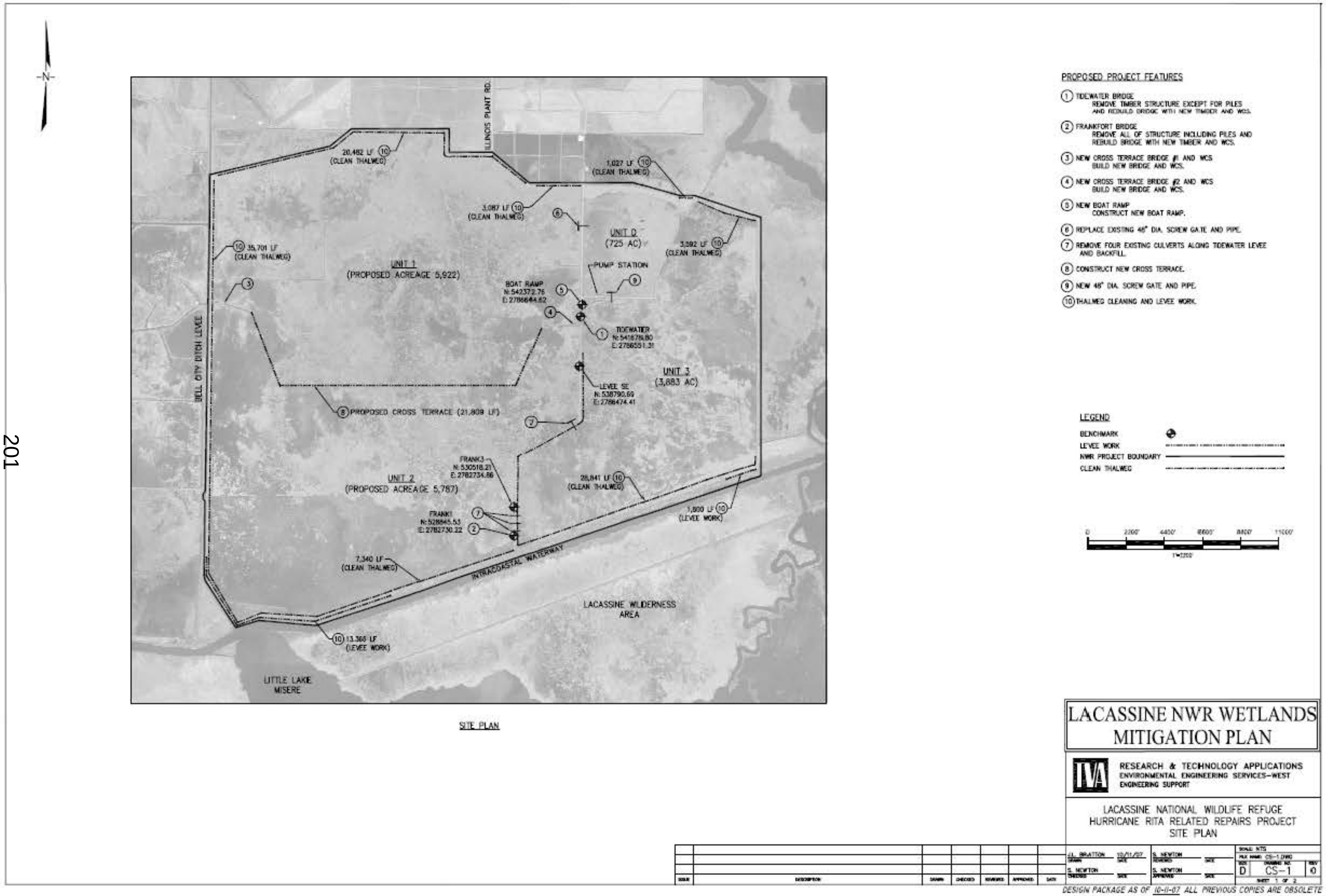


PHOTO 5 - Field S-4: West View from Northeast Corner





N
ILLINOIS PLANT RD.
20,482 LF (10) (CLEAN THALWEG)
1,027 LF (10) (CLEAN THALWEG)
3,087 LF (10) (CLEAN THALWEG)
UNIT 0 (725 AC)
3,592 LF (10) (CLEAN THALWEG)
(10) 35,701 LF (CLEAN THALWEG)
UNIT 1 (PROPOSED ACREAGE 5,922)
PUMP STATION
BOAT RAMP
TIDEWATER
UNIT 3 (3,883 AC)
LEVEE SE
BELL CITY DITCH LEVEE
(8) PROPOSED CROSS TERRACE (21,809 LF)
FRANK3
UNIT 2 (PROPOSED ACREAGE 5,787)
28,841 LF (10) (CLEAN THALWEG)
FRANK1
1,800 LF (10) (LEVEE WORK)
7,340 LF (CLEAN THALWEG)
INTRACOASTAL WATERWAY
LACASSINE WILDERNESS AREA
(10) 13,368 LF (LEVEE WORK)
LITTLE LAKE MISERE
SITE PLAN
PROPOSED PROJECT FEATURES
(1) TIDEWATER BRIDGE
REMOVE TIMBER STRUCTURE EXCEPT FOR PILES AND REBUILD BRIDGE WITH NEW TIMBER AND WCS.
(2) FRANKFORT BRIDGE
REMOVE ALL OF STRUCTURE INCLUDING PILES AND REBUILD BRIDGE WITH NEW TIMBER AND WCS.
(3) NEW CROSS TERRACE BRIDGE #1 AND WCS
BUILD NEW BRIDGE AND WCS.
(4) NEW CROSS TERRACE BRIDGE #2 AND WCS
BUILD NEW BRIDGE AND WCS.
(5) NEW BOAT RAMP
CONSTRUCT NEW BOAT RAMP.
(6) REPLACE EXISTING 48" DIA. SCREW GATE AND PIPE.
(7) REMOVE FOUR EXISTING CULVERTS ALONG TIDEWATER LEVEE AND BACKFILL.
(8) CONSTRUCT NEW CROSS TERRACE.
(9) NEW 48" DIA. SCREW GATE AND PIPE.
(10) THALWEG CLEANING AND LEVEE WORK.
LEGEND
BENCHMARK
LEVEE WORK
NWR PROJECT BOUNDARY
CLEAN THALWEG
LACASSINE NWR WETLANDS MITIGATION PLAN
RESEARCH & TECHNOLOGY APPLICATIONS
ENVIRONMENTAL ENGINEERING SERVICES-WEST
ENGINEERING SUPPORT
LACASSINE NATIONAL WILDLIFE REFUGE
HURRICANE RITA RELATED REPAIRS PROJECT
SITE PLAN
J.L. BRATTON 10/11/07
S. NEWTON
S. NEWTON
S. NEWTON
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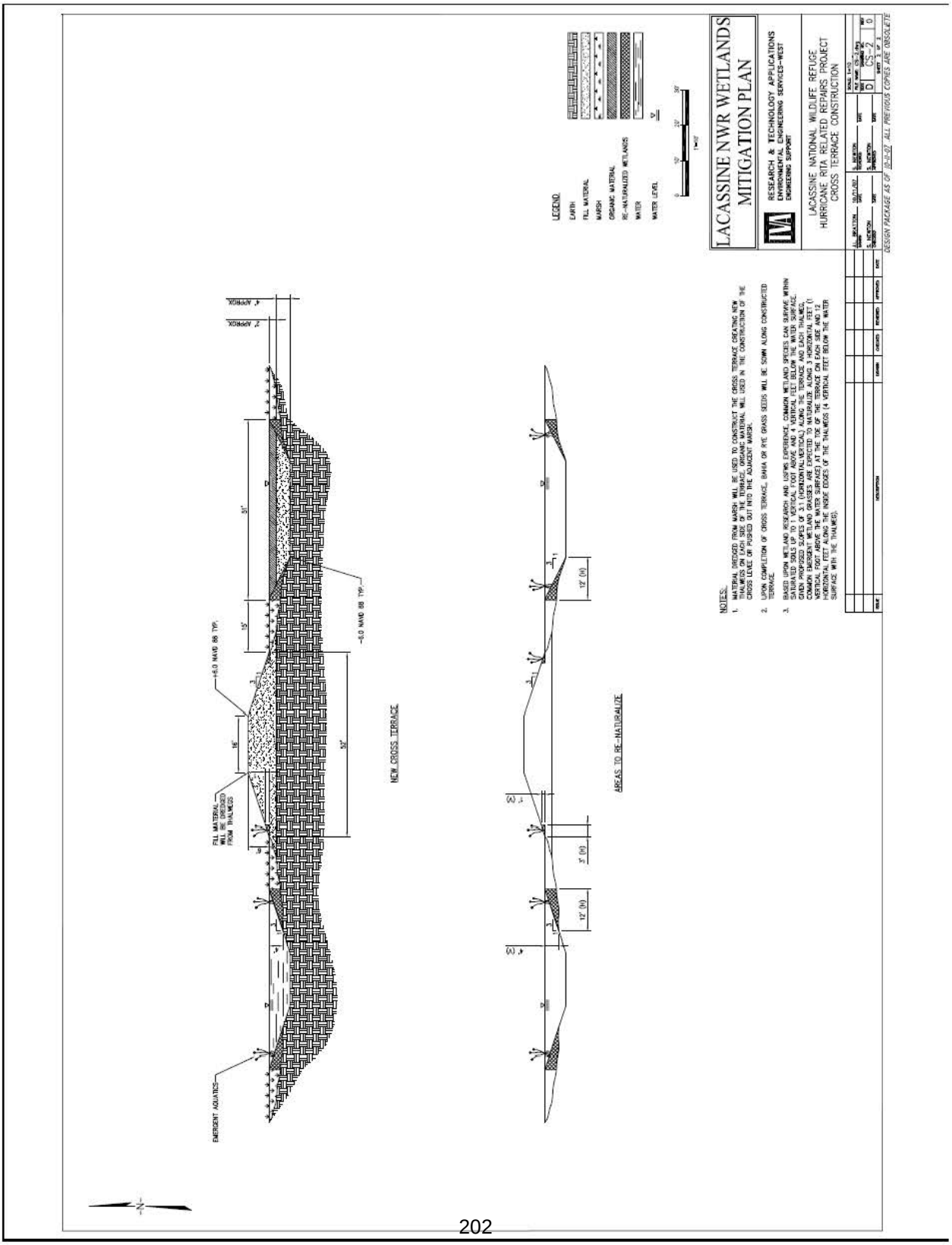
DESIGN PACKAGE AS OF 10-11-07 ALL PREVIOUS COPIES ARE OBSOLETE


LACASSINE NWR WETLANDS
MITIGATION PLAN
RESEARCH & TECHNOLOGY APPLICATIONS
ENVIRONMENTAL ENGINEERING SERVICES-WEST
ENGINEERING SUPPORT
LACASSINE NATIONAL WILDLIFE REFUGE
HURRICANE RITA RELATED REPAIRS PROJECT
CROSS TERRACE CONSTRUCTION
LEGEND
EARTH
FILL MATERIAL
MARSH
ORGANIC MATERIAL
RE-NATURALIZED WETLANDS
WATER
WATER LEVEL
NOTES:
1. MATERIAL DREDGED FROM MARSH WILL BE USED TO CONSTRUCT THE CROSS TERRACE CREATING NEW THALWEGS ON EACH SIDE OF THE TERRACE. ORGANIC MATERIAL WILL USED IN THE CONSTRUCTION OF THE CROSS LEVEE OR PUSHED OUT INTO THE ADJACENT MARSH.
2. UPON COMPLETION OF CROSS TERRACE, BAHIA OR RYE GRASS SEEDS WILL BE SOWN ALONG CONSTRUCTED TERRACE
3. BASED UPON WETLAND RESEARCH AND USFWS EXPERIENCE, COMMON WETLAND SPECIES CAN SURVIVE WITHIN SATURATED SOILS UP TO 1 VERTICAL FOOT ABOVE AND 4 VERTICAL FEET BELOW THE WATER SURFACE. EMERGENT WETLAND GRASSES ARE EXPECTED TO NATURALIZE ALONG 3 HORIZONTAL FEET (1 VERTICAL FOOT ABOVE THE WATER SURFACE) AT THE TOE OF THE TERRACE ON EACH SIDE AND 12 HORIZONTAL FEET ALONG THE INSIDE EDGES OF THE THALWEGS (4 VERTICAL FEET BELOW THE WATER SURFACE WITH THE THALWEG).
NEW CROSS TERRACE
AREAS TO BE RE-NATURALIZE
FILL MATERIAL WILL BE DREDGED FROM THALWEGS
EMERGENT AQUATICS
+5.0 NAVD 88 TYP.
-6.0 NAVD 88 TYP.
DESIGN PACKAGE AS OF 09-01-07 ALL PREVIOUS COPIES ARE OBSOLETE

Appendix G

Cooperative Land Management Agreement and Management Plan for the Duralde Prairie Unit

Agreement No. 40181BK002

COOPERATIVE LAND MANAGEMENT AGREEMENT
By and Between
UNITED STATES DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE
Southeast Region
And
CAJUN PRAIRIE HABITAT PRESERVATION SOCIETY
5070 Hwy. 399
Pitkin, LA 70656
Regarding
Southwest Louisiana National Wildlife Refuges
Prairie Restoration Program

PARTICIPANTS

THIS COOPERATIVE LAND MANAGEMENT AGREEMENT ("Agreement") is entered into by and between the UNITED STATES DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE ("USFWS"), acting through its Regional Director, Southeast Region, and the CAJUN PRAIRIE HABITAT PRESERVATION SOCIETY (CPHPS), a Louisiana non-profit corporation, acting on the basis of the following facts and circumstances:

II. RECITALS

A. The USFWS has established the Southwest Louisiana National Wildlife Refuge Complex (the "Complex") to protect, restore, enhance, and manage a representative portion of freshwater and associated habitats for the benefit of wintering waterfowl, other migratory birds, threatened and endangered species, and people. The purpose of the USFWS managed Vidrine prairie restoration site is to restore tall-grass prairie for the benefit of upland birds, and provide a seed source for further restorations within the Vidrine site and other areas in southern Louisiana.

B. The conversion of some of these lands to prairie habitat would aid and enhance wildlife management and conservation on the Refuge.

C. The CPHPS has developed expertise in restoration of prairie habitat and in managing conservation areas, and has indicated a willingness to manage Refuge lands for the purposes of prairie habitat restoration.

III. PURPOSE

A. Project Cooperation. USFWS and CPHPS shall cooperate to restore prairie habitat on the Refuge as set forth in Part X. of this agreement.

IV. AUTHORITY

A. Migratory Bird Conservation Act, 16 U.S.C. 715i
B. National Wildlife Refuge System Administration Act of 1966, 16 U.S.C. 668dd-ee
C. Endangered Species Act of 1973, 16 U.S.C. 1531-1544
D. National Wildlife Refuge System Volunteer and Community Partnership Act PL 105242
E. Part 29.2 and 29.5 of Title 50, Code of Federal Regulations, entitled "Cooperative Land Management," provides respectively:

Cooperative agreements with persons for crop cultivation, haying, grazing, or the harvest of vegetative products, including plant life, growing with or without cultivation on wildlife refuge areas may be executed on a share-in-kind basis when such agreements are in aid of or benefit to the wildlife management of the area.

Fees and charges for the grant of privileges on wildlife refuge areas and for the sale of products taken there-from, where not otherwise prescribed by law or regulation, shall be set at a rate commensurate with fees and charges for similar privileges and products made by private land owners in the vicinity or in accordance with their local value. Fees or rates of charge for products and privileges may be based either on a monetary exchange or on a share in kind of the resource or product.

V. PERIOD OF PERFORMANCE

The period of performance will be in accordance with the attached Management Plan . This Agreement may be terminated by either party upon not less than sixty days' prior written notice to the other, provided that upon termination USFWS and CPHPS shall cooperate to fulfill any outstanding obligations to third parties.

VI. FUNDING INFORMATION

The USFWS will not provide any funds to the CPHPS to fulfill the terms of this agreement nor will USFWS receive any funds from CPHPS. This agreement is a share-in kind program for the benefit of wildlife and plants.

VII. PROJECT MANAGER/OFFICER FOR EACH PARTY

USFWS:	CPHPS:
Donald J. Voros	Dr. Charles Allen
1428 Hwy. 27	5070 Hwy. 399
Bell City, LA 70630	Pitkin, LA 70656
ph. (337)-598-2216	ph. (337)-531-7535
fax (337)-598-2492	fax (337)-531-4864

VIII. REPORTING REQUIREMENTS

Annual Report. CPHPS will provide a brief annual report of project activities for each Unit under the Agreement by January 15 of each year for the prior fiscal year's activities. CPHPS and USFWS shall jointly review the Plan, including resources, expenses and restoration activities, and an evaluation of project equity, at least annually. USFWS will annually audit the previous year's financial records including receipts provided by CPHPS.

IX. MODIFICATIONS

Modifications; Assignment. Modifications to this Agreement shall be made in writing, with the mutual consent of CPHS and USFWS. The rights and obligations of CPHPS set forth in this Agreement to carry out particular project planning or implementation purposes may be assigned in part by CPHPS with the consent of the Refuge Manager. This Agreement may not be assigned in whole by CPHPS without the prior written consent of USFWS.

X PROVISIONS

1. Habitat Restoration:

(a) USFWS share: USFWS shall make available to CPHPS for its exclusive use, solely for the benefit of this project, the units of the Refuge shown on **Exhibit A** to this Agreement (the "Units"), as such list may be amended from time to time upon the mutual agreement of USFWS and CPHPS, and appurtenant real property rights and improvements on the Units, together with the right to collect native seeds and cuttings for cultivation on the Units. All funds generated from the collection of native seeds will be used to enhance and manage the Units.

(b) CPHPS share: CPHPS, operating on a non-profit basis, (a) shall manage the Units and shall cultivate and provide to USFWS prairie habitat within the Units, including furnishing all cuttings, seed, fertilizer, labor, materials and equipment, as set forth more fully below, and (b) shall provide other funds to the project for the restoration purposes of this Agreement.

(c). Mutual Sharing of Information: USFWS and CPHPS will furnish to each other, or otherwise make available upon request, such plans, maps, documents, instructions, records and reports as either party considers necessary in connection with the Agreement, subject to reasonable restrictions to ensure confidentiality of information shared as appropriate.

i. Shared Resources: The parties shall cooperate from time to time to obtain funding, staffing and other resources from other sources for the benefit of the project.

ii. Shared Equipment and Supplies: It is anticipated that funds derived from the sale of seed will be used to contract equipment usage with local farmers to avoid requiring the FWS to provide and transport equipment long distances to reduce the overall costs of managing the area. Equipment may be shared or loaned by one party to another when practicable from time to time for project purposes with the consent of such party for use under the control and supervision of the borrower. Such equipment shall become the responsibility of the borrower, and shall be returned in the same condition as when received, fair wear and tear excepted. The borrowing party will repair or reimburse for damages in excess of normal wear and tear and will replace or reimburse for items lost, destroyed, or expended

iii. Shared Staffing: It is anticipate that FWS staff will have a minimal role in the management of this site except as otherwise noted in this agreement. CPHPS agrees to provide staff at a level appropriate for its role in planning, management, Agreement Implementation and oversight of the project.

2. Plan; Approved Practices. CPHPS will perform its project activities in accordance with the Lacassine National Wildlife Refuge Prairie Restoration Plan (the "Plan" copy attached), as such Plan may be amended, updated or extended from time to time by CPHPS in consultation with and with the approval of USFWS. All management practices on the Units shall be approved by the Southwest Louisiana National Wildlife Refuge Complex Biologist (the "Refuge Complex Biologist").

3. Restoration Techniques. CPHPS will determine the habitat objectives and propagation techniques to be used in this restoration program in consultation with the Refuge Complex Biologist. All prescribed burning and control of wildfires is the responsibility of USFWS.

4. Pest Control. Any use of herbicide, fungicide, insecticide or biological control measures by CPHPS on Refuge lands during the term of this Agreement must be approved in advance by USFWS.

5. Refuse. Refuse may not be dumped or otherwise disposed of on Refuge lands without the permission of the Refuge Manager.

6. Damage. The United States shall not be responsible for any loss or damage to property; or injury to CPHPS or its officers, agents, employees, or any others who are on the Units by direction or by the consent of CPHPS or its associates; or for any damages or interference caused by wildlife or employees or representatives of the Government carrying out their official responsibilities. Upon termination of this Agreement, CPHPS shall give up the Units in as good order and condition as when received except for (a) alterations approved by the parties for restoration and management improvements, and (b) reasonable wear, tear or damage occurring without fault or negligence, including without limitation flood damage.

7. Operating Rules and Laws. CPHPS shall keep the Units in a neat and orderly condition at all times, and shall comply with all municipal, county, and State laws applicable to its operations under this Agreement as well as all Federal laws and regulations governing National Wildlife Refuges and the areas described in this agreement. CPHPS shall comply with all instructions issued by the Refuge Manager applicable to this Agreement and the Plan. CPHPS shall take all reasonable measures to minimize flood damage to irrigation equipment.

8. Auditing : All funds generated from the collection of native seeds will be used to enhance and manage the management area. The following auditing procedures will be met by CPHPS:

(a). FWS will be notified when seed is collected, the Unit that it will be collected from and the number of acres involved.

(b). The seed species will be identified.

(c). The dry weight of the seed will be recorded, reported to FWS and held on file.

(d). All weights will be obtained using reputable scales approved by the FWS

(e). Receipts for sale will be provided to the FWS after each sale.

(f). All funds received by CPHPS will be kept in a separate account.

(g). All receipts against this account will be provided to FWS on a quarterly basics.

(h). An annual accounting report which provides full financial disclosure of the account and use of funds will be provided by CPHPS to the FWS by September 30 annually.

9. Remedies. Either party shall have the right to enforce this Agreement by any available remedy under the laws of the United States or the State of California, as applicable. Failure of USFWS to insist upon a strict compliance with any of the terms, conditions and requirements of this Agreement shall not constitute a waiver or be considered as a giving up of USFWS's right to thereafter enforce any of the Agreement's terms, conditions or requirements.

10. Officials Barred From Participating. No member of Congress or Resident Commissioner shall participate in any part of this Agreement or to any benefit that may arise from it, but this provision shall not pertain to this Agreement if made with a corporation for its general benefit.

11. Nondiscrimination in Employment. CPHPS agrees to be bound by the equal opportunity clause of Executive Order 11246, which is made a part of this Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this Cooperative Land Management Agreement.

United States Fish and Wildlife Service

By Dale J Norman

Date: 11/17/2010

Cajun Prairie Habitat Restoration Preservation Society

By Charles McAllen

Date: Nov 9, 2010

Southwest Louisiana National Wildlife Refuge Complex

Lacassine National Wildlife Refuge

October 2010

Vidrine Prairie Restoration Management Plan

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INTRODUCTION

Scope and rationale

The coastal prairie is a tallgrass prairie ecosystem that once encompassed an estimated

3.5 million ha (8.6 million acres). Today only a fraction remains with fewer than 40 ha (100 acres) of upland prairie found in small narrow patches paralleling railroads and 40 to 120 ha (100 to 300 acres) of wet prairie remaining in disjunct remnants on private land. This critically endangered ecosystem is becoming a high priority for the USFWS (Schroeder and Askerooth 1999).

Climate, soils, fire, and grazing are the primary factors contributing to the development and maintenance of coastal prairie. The interaction of these factors, together with disturbance and availability of propagules, creates a mosaic of habitat conditions. Like Midwestern prairies, coastal prairie is dominated by grasses such as little bluestem, switchgrass, indiangrass and big bluestem, with over 500 species of grasses, sedges and wildflowers. However, coastal prairie is distinct in several ways including the presence of species that are not found in the midwestern prairies such as slender bluestem (Schizachyrium tenarium), brownseed paspalum (Paspalum plicatulum), and sweet goldenrod (Solidago odora). A number of coastal prairie plant species are now rare such as prairie nymph (Herbertia lahue var cerulea), Oklahoma grass pink orchid (Calopogon oklahomensis) and prairie parsley (Polytaenia nuttallii).

Bison, elk, and antelope once grazed coastal prairie in the company of a variety of other mammals (including the now extinct prairie vole), birds, reptiles, insects, and others. Insects such as grasshoppers and native pollinators such as butterflies, bees and wasps are plentiful and diverse on coastal prairie remnants. The Attwater's prairie chicken has been bred in captivity with hopes of releasing it to restored prairies in its native range, including Louisiana. Both sandhill cranes and whooping cranes used costal prairie in their migratory routes and may again someday.

In tallgrass prairie, grassland birds have exhibited a steeper, more consistent decline during the past 25 years than any other group of North American birds (Knopf 1995). In Louisiana, old fields and pastures that once provided grassland bird habitat are being replaced with forests of the exotic, invasive Chinese tallow tree. Some of the many species of concern include the Henslow's sparrow, grasshopper sparrow, savannah sparrow, Le Conte's sparrow, eastern meadowlark, loggerhead shrike, dickcissel, yellow and black rail, bobolink, short-eared owl, and the northern harrier.

The need for restoring and preserving coastal prairie is clear but the scale of restoration adequate for preserving prairie biodiversity has not been determined. The Attwater=s prairie chicken is said to require a minimum of 4,000 ha (10,000 acres), while it has been estimated that 24,000 to 61,000 ha (60,000 to 150,000 acres) of tallgrass prairie would be needed to reintroduce large animals such as bison and elk (Platt 1983). A useful approach is to manage for sensitive animal

species considered indicators of environmental stress. From an ecological point of view, recruitment of grassland birds to restored prairie may be an indicator of the restoration of ecosystem function.

Grassland bird habitat is affected by both area and vegetation structure (Herkert, 1994). Rayn (1986) notes that large homogeneous areas may have less value than several smaller areas with distinct vegetative components. The structure of the leaf canopy of prairie vegetation is variable, creating a mosaic of habitat conditions. Several small, but high quality restorations of from one to several hundred acres would provide the most habitat for grassland birds.

Most introduced grasses, intentionally planted or invading old fields, tend to be uniform in height and density (Wilson and Belcher 1989), limiting an areas value to wildlife. Problematic exotics such as Chinese tallow tree (Sapium sebiferum) and Macartney rose (Rosa bracteata) rapidly invade abandoned farm land and overgrazed fields. These species can evade control by fire when fires are conducted infrequently and/or during the dormant season. Native woody plants such as eastern baccharis (Baccharis halmifolia) and wax myrtle (Myrica cerifera) are also becoming a management problem in the coastal prairie region. Exotic species such as cogongrass, not yet arrived in south Louisiana, may someday pose more of a threat to Cajun prairie than Chinese tallow. The use of fire and establishment of better adapted, more competitive, native species can reduce the cost of control of exotics plants on the refuge.

Relationship to other plans

This plan is written in conjunction with a cooperative land management agreement between U. S. Fish and Wildlife Service, Southwest Louisiana National Wildlife Refuge Complex and the Cajun Prairie Habitat Preservation Society see attachment 1). This plan will direct all activities authorized under the agreement.

Time Period

This plan will need a review every five years.

BACKGROUND

Description of habitat

Prairies are usually defined as areas dominated by herbaceous perennials, in particular grass species and few woody plants, especially trees. Prairies are formed in many parts of the world under several environmental conditions. Prairies are created by elements that restrict the growth of trees and other woody plants and allow the growth of herbaceous perennials. Factors reported to restrict woody plants and thus promote prairie creation are: (1) low annual rainfall-the prairies of the Midwest United States are reported to be mainly created by total annual rainfall of less than 30 inches; (2) fire-this would kill the woody plants but not harm the perennials with their underground rhizomes and other survival parts; (3) clay layer below surface of soil-a hard clay pan layer located below the surface restricts the growth of roots (the underground system of

herbaceous perennials could develop above the clay layer but there would not be enough room for the root system of trees); (4) high clay content of soil-soils with much clay shrink and swell with dry and wet conditions creating a hostile environment that herbaceous perennials can tolerate but trees cannot; (5) wet/drought conditions-the inhospitable conditions created by wet conditions followed by extreme drought can be tolerated by herbaceous perennials but not by many woody plants (6) grazing animals-bison and other herbivores can seriously damage woody plants by their concentrated grazing (herbaceous plants are grazed as well but resprout much more prolifically than woody plants); (7) wind-woody plants are often blown over by winds while the herbaceous perennials are shorter and more flexible; and (8) mycorrhizae-these are fungus-root mutual relationships where the fungus provides water and nutrients to the roots and receives food back from the roots (mycorrhizae are important for trees and the fungus may not be present in prairie areas). Prairies do not develop as a result of one of these factors but a combination of two or more. Fire is the one that seems to be prevalent in almost all natural prairie systems.

Historic condition

The coastal prairie is a tallgrass prairie ecosystem that once encompassed an estimated

3.5 million ha (8.6 million acres). Grasses usually formed the backbone or matrix of a prairie, including: switch grass (Panicum virgatum), big blue stem (Androgon gerardii), little blue stem (Schizachyrium scoparium), slender blue stem (Schizachyrium tenerum), Indian grass (Sorghastrum nutans), and eastern gama grass (Tripsacum dactyloides). These species are dominants in the remaining Cajun Prairie remnants. Other grasses that would also be important in the prairie are Florida Paspalum (Paspalum floridanum), muhly grass (Muhlenbergia capillaris), pineywoods dropseed (Sporobolus junceus), and brownseed paspalum (Paspalum plicatulum). Some species or genera that would be essential are blazing stars (Liatris), compass plant (Silphium laciniatum), rosin weeds (Silphium gracile), flowering spurge (Euphorbia corollata), button snakeroot (Eryngium yuccifolium), Indian plaintain (Arnoglossum ovatum), false indigos (Baptisia), grass leaved golden aster (Pityopsis graminifolia), snout pea (Tephrosia onobrychoides), phlox (Phlox pilosa), wine cup (Callirhoe papaver), sweet golden rod (Solidago odora), aster (Aster spp.), milkweeds (Asclepias spp.), tick seeds (Coreopsis spp.), wooly sunflower (Helianthus mollis), and Indian blanket (Gaillardia aestivalis).

Habitat changes/Restoration efforts

In August, 1993 the property was transferred in fee title to FWS to become an addition to Lacassine NWR and the deed was registered with the Parish clerk's office. Coordination began in May 1993 with Dr. Charles Allen of Northeast Louisiana University, Monroe, Louisiana concerning prairie restoration on refuge lands. A management plan for the Vidrine was prepared and approved by the Regional Office in October 1993.

In February 1994, Dr. Charles Allen (NLU) and Dr. Malcomb Vidrine, LSU at Eunice, Louisiana, met with refuge staff to plan restoration efforts. A grant was drawn up and awarded to

Dr. Allen in June 1994 ($14,000, 1121) to give technical assistance and monitor the restoration effort. Seeds were purchased for five grasses: big bluestem (Andropogan gerardi), little bluestem (Schizachyrium Scoparium), switchgrass (Panicum virgatum), Indian grass (Sorghastrum nutans), and eastern gamagrass (Tripsacum dactyloides).

Biologist Charlotte Parker requested a contract to level old rice levees and knock down trees on approximately 107 acres. A farmer in the area, Mr. Todd Fontenot, was contracted to double disc the cleared area as weather permitted. Manager Grafe and volunteer Chip Grafe planted prairie vegetation at the Vidrine Unit in January, 1995. Twenty-two volunteers from The Nature Conservancy (TNC), LDWF Natural Heritage Program, LSU, Northeast Louisiana University (NLU), Eunice High School and NBS assisted with the project. Ground preparation of 107 acres for prairie restoration at the Vidrine Unit was accomplished by the end of April, 1995.

The 107 acres cleared in April at Vidrine were divided into six units each about 15 acres in size. They were labeled A through F with A being the westernmost. On May 2, 1995 Robbie Miller Flying Service seeded the area with 270 lbs. of Gama seed with Units A, C, and E receiving four pounds per acre and Units B, D, and F receiving two pounds per acre. On May 3 Dave McGee vibra-shanked the southern 2/3 and disced the northern 1/3 (the northern 1/3 had harder, rougher ground with more remaining roots) to till under the Gama seed at 1½ to 2 inches depth. Robbie Miller Flying Service seeded the same 90 acres on May 6 with a mixture of Aldous Little Bluestem (61 lbs.), Kaw Big Bluestem (171 lbs.), Cheyenne Indiangrass (109 lbs.), and Alamo Switchgrass (54 lbs.) at six pounds per acre for Units A, C, and E and three pounds per acre for units B, D, and F. The field was not vibra-shanked following the seeding, but a heavy rain occurred on May 8. Biologist Syron worked with Dr. Charles Allen and two graduate students from NLU on May 12 setting up sampling stations and taking soil samples. On May 24, grass about two inches was appearing and was heaviest on the western end, but it was uncertain if this was planted or natural grass.

Dr. Allen (NLU) transplanted prairie wildflowers to the Vidrine Unit and collected flower and grass seeds in early November, 1995 and at various other times from 1995 to the present.

The Partners for Wildlife/FSA Transfer Lands program funded $70,000 in December, 1996 to continue prairie restoration efforts at our Duralde site. The majority of the force account work was prescribed burning and land clearing to prepare 227 acres for contract planting of prairie grass and flower species. The seeds to be planted were harvested off a natural prairie at Attwater Prairie Chicken NWR in Texas and the contractor was expected to be the “sole source” firm of Neiman Environments Inc. of Junction, TX

A contract package for aerial spraying the herbicide Arsenal to control Chinese tallow at the Vidrine Unit was sent to CGS on 06/05/96. Herbicide spraying was conducted on 227.25 acres at our Vidrine property on 07/14-07/16 by Cane Air. A mixture of Arsenal, methylated seed oil, and water was applied by helicopter. The area was inspected on 07/29 and all trees were stressed and showing dead leaves. Additional hand spraying using Garlon 4 was conducted from 1996 to the present.

The Vidrine prairie restoration project was the primary work project for 1997. Over 200 acres of invasive tallow trees which had been chemically treated and killed the previous year were dozed down, piled and burned in preparation for a spring or fall planting the next year. Existing rice levees were either cut or levelled to ensure drainage.

CGS finalized the solicitation for bid in June, 1997 and issued a contract for the prairie planting to Neiman Environments, Inc., of Texas. Assistant Manager Miller met with contractor Bill Neiman of Neiman Enterprises to conduct a site visit of the Vidrine Unit on 3/23/98. It was determined that additional site preparation was required and that a late summer/early fall planting would be done. Burning of the piles of dead tallow trees was completed during July. Land leveling operations were begun in July and completed in early August. Site preparation of the unit by refuge staff was completed in early August and the contractor, Neiman Environments Inc., began on 8/11. Heavy rains shut down the planting on 8/14 with about 1/3 of the unit planted. Planting resumed on 8/25 and was completed on 8/29. On 10/27 and 10/30, Crane Operator Alfred mowed a portion of the restoration site, about 25 to 30 acres between the old homestead and Valentine Coulee and east to Navy Road, at about 5" height, to reduce weed competition with the newly seeded prairie plants. Seeding was completed by October, 1998.

Dr. Charles Allen collected prairie plants and seeds from remnant prairie strips for fall/winter transplanting various times from 1995 to the present. The Duralde Prairie area was a site to behold during May, 1999 as it was a solid expanse of over 200 acres of bright yellow coreopsis blooms, some of the seed planted the previous fall.

Current habitat condition

The area is currently restored prairie in good condition and species diversity. However, transplanting and spreading of seed from remnant prairies should continue to enhance diversity and overall robustness.

RESOURCES OF CONCERN

Identification of prairie species of concern

Some of the many species of concern include the Henslow's sparrow, grasshopper sparrow, savannah sparrow, Le Conte's sparrow, Sprague’s pipit, eastern meadowlark, loggerhead shrike, dickcissel, yellow and black rail, bobolink, short-eared owl, and the northern harrier.

Species accounts/Habitat requirements for species of concern

Dickcissels and Henslow’s sparrows have declined severely during the past thirty years (Winter, 1999). In general, other grassland species have shown lesser declines or have remained stable. Sprague’s pipits showed a preference for sites in dense, grassy, and relatively tall vegetation with low forb density and little bare ground (Sutter, 1997) and Henslow’s sparrows rarely were encountered on grassland fragments less than 100 hectares (247 acres) and preferred areas having tall dense vegetation with a high proportion of residual standing dead plant material

(Herkert, 1994). Grassland birds generally were found in higher densities in habitats that had woody canopy coverage of less than 30% (Igl, 1999). Our established Duralde Prairie with 334 acres, 3 to 6 foot tall vegetation, and less than 10% woody coverage meets the above habitat requirements.

Area contribution to habitat needs

This area meets the general habitat requirements for these species. Use of the area by these species is unconfirmed, but summer breeding bird surveys (and possibly other surveys) will be considered, planned, and implemented by Lacassine NWR, possibly with help of CPHPS.

HABITAT GOALS AND OBJECTIVES

Provide the technical and financial support to maintain and enhance coastal prairie as habitat for grassland bird species, as a seed collection site for further restorations, and as an outdoor classroom for prairie restoration activities.

HABITAT MANAGEMENT STRATEGIES

Potential management strategies

1.) Cajun Prairie Habitat Preservation Society (CPHPS) will manage Vidrine prairie for high quality prairie vegetation and monitoring using the AFloral Quality Assessment@ system designed for coastal prairie (Allain and Allen 2002). The U. S. Fish and Wildlife Service, Southwest Louisiana National Wildlife Refuge Complex (FWS) will provide management direction for this project through this plan and by annual reviews. Management tools such as fire, mowing, transplanting, over seeding and postseeding introduction of additional plant species, and selective herbicide application should be used. Mowing or haying (where clippings are removed) may be used in areas where fire is not an option. All burning will be accomplished by FWS while CPHPS will manage herbicide application and mowing under the direction of FWS.

It is anticipated that most of this work will be accomplished through contracts paid for with funds generated from the sale of native prairie seed. CPHPS will be responsible for all transplanting, seed collection and spreading, research coordinated through FWS, and erection and maintenance of boundary signs provided by FWS (posts, nuts, washers, and bolts provided by CPHPS).

Because most prairies are in part maintained by fire, prescribed fire will be an integral part of the annual maintenance program. If fire is not an option in any given year, then mowing will be used as a management tool. Mowing should occur during the dormant season. Since the herbaceous perennials are underground, the mower should be set at the lowest level possible. The mowing will simulate the action of the fire by removing the dead growth from the previous year and most importantly, cut back the woody plants. Repeated mowings should keep the woody plants under control but some woody species may require chemical or mechanical

control. Annuals will be common the first year but will decrease in numbers dramatically the second year and will steadily decrease in proceeding years. If the area is tilled or disturbed, annuals will reappear. To hasten the development of the prairie, the use of chemicals or physically removing unwanted woody and herbaceous perennial species should occur.

Transplanting and rescuing work should be performed during December and January. The following procedures should be used when transplanting:

A. A hole should be dug as close to the size of the ball of roots and soil of the potted plant.

B. At a minimum plants will be removed from their original pot and the soil disturbed supporting the root mass; it is also a common practice to remove all soil so that a bare root plant results.

C. The plant should then be placed in the hole and the soil replaced around the root mass.

D. The soil should be packed down around the top of the plant. Cutting the back the stem to reduce water loss and increase the chances of the plant surviving may also be done at this time.

When rescuing plants, a hole should be dug to match the size of the clod. The clod should then be placed in the hole and the dirt placed in the space between the clod and the side of the hole plus some on top of the clod.

Seeds may also be harvested from the wild; it should be noted that the percent of germination of many wild collected seeds is often low. The FWS will be notified before any seed is harvested. The notification will include the number of acres to be harvested and the targeted seed source e.g. blue stem, mixed seed etc. Seeds should be harvested as soon as possible after maturity; most seeds change from green to another color, brown, black, red, yellow etc. with maturity. At a minimum the seed should be handled as follows:

A. Place the seeds in a brown paper bags and allow them to dry.

B. After drying, place the seeds in plastic bags. Do not store seeds in a plastic bag until the seeds are dry.

C. If it is time for planting or sale of the seed, plant or sell the dry seeds as is.

D. For seed that will go into storage, it is best to store the seeds in a refrigerator until time for planting or sale. The cool storage does apply some stratification (exposure of seeds to cold temperatures to cause the embryo to mature) and also protects the seeds from insect attack. If hand planting seed, it is not required to put a lot of effort into sorting the seeds from the chaff.

All woody plants wii be removed from the site and this can be accomplished mechanically or with chemicals. If possible, herbaceous plants, especially invasive species, should also be removed.

2.) CPHPS will establish a long term monitoring plan using standard protocol(s) (e.g., Project Prairie Bird) to measure grassland bird use and adapt management to achieve high bird usage.

3.) CPHPS will make several transplantings, each from a different prairie remnant and each isolated genetically from one another, to serve as germ plasm collections. Seeds from these collections could be used for plant material development, seed increase, and restoration.

4.) CPHPS will encourage research on issues critical to successfully restoring prairie on a large scale such as: fire, historical effects, planting technology, seed technology, genetic issues, ecology, climate, etc.

5.) CPHPS will provide an annual report of project activities for each Unit under the Agreement by January 15 of each year for the prior fiscal year's activities. CPHPS and USFWS shall jointly review the Plan, including resources, expenses and restoration activities, and an evaluation of project equity, at least annually. USFWS will annually audit the previous year's financial records including receipts provided by CPHPS.

6.) CPHPS will erect an observation tower in accordance with provided USFWS specifications with material supplied and delivered by USFWS. The actual site for the tower will be designated by USFWS and the construction will be supervised by a USFWS Contractor's Officers Representative.

Constraints to strategies

Conflicts between habitat requirements of different target bird species make management decisions difficult. A better management strategy should be based on floral quality with parameters that grassland birds share in common, such as avoiding burns during spring nesting season, incorporated in the management plan. Floral quality analysis can be incorporated into a long-term monitoring plan and used to quantitatively assess prairie vegetation (Swink and Wilheim 1994, Ladd 1993). Coefficient of conservatism values for Louisiana=s prairie species were developed by Larry Allain and Charles Allen and will soon be available on the USGS/NRCS website.

Impacts to resources of concern

The Duralde prairie as managed under this Management Plan will benefit all the stated resources of concern.

Management strategy selection and prescription

The management strategy selected will be what is stated above in Potential Management Strategies.

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Appendix H

U. S. FISH AND WILDLIFE SERVICE

ENVIRONMENTAL ACTION STATEMENT FOR CATEGORICAL EXCLUSION

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

Proposed Action and Alternatives. The proposed action is the approval and implementation of the Habitat Management Plan (HMP) for Lacassine National Wildlife Refuge (NWR). This plan is a step-down management plan providing the refuge manager with specific guidance for implementing goals, objectives, and strategies identified in the Lacassine NWR Comprehensive Conservation Plan (CCP) (USFWS 2007).

The proposed CCP action was the preferred alternative among three alternatives considered in the Environmental Assessment (EA) (Draft CCP and EA 2006). In the CCP, the proposed action was to "Maximize refuge management capabilities in all programs. Under the proposed action "Lacassine Refuge would fulfill its approved acquisition boundary. The 3,300-acre Wilderness Area would remain the same size. Gross habitat acreages would not change appreciably from those under Alternative A, but habitats, in general, would be managed more intensively. The refuge would also expand on existing wildlife management programs including:

• Focus refuge management on improving/extending the value of the Lacassine Pool as a waterfowl sanctuary;

• Provide additional waterfowl food to benefit migratory birds, especially northern pintails;

• Pursue opportunities to reduce erosion to refuge marshes;

• Conduct/evaluate prescribed fire in Lacassine Pool and other refuge marshes;

• Seek support to control invasive plants in Wilderness Area and refuge-wide;

• Continue partnerships to manage and protect the 334-acre coastal prairie;

• Improve hunting/fishing experiences; and

• Manage oil and gas activities in accordance with Service policy (Refer to Chapter II, Refuge Related Problems, Oil and Gas Activities)." (USFWS 2007).

The CCP has defined goals, objectives and strategies to achieve the stated action. The actions (strategy prescriptions) further detailed in the HMP have been identified, addressed, and authorized by the Lacassine NWR CCP. These include:

- Impounded Freshwater Marsh Habitat Management Strategies: Maintain and operate water control structures to manipulate water levels in individual units on a rotation, and incorporate prescribed fire to reduce biomass accumulation.
  - Repair and maintain 70 miles of spillways and levees annually.
  - Operate the spillway structures to accommodate a pool level that benefits migratory birds and takes into consideration fish and other wildlife.
  - Depending upon availability of resources, environmental conditions (i.e., such as when drought conditions are most favorable), but no more frequently than every 5 years for any one subunit, individual sub-units will be completely drawn down to a target level of -1.80 feet (NAVD 88) to allow for oxidation and to conduct prescribed burns to set back natural succession and dispose of accumulated dead plant material.
  - Monitor changes in Lacassine Pool with an emphasis on identifying aquatic plant types, ratios of open water to vegetation coverage, and comparisons of vegetation/water ratio trends over a 5-year time period. Determine vegetation/water ratio changes associated with years following major hurricane events and any introduction of higher salinity waters.
  - Control invasive exotic vegetation with herbicides as needed to achieve Objective 4.1.1 and 4.1.2 and maintain open water at a ratio of 1:1 with marsh vegetation in Lacassine Pool.
- Unimpounded Freshwater Marsh Management Strageties:
  - Continue to burn unimpounded marsh units on a 3-year cycle as conditions allow. Units should be burned when water is mostly off the unit but soils are still too wet to ignite, to avoid undesirable ground fires. Objective of the burns is to top-kill woody plants including baccharis and waxmyrtle, topkill woody invasives including Chinese tallowtree, and open up space for large-seeded annual plants to establish.
  - Use approved herbicides as needed to control giant salvinia, water hyacinth, and tallowtree. Units should be evaluated on an annual basis for presence of these plants, and treatment should be applied as needed to keep populations below levels which would negatively impact habitat quality for waterfowl or colonial waterbirds. At a minimum, this means that waterways are mostly open water (>90%) and tallowtree stems are small enough and far enough apart so as

not to significantly reduce marsh productivity.

- Moist Soil Management Strategies:
  - Provide shallow early successional wetlands with sheet water from mid-July through September for migrating shorebirds in Field S-4 of Unit B, Unit A, and/or Unit C. From September through March, provide up to 8 inches of water and a minimum of 80% of vegetation cover for wintering migratory waterfowl.
  - Manage all moist soil fields to maximize production of annual plants recognized as preferred waterfowl habitat. Use various management tools, including manipulating water levels and soil moisture, discing, burning, mowing, water buffaloing, and selective herbicide application. Disking and mowing will be used in dry years; water buffaloing will be used under wet conditions. All of these actions will result in setting back succession to annuals, which are desirable for waterfowl food production.
  - Rework all levees in unit C, replace the water control structure with a Sea Breeze water control structure.
  - Monitor and document plant and wildlife responses in all moist soil fields, and document management actions and unmet management needs for the following year in Annual Work Plans.
- Coastal Prairie Management Strategies
  - Burn the prairie during early-to-mid-growing season with an average fire return interval of three years.Apply prescribed fire in an adaptive management context, varying weather conditions, season, intensity, and frequency of burns as indicated by outcomes of previous treatments. The goal is to restore prairie structure and function to the unit by mimicking a natural fire regime. Fire return interval should average approximately 3 years, and season of burn should mirror lightning occurrence; i.e. early-to-mid growing season.
  - Annual monitoring is needed to document success and any needed management for the following year. Monitor changes in vegetation on an annual basis to inform decisions about management actions. Monitoring should include measurements of herbaceous diversity and cover of desirable and undesirable species. Work with partners to establish a long-term monitoring plan using standardized protocol(s) (e.g., Project Prairie Bird) to measure grassland bird use and adapt management to achieve high-quality prairie habitat.
  - Work with partners through a Cooperative Land Management Agreement (Appendix G) to transplant from prairie remnants.
  - Work with partners through a Cooperative Land Management Agreement (Appendix G) to mow and apply herbicides to pest species.
  - Work with partners through a Cooperative Land Management Agreement

(Appendix G) to make several small prairie plantings, each from a different prairie remnant and each isolated genetically from one another (i.e., at least one mile between sites), to serve as diverse seed sources.

- Cropland Management Strategies

  - Maintain a farm agreement in accordance with Region 4 farming policy and procedure which requires the farmer to leave a percentage of the first and second crop unharvested, providing a quality food source for wintering waterfowl.
  - Management of fallow rice fields should be similar to that for moist soil units to provide improved foraging habitat for wintering waterfowl. Fallow fields should be managed to provide improved habitat for wintering waterfowl by allowing plant seed maturation before discing or water buffaloing. See the section on moist soil management units (5.3) for details of practices. When managing fallow cropland for shorebirds, alter drawdown schedules to provide shallow water/mudflats from mid-August through October.
  - If cooperative farming is lost as an available management option, contract farming or force account farming should be considered.

- Forested Wetland Habitat Management Strategies

  - Control Chinese tallowtree and other invasive exotic plant species with herbicide and mechanical treatments.

- Wilderness Area Management Strategies

- Wilderness Stewardship Plan—To manage with a minimum of intrusion, preserve the character, and to prevent a loss of wilderness values, prepare a Wilderness Stewardship Plan by 2014 (610 FW 3).
- Prescribed Fire—Apply growing season fires on a 3-year return interval in unit I (Wilderness Area) to reduce the encroachment of exotic plant species.
- Chemical control of invasive exotic plants—Use herbicides or other management tools to reduce cover of aquatic invasives including water hyacinth and giant salvinia to less than 200 acres. Exotic species will be actively contained and suppressed and where possible extirpated. E xotic plants which show increasing cover trends over a 5 year period under the above fire regime will be considered for chemical or mechanical (hand) control, subject to the procedures described above in section 5.7.1. All herbicide use will follow approved FWS procedures.
- Monitoring—Conduct aerial surveys of unimpounded marsh in unit I (Wilderness Area) at least once every two years to visually monitor and record habitat changes and migratory bird presence within the Wilderness Area. Variables to be monitored include: presence of people, bird colonies, areas with invasive exotic species, and endangered and threatened species. Areas where these variables are

measured will be mapped with GPS and photographed, and a standard record of site observations will be made. Indicators to be evaluated will be size of area, vegetation condition, and bird colony condition. Baseline and threshold conditions for action will be established in the Wilderness Stewardship Plan as described in 610 FW 3.8.

Categorical Exclusion(s). Categorical Exclusion Department Manual 516 DM 6, Appendix 1 Section 1.4 B (10), which states *"the issuance of new or revised site, unit, or activity-specific management plans for public use, land use, or other management activities when only minor changes are planned. Examples could include an amended public use plan or fire management plan."*, is applicable to implementation to the proposed action.

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

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

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

All details are consistent with the CCP and serve to provide the further detail necessary to guide the refuge in application of the intended strategies for the purpose of meeting the habitat objectives.

Permits/Approvals. Endangered Species Act, Intra-Service Section 7 Consultation was conducted during the CCP process. The determination was a concurrence that the CCP may affect, but is not likely to adversely affect the threatened bald eagle, the threatened Louisiana black bear, or the threatened (due to similarity of appearance) American alligator (signed April 13, 2006 within CCP).

Other Items to include that should be listed and can be found in the FONSI accompanying the final CCP:

- Executive Orders 11988/11990

- Floodplain Management and Protection of Wetlands
- Form DI-711, Intergovernmental Notice of Proposed Action
- Fish and Wildlife Service Policy 603 FW 2 section 2.11D, Oil and Gas Activities
- National Historic Preservation Act, Protection of Cultural Resources

Public Involvement/Interagency Coordination. The proposed HMP is a step-down of the approved CCP for Lacassine NWR. The development and approval of the CCP included appropriate NEPA documentation and public involvement. An Environmental Assessment was developed (Draft CCP and EA 2006) which proposed and addressed management alternatives and environmental consequences. Public involvement included public notification (Notice of Intent: Federal Register January 17, 2003, Volume 68, Number 12, and Notice of Availability: Federal Register November 9, 2006, Volume 71, Number 217. Public comment period was November 9, 2006 through December 11, 2006.

Scoping Meetings—General: The Service invited the public to participate in a series of scoping meetings. Meetings were held in various communities in Cameron Parish in 2002, as follows: October 1, Carlyss; October 8, Grand Lake; October 10, Cameron; October 16, Hackberry; and October 17, Johnson Bayou. Approximately 25 people in total attended these meetings. On January 16 and February 4, 2003, public open house meetings were held in Lake Charles, with a total of 33 people attending. On February 6, 2003, a public meeting was held in Lafayette, with four people attending and on February 8, 2003, a meeting was held in nearby Jennings, with two people in attendance. Comment forms were placed in the Visitor Center and invitations to comment or provide input were issued at various special events. Various issues emerged from these meetings and were considered during the preparation of the plan. In particular, many of the attendees brought up concerns about fishing on the refuge.

Special Fishing Focus Group Meeting: An intensive effort to bring together people who were interested in fishing issues at the refuge resulted in over 40 members of the public attending a Fishing Focus Group meeting in Lake Charles on September 4, 2003. Participants were given an overview of the refuge, the planning process, and then randomly assigned to smaller groups to discuss issues. Each group brainstormed, identified and prioritized issues, and then each group presented its results to the entire audience. The format of the meeting facilitated open discussion among user groups with conflicting interests, and among the public and Service staff. Results of the meeting can be found in Appendix E of the CCP (USFWS 2007).

Special Lacassine Pool Meeting: More than 100 people attended a meeting on May 18, 2005, at the Lake Charles Civic Center, to discuss future management of the Lacassine Pool. Continued interest in Lacassine Pool and associated issues with fishing prompted the Service to hold the meeting. The Service presented ten management proposals for Lacassine Pool and invited participants to review and select their preferred solution. The majority of the participants chose

the Service's preferred action plan, Proposal Number 8, which is included in the goals, objectives, and strategies.

Special Hurricane Damage Meeting: Finally, on March 9, 2006, the Service held a meeting at the Lake Charles Civic Center to discuss the devastation caused by Hurricane Rita in September 2005, and its impacts on the refuges within the Southwest Louisiana National Wildlife Refuge Complex. In part, a presentation given by the refuge manager to the more than 100 people in attendance explained what the damages were, how the Service would address them, and when the public could use refuge facilities.

Notice of availability for the final CCP was published in the Federal Register September 26, 2007 (Volume 72, Number 186).

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

USFWS. 2007. Lacassine National Wildlife Refuge Comprehensive Conservation Plan.

USFWS. 2006. Lacassine National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment.

Lacassine National Wildlife Refuge Fire Management Plan

Cooperative Land Management Agreement By and Between United States Department of the Interior, Fish and Wildlife Service Southeast Region and Cajun Prairie Habitat Preservation Society (2010)

Mitigation Plan for Long-Term Restoration and Management of the Lacassine Pool (2008)

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(Project Leader) (date)

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(Regional Refuge NEPA Coordinator) (date)