ROCKEFELLER WILDLIFE REFUGE MANAGEMENT PLAN

ROCKEFELLER WILDLIFE REFUGE
GRAND CHENIER, LOUISIANA

FINAL DRAFT APPROVED BY
LOUISIANA DEPARTMENT OF WILDLIFE AND FISHERIES
COASTAL AND NON-GAME RESOURCES DIVISION

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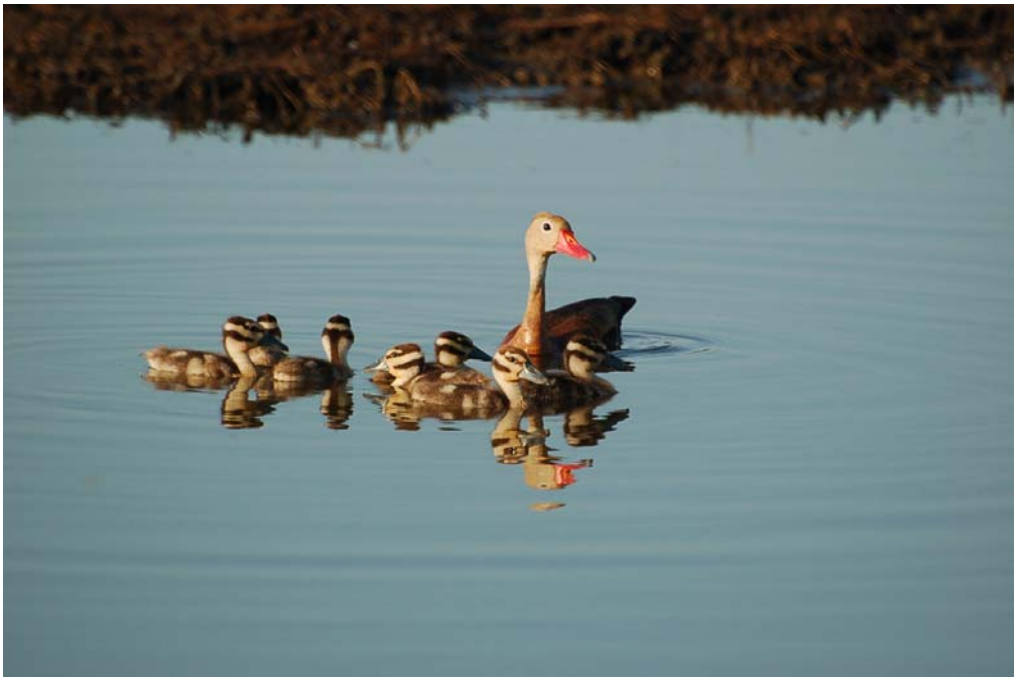

Black-bellied Whistling-Ducks (*Dendrocygna autumnalis*) **Photo by Ruth Elsey**

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1. Introduction

1.1: Physical Description

Location.— Rockefeller Wildlife Refuge (RWR) lies within the southeastern portion of the Chenier Plain Region of southwestern Louisiana in Cameron/Vermilion Parishes (between approximately 92º54' E and 92º30' E longitude). RWR borders the Gulf of Mexico for 26.5 miles and extends inland toward the Grand Chenier ridge, a stranded beach ridge six miles from the Gulf. RWR is owned by the Louisiana Department of Wildlife and Fisheries (LDWF) and managed by the Coastal and Non-Game Resources Division. When it was deeded to the state in 1914, RWR encompassed approximately 86,000 acres. However, since then the property has lost approximately 14,000 acres (16.6% acreage loss) and currently stands near 72,650 acres; the loss of acreage is primarily due to shoreline/beach erosion. The refuge boundaries are very linear because the land was purchased by sections or portions thereof and some section boundaries serve as the refuge boundaries.

Regional Hydrology.— The Mermentau River Basin is divided into three sub-basins: the Upland Sub-basin (primarily agricultural lands), the Lakes Sub-basin (land between the Gulf Intracoastal Waterway and LA Hwy 82, including Grand/White lakes), and the Chenier Sub-basin (south of Highway 82 to the Gulf of Mexico; Figure 1). RWR is located at the lower end of the Mermentau River Basin, within the Chenier Sub-Basin. The Lakes and Chenier Sub-basins encompass 722,367 acres of fresh, intermediate, brackish, and salt marsh, non-marsh/other, and water (Table 1).

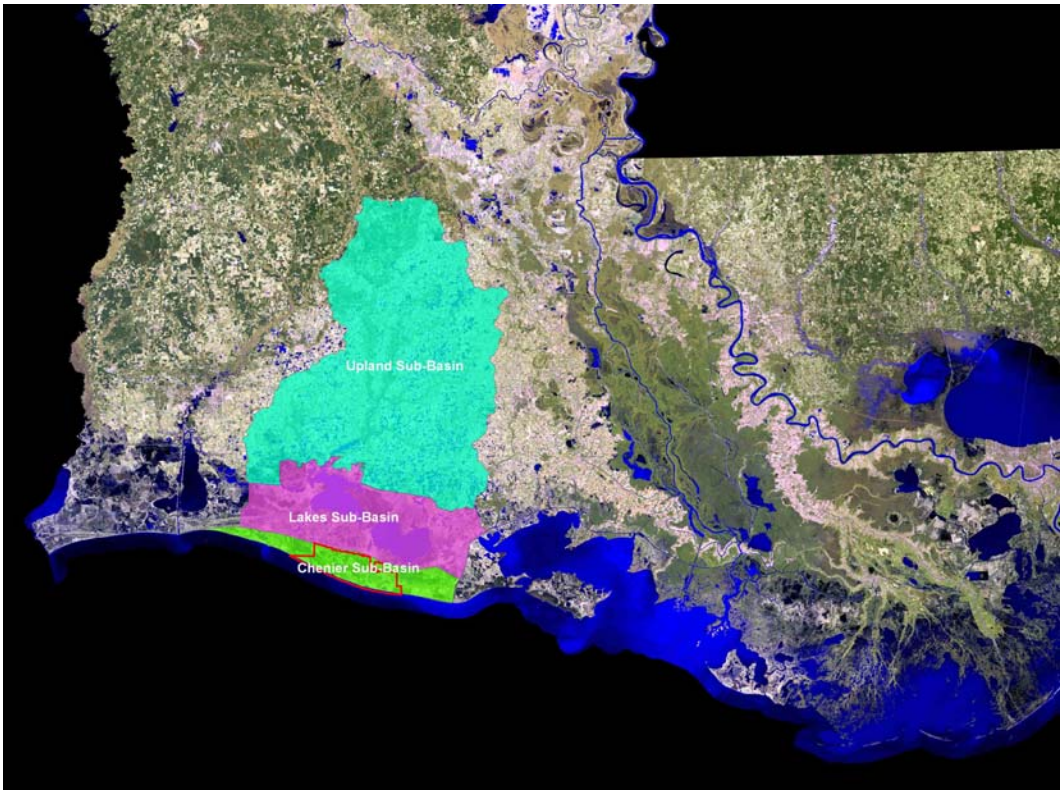

Figure 1: Mermentau River Sub-Basins.

Historically, drainage in the Mermentau River basin was achieved through two primary methods. The first was direct drainage of the basin uplands into the Lakes Sub-basin, and finally into the Chenier Sub-basin via the Mermentau River. The second method consisted primarily of water moving as sheet flow across the marsh in the lower sub-basins. This sheet flow would eventually find its way into the Gulf of Mexico via small tidal bayous and streams scattered through the Chenier Sub-basin. Prior to 1951, Gunter and Shell (1958) reported that Grand and White Lakes were low salinity estuaries.

Beginning early in the twentieth century, large scale human-induced hydrologic alterations began to alter hydrology of the entire region (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2002). The first major alteration to this area's hydrology began in 1912 with the dredging of the Old Intracoastal Waterway, a navigational channel from Franklin, LA to the Mermentau River. Completed in 1924, the channel was dredged through both Grand and White Lakes thus connecting the two large lakes together. This event was the beginning of change for wetlands south of Grand/White Lakes to the Gulf of Mexico. Water began to flow east/west through the new canal rather than sheet flowing across the marsh in a southerly direction toward RWR. The dredging of a larger second navigational canal, the Gulf Intracoastal Waterway (GIWW), occurred between 1925-1944 and stretched from Brownsville, TX to Apalachicola, FL. Wicker et al. (1983) reported that the natural hydrologic regime was altered significantly with construction of the GIWW.

North/south water flow patterns continued to change with the dredging of the upper Mermentau River and its four major tributaries between 1915 and 1935. Dredging, channelization, and desnagging continued through the 1970's facilitating rapid transport of storm-water and agricultural runoff into the Lakes and Chenier sub-basins (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2002).

Table 1. Wetland and aquatic habitat acreage in the Mermentau Lakes and Chenier sub-basins (after Chabreck and Linscombe 1997).

Habitat type	Acres	Percent of total cover (%)
Fresh marsh	319,098	44
Intermediate marsh	141,656	20
Brackish marsh	60,359	8
Salt marsh	25,090	3
Non-marsh/other	55,627	8
Water	120,537	17
Total	722,367	100

The alterations to the Mermentau Basin have resulted in the necessity to implement marsh management strategies which involve levees and water control structures to maintain healthy marsh ecosystems. Three major water control structures were constructed beginning in the 1950's to complete the Mermentau Basin Project (Figure 2), with the objectives of: conserving fresh water by maintaining normal to above normal lake stages in Grand and White Lakes for agricultural purposes, preventing uncontrolled tidal inflow during the agriculture irrigation season (April through August), and maintaining minimum water levels for navigation (Bodin 1983). Periodically the gates are operated to benefit fish and wildlife (when not detrimental to other interests) and flood water evacuation. The three structures serving these purposes include Calcasieu Locks (1950), Catfish Point Control Structure (1951), and Schooner Bayou Control Structure (1951). Calcasieu Locks was constructed to prevent salt water intrusion from the west via the newly constructed ship channel dredged in the Calcasieu River. Catfish Point Lock was built to prevent uncontrolled tidal inflow from the south via the Mermentau River. The value of this particular structure was further realized following the dredging of the Mermentau River Ship Channel in 1971, which caused significant saltwater intrusion and interior marsh loss throughout this region. Schooner Bayou Lock was designed to prevent uncontrolled tidal inflow from the east via the Old Intracoastal Waterway by way of Vermilion Bay. Two additional control structures were added in later years (Figure 2), including the Freshwater Bayou Canal Lock (1968) and Leland Bowman Lock (1985). The former was built after construction of the Freshwater Bayou Navigation Channel and the latter was a replacement of the 1933 Old Vermilion Lock (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2002). Presently all five control structures are operated in unison to maintain the Lakes Sub-basin as a freshwater reservoir to accommodate primarily agricultural (rice/crawfish farming) and navigation interests.

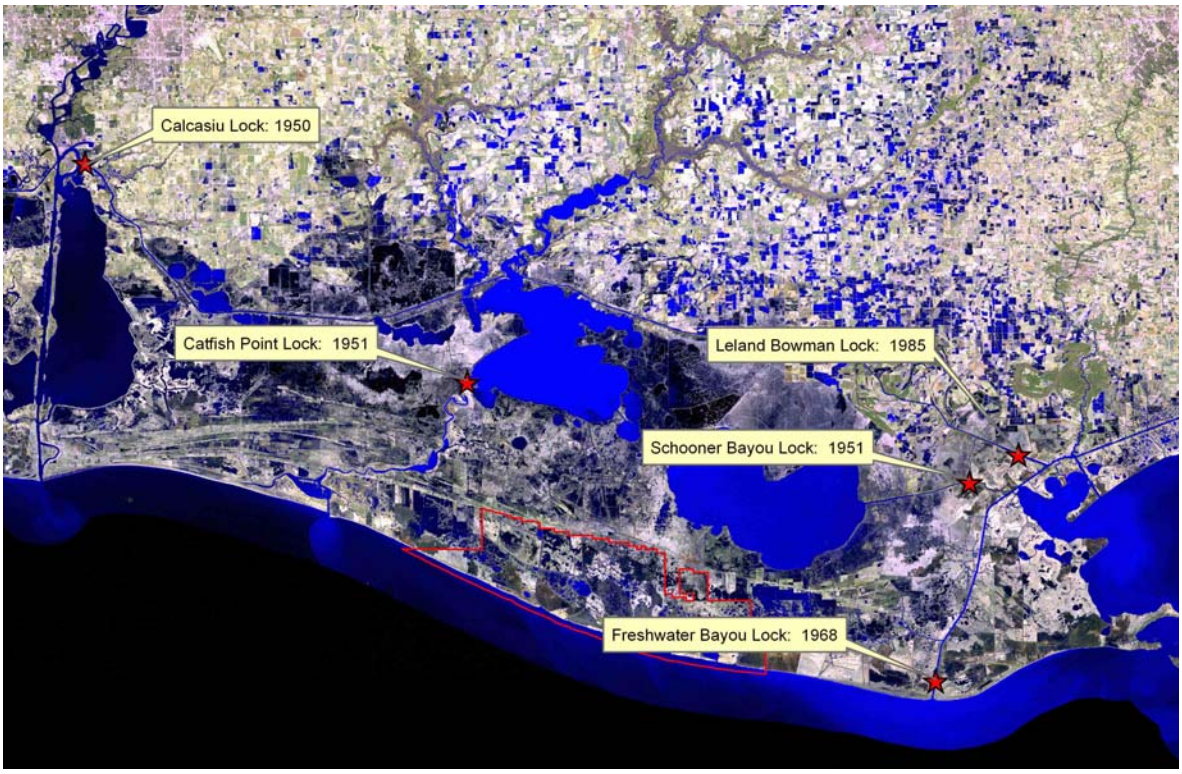

Figure 2: U.S. Army Corps of Engineers lock locations in the Mermentau River Basin.

Subsequent projects gradually segmented the wetlands and disrupted the natural flow of water, such as the construction of Highway 82 (which connected the Grand Chenier and Pecan Island ridges); the dredging of oil, gas, drainage and navigation canals; and the impounding of wetland areas through the deposition of spoil. In some areas, elevated water levels drowned existing vegetation and prohibited the reestablishment of vegetation that had been destroyed by other means such as eat-outs or fires. Canals that permitted rapid flooding of interior freshwater marshes with saltwater and rapid drainage of the natural freshwater that historically had remained in the marshes destroyed the freshwater environments. Brackish-to-saline marsh species have been slow to colonize the bare peat exposed in these former fresh-to-intermediate vegetation zones. The result has been a net loss in vegetation coverage.

Regional Geography, Chenier Formation, and Marsh Loss.—During the period of Mississippi River Delta progradation in the western portion of the Deltaic Plain, fine-grained sediments were transported west to the Chenier Plain by nearshore currents, and the shoreline prograded through the development of mud flats and coastal marsh deposits. When the Mississippi River shifted eastward, sediment supplies decreased and the gulfward progradation of the Chenier Plain slowed. In some instances, marine processes eroded the shoreline, creating beach ridges. This alternating progradation and erosion of the Chenier Plain was cyclic and resulted in a series of abandoned beach ridges, which mark ancient shorelines and stretch in an east-west direction roughly parallel to the coast (Gould and Morgan 1962).

One of the longest ridges is Grand Chenier, which extends eastward from the Mermentau River for approximately 45 miles and marks the northern boundary of the refuge. Like most ridges, this one is narrow (~ 400 yards wide) and seldom exceeds 10 ft in elevation (Russell and Howe 1935, cited in Wicker et al. 1983). Chenier "ridges" are very distinctive features on the landscape since they are interspersed among low-lying coastal marshlands. These ridges were historically dominated by coastal live oak-hackberry forests (*Quercus virginiana, Celtis laevigata*), but only small fragments of these forests remain (~2-10%, Lester et al. 2005) due to agricultural practices, including cattle grazing. The region is labeled Chenier Plain because of the prominence of the live oak (Gould and Morgan 1962), with "chene" being the French word for oak.

The geomorphology and meteorology of the Chenier Plain region influence the distribution of vegetative zones and distinguish it from the Deltaic Plain Region of coastal Louisiana (Wicker et al. 1983). Regional rainfall averaged approximately 52 inches per year. Historically, chenier ridges played a strategic role in the regional hydrology by restricting the movement of water to and from the Gulf of Mexico and the interior marshes (Chabreck 1972, Palmisano 1972). The well-defined beach rim, approximately 5 ft in elevation (Nichols 1959) and extending along the southern border of the RWR, restricts regular tidal inundation to the six tidal channels and one canal connecting interior marshes and the Gulf. Over the past 30 years, the number of channel openings to the Gulf has increased to a maximum of nine (due to canal dredging or shoreline erosion), but recent encroachment of vegetative growth in Big Constance Bayou/East Royalite Canal and a "sand plug" on Pigeon Bayou have closed these three tidal channels and one canal.

Wicker et al. (1983) extrapolated aerial measurements made for selected transects and reported a rate of marsh loss of approximately 192 ac per year between 1930 and 1974. During this period, the approximate rate of shoreline erosion along the entire refuge was 97 ac per year. This extreme loss was supported in a recent study in which the rate of shoreline loss averaged

28.5 ft. per year in the area of Rockefeller Wildlife Refuge (Byrnes et al. 1995). Natural processes contributing to land loss are marine and estuarine (i.e., wave) erosion, subsidence, waterfowl and muskrat eat-outs, and deep burns during droughts. The major man-made process contributing to land loss in the region is the alteration of the natural hydrologic regime in the absence of active wetland management.

Rockefeller Wildlife Refuge Geomorphology and Hydrology.—The marshes on the RWR occupy an elongated basin confined by the high Grand Chenier Ridge to the north and the lower sea rim beach to the south. Prior to major man-made landscape changes, freshwater reached this basin through precipitation and drainage from surrounding ridges, thus creating deep freshwater rush marshes near the chenier ridge. The rush marsh zone was vegetated primarily by bulrush (*Scirpus californicus*), giant cutgrass (*Zizaniopsis miliacea*), sawgrass (*Cladium mariscus*), and cattail (*Typha* sp.; Lynch 1942 cited in Wicker et al. 1983). Freshwater ponds in this zone contained various species of algae, frogsbit (*Limnobium spongia*), bladderwort (*Utricularia macrorhiza*), water pennywort (*Hydrocotyle sp.*), duckweeds (*Lemna* spp. and *Spirodela* spp.) and exotic water hyacinth (*Eichhornia crassipes*; Lynch 1942 cited in Wicker et al. 1983). Originally brackish (interior marsh zone) to saline (sea rim marsh zone) marshes occupied the lower two-thirds of the area which was drained by dendritic tidal channels. A series of low salinity marsh ponds were situated at the inland extremities of the tidal marsh and supported widgeongrass (*Ruppia maritima*; Lynch 1942 cited in Wicker et al. 1983). The brackish interior marshes were densely vegetated with leafy-three square (*Scirpus robustus*) and wiregrass (*Spartina patens*), while the sea rim marshes contained saltgrass (*Distichlis spicata*), hogcane (*Spartina cynosuroides*), iva (*Iva frutescens*), and oystergrass (*Spartina alterniflora*; Lynch 1942 cited in Wicker et al. 1983). The distribution of vegetation zones that constitute major wildlife habitat types on the refuge has been altered considerably over the past 40 years due to the management of areas via water control structures/levees (see Appendix 1 for more listing of plants).

The average elevation of the RWR marshes is approximately 0.8-1.0 ft. NAVD 88. Normal tides are contained within the channels and canals, and the amount of water covering the marsh is governed by weather conditions, primarily precipitation and wind direction (Nichols 1959). While the average tidal fluctuation in the area is 1 ft, extremely high tides associated with southerly winds from storms flood the interior marshes at least once or twice a year, bringing in marine mud and saltwater (Chabreck 1960a, Lynch 1942 cited in Wicker et al. 1983). The introduction of saline mud creates a firmer marsh than is present in the Deltaic Plain because it prevents the formation of highly organic marsh peats (Lynch 1942 cited in Wicker et al. 1983). Creation of leveed impoundments on the refuge (beginning in 1954) has restricted, to some degree, the input of saline water and mud to only the unimpounded areas nearest the gulf (Chabreck 1960a). However, extreme high water can overtop or even break the levees, and cause the impounded areas to be subjected to higher salinities than are desirable under the management program. During periods of drought or prolonged northerly winds, which cause low winter tides, the marsh is subject to extreme low water. Extended low-water periods expose the marsh to the threat of fire, with the possibility of intense peat fires that create new lakes at the cost of loss of vegetated marshlands.

Regional and local hydrology changes caused by navigation, drainage, and mineral development projects have necessitated and influenced marsh management strategies employed on RWR. In 1940 the Humble Canal was dredged from the East End Headquarters to the mouth

of Joseph Harbor Bayou to facilitate oil and gas exploration. This event allowed the beginning of saltwater intrusion into the interior brackish and intermediate marshes of RWR. In 1953, the dredging of the Union Producing Canal permanently changed the hydrology in the western half of the refuge (Nichols 1961). These actions along with drought conditions in 1948, 1951, and 1954 caused marsh die-offs and wildlife habitat deterioration (Wicker 1983).

Construction of the Superior Canal connecting Grand Lake with RWR began in 1951 to facilitate oil and gas exploration in that area (Nichols 1961). This event caused additional changes in regional water flow patterns when the canal breached Highway 82 allowing water from Grand Lake to flow directly into the central portion of RWR. Additional oilfield canals were constructed off the Superior Canal to allow mineral development on the refuge. This action permanently altered normal sheet flow patterns and changed regional hydrology by creating a direct link between the Chenier Sub-basin and the Lakes Sub-basin via the Superior Canal. Several years later, in 1954, a property line canal was dredged from the Superior Canal to the Humble Canal (Nichols 1961). This action allowed saltwater intrusion from the Gulf of Mexico into the Mermentau River Lakes Sub-basin via the Property Line Canal and Superior Canal. Because of this, RWR was forced by agricultural interests in the Upland Sub-basin to construct the East End Locks in 1961 at the intersection of the Property Line Canal and Humble Canal; this effectively stopped saltwater intrusion into the Mermentau Basin. The structure, which is still in operation, also allows the rapid release of floodwater from the region to the Gulf of Mexico (Louisiana Wildlife and Fisheries Commission [LWFC] 1962).

Active management was initiated on Rockefeller Refuge in the mid-1950s at a time when royalties from oil/gas operations on the refuge increased and habitat degradation from eat-outs, fires, saltwater intrusion and vegetation die-offs was approaching major proportions. Management operations, while founded on the best management principles of the time, were (and still are to some extent) experimental. Refuge personnel were instituting management plans based primarily on a system of leveed impoundments and water control structures to enhance wildlife habitat. By 1954, over 40 gated culverts were placed in levees constructed in strategic locations on the refuge for salinity control, with each individual impoundment created identified as a management unit. On June 27, 1957, Hurricane Audrey significantly damaged levees and water control structures. These were later repaired and additional management units were constructed with major improvements over time.

In 1961, a six mile levee was constructed from Deep Lake to the Property Line Levee south of Unit 13 creating the 13,500 acre Management Unit 6. Additionally, two large, radial-arm, three-gate water control structures were constructed on Big Constance and Little Constance bayous on the south end of the unit to prevent saltwater from entering the unit. A sheet pile dam was constructed across Dyson Bayou in 1962 to completely eliminate uncontrolled tidal flow into Unit 6 which serves as the southern boundary of the Mermentau Basin. The water control structures associated with this unit along with the East End Locks are key elements in controlling saltwater intrusion and flooding in the region (LWFC 1964).

Hydrologic alterations occurred in eastern portions of RWR when Rollover Bayou Channel was dredged from the Gulf of Mexico to Highway 82 in the 1950s. A large radial arm three gate water control structure was constructed on the lower end of Rollover Bayou in 1957 to control salt water intrusion. The structure was damaged by Hurricane Audrey and repaired in 1959 (LWFC 1960). Structure operation was discontinued in the 1960s due to local concerns over flooding of private property east of RWR. In 1963 an additional radial arm three gate structure was constructed on Middle Bayou west of Rollover Bayou to gain water level control

and stop saltwater intrusion on 9,000 acres west of Rollover Bayou (LWFC 1964). Structure operation was also discontinued in the 1960s due to flooding concerns by the local community. Numerous Wakefield type weirs were constructed in this particular area of RWR in the 1960s to allow access for fur trapping, control water levels, stabilize water salinities, reduce water turbidity, and promote the growth of aquatic vegetation.

Hurricane Rita struck RWR on September 24, 2005 and caused extensive damage to levees and water control structures. However, repairs have been made to all the pumps and all management units currently have water level or water salinity control at this time except for Unit 15. In the fall of 2007, a five million dollar Coastal Wetlands Planning and Protection Act (CWPPRA) project entitled "Fresh Water Introduction South of Highway 82" was completed to remove excess water from the Mermentau Basin and provide additional fresh water to the southeast RWR tidal marsh. Four aluminum stop-log flap-gate structures were installed and Little Constance structure was automated with large aluminum flap-gates.

1.2: History and Origin of the Property

Only a year after purchasing and donating Marsh Island and State Wildlife refuges to the Conservation Commission of Louisiana, E.A. McIlhenny became interested in creating another wildlife refuge on a large tract of land located in western Vermilion and eastern Cameron Parishes totaling 86,000 acres (McIlhenny 1930). On July 12, 1913, he purchased the property for $212,500 using $27,500 cash and $185,000 of donated monies. On May 20, 1914 he sold the property to the Rockefeller Foundation for preservation and protection of migratory birds. Through the encouragement of McIlhenny, the Rockefeller Foundation agreed to allow the Conservation Commission of Louisiana to control the lands for a period of five years, and on September 25, 1914, the State formally accepted the care of the property. The property was donated to the State on December 18, 1919 and the State of Louisiana officially accepted the lands in 1920 thus creating the Rockefeller Wildlife Refuge.

During the early years, management practices at RWR consisted primarily of patrolling the area against poaching and trespassing, burning the marsh to encourage production of preferred goose and muskrat foods, and a trapping program aimed particularly at muskrats. RWR at this time was held to be self-supporting: that is, any funds needed for management or patrolling on the refuge had to be generated from within the refuge (Lynch 1942, cited in Wicker et al. 1983.) Thus, the sale of fur hides, especially those of the abundant muskrat, was an important source of revenue in the refuge's early history.

In addition to being "one of the most important wildlife areas in the United States", the refuge functions as a natural laboratory for research on "marsh management, plant ecology, pond culture and life history studies of the many forms of fish and wildlife found on the refuge" (Joanen 1969a). The information gained in these research efforts "demonstrates what man can do to improve on nature to benefit wildlife" (Joanen 1969a) and can serve as management guidelines for other state and Federal management areas, as well as private property owners.

1.3: Purpose/Need

The original purpose of RWR was to provide a sanctuary/preserve for wildlife and fisheries and there has been little deviation since then to this original vision. The refuge also serves as a research site for marsh management strategies (i.e., limiting saline encroachment,

reversing marsh deterioration, and providing productive wildlife habitat), while also serving as a research site for wildlife/fisheries research by RWR staff and other governmental/academic agencies. RWR staff provides professional expertise for the implementation of international, federal, and state legislation and regulations governing wise use of alligators, coastal wetlands, and other important wildlife/fisheries resources. Further, management expertise and guidance is provided by RWR staff to local landowners of marshland. Lastly, RWR serves as a recreational outlet for local residents, as well as a destination for regional tourists.

1.4: Goals

Primary Goals

1. Based upon the original deed of donation, the primary goal of the RWR is to provide a refuge and preserve for all wildlife and fisheries species.

    a. When possible, multiple use marsh management should be considered in order to provide habitat for waterfowl, shorebirds, wading birds, and estuarine organisms (i.e., fish, shrimp, and crabs).

    b. Additional considerations should be given to establish and maintain the historical flora/fauna of RWR.

    c. RWR should also contribute the maintenance of the Mermentau River Basin hydrology.

2. The deed also states that the refuge should study and improve wildlife foods, as well as study/remove the enemies to valuable wildlife species.

    a. Research activity on RWR addresses pertinent biological questions related to marsh management, wildlife, or fisheries resources.

    b. Research findings should also be disseminated (in publications or presentations) to local, state, national, and international audiences. Since 1955, RWR staff has contributed over 500 professional publications, reports, and professional conference abstracts to a wide range of audiences.

Secondary Goals (these goals should not supersede Goals 1 or 2)

3. The goal of public outreach with local landowners and/or state, federal, and international groups on legislation/regulation is to encourage best conservation/management practices for fish and wildlife species, as well as their habitats.

4. The goal of recreation is to provide a destination for recreational activities, primarily through the abundance of the fisheries resource (i.e., fishing, shrimping, crabbing; permitted by subsequent Deed Memorandum of Agreements) and the diversity of watchable wildlife (i.e., birdwatchers).

5. The goal of education is to actively engage in educational programs with local, regional, and statewide groups. This includes providing educational programs to local school groups, as well as continuing to host 4H Marsh Maneuvers at RWR.

1.5: Important Considerations of Sale or Deed of Donation

When the Rockefeller Foundation officially granted the property to the state, they spelled out in the Deed of Donation exactly how the property was to be used. The major terms of the original agreement stipulated 1) the property must be maintained as a wildlife refuge, 2) boundaries must be posted, 3) enforcement agents must protect the area from trespassers and poachers, 4) no public taking of fish or animals is allowed, 5) refuge staff must study and manage the property for wildlife, and 6) mineral revenues must be used on the refuge first (surplus may go toward education or public health). It was amended in 1983 with a Memorandum of Agreement (MOA) between the Department of the Interior and the LDWF. The MOA allows for regulated sport fishing and commercial trapping when compatible with the primary purpose of the refuge as a wildlife sanctuary. It has a provision that requires the U. S. Fish and Wildlife Service (USFWS) to make periodic inspections of refuge activities and the USFWS has reversionary rights over the refuge should the LDWF fail to meet its obligations pertaining to the Deed of Donation (with amendments).

Planners had the foresight to realize that mineral revenues would cease at some point in time, and steps were taken to ensure funding for maintenance in perpetuity. Act 321 of the 1972 legislature created the Rockefeller Wildlife Refuge Trust and Protection Fund (Trust Fund). One fourth of funds derived from royalties, rentals, or otherwise from RWR mineral leases were to be deposited in the Trust Fund until a principal of $5 million was reached. The Trust Fund's minimum value and allocations were amended on several subsequent occasions. Act 342 in 1978 raised the Trust Fund goal to $10 million; Act 807 in 1980 increased the Trust Fund goal to $20 million, and established the Rockefeller Scholarship Fund for Louisiana wildlife students from 5% of interest from the Trust Fund; Act 63 of 1982 raised the Trust Fund goal to $30 million; Act 707 of 1989 reduced additions to the Trust Fund from 25% to 5% of mineral revenues; Senate Bill 662 of 1989 established an annual donation of $150,000 to the Fur and Alligator Advisory Council; and Act 832 of 1995 raised the Trust Fund cap to $50 million.

2. Status of Biological and Physical Resources

2.1: Wildlife and Fisheries Resources

Because of its unique location, Rockefeller Wildlife Refuge is one of the most important wildlife areas in the United States. Louisiana's position at the southern terminus of the Mississippi and Central Flyways allows the state to serve as a wintering home for waterfowl from northern nesting grounds. RWR hosts hundreds of thousands of ducks, geese, coots, and numerous shorebirds/wading birds each year with 273 species documented on the refuge (Appendix 2). This includes providing wintering habitat for the federally Threatened Piping Plover (*Charadrius melodus*). The refuge and surrounding chenier "ridges" also serve as critical spring stop-over habitat for many neotropical migratory birds on their journeys to northern breeding grounds, while also serving as a "last stop to fuel" on their fall journeys to Central and

South America. Further, the refuge serves as a very important fisheries nursery (including crustaceans) for the southwestern Louisiana coast, and RWR has played a pivotal role in the recovery of the American alligator and its habitat.

2.2: Timber or Botanical Resources

While RWR contains live oaks (*Quercus virginiana*) and hackberry trees (*Celtis laevigata*) on the most northern portion of the property along the chenier ridge, the refuge is primarily comprised of four distinct vegetative coastal marsh zones. The salt content of the surface water and the soil properties play a large role in the type of vegetation seen throughout the marsh. The site is comprised of fresh, intermediate, brackish, and salt marshes (Chabreck and Linscombe 1997). Refer to Appendix 1 for a list of common trees and plants that are found on the refuge.

2.3: Endangered Species

The only Endangered/Threatened species known to occur on RWR is the Piping Plover (*Charadrius melodus*). Piping Plovers are considering wintering residents and are found inhabiting beaches/mudflats along the Gulf of Mexico. The number of Piping Plovers that utilize RWR beaches during the winter is unknown, but surveys have noted individuals on Rockefeller beaches/mudflats (B. Salyers and W. Selman, pers. obs.). For more information on the future research opportunities or the management of this species, refer to sections 5.8 and 6.6, respectively.

2.4: Mineral Resources

The canals dug by early oil exploration in coastal Louisiana (including on RWR) have had lasting impacts on the surrounding landscape; canals allow for the rapid movements of water across the marsh, as well as easier routes for saline encroachment on freshwater marshes. However, RWR is an excellent example of how conscientious mineral development can be compatible with wildlife management. Negative environmental impacts of drilling have been minimized due to a cooperative relationship between wildlife managers and mineral production companies. The importance of the revenues generated from mineral leases on RWR cannot be overstated; they are used for wildlife research, habitat management/enhancement, to purchase/repair refuge equipment, land acquisitions, and salaries. Therefore, the responsible production of new wells is encouraged due to the lasting benefits the revenues will have for conservation on the refuge.

The original discovery of oil/gas within RWR occurred in 1952, with four oil/gas fields being developed since then. Fields that were developed include: Deep Lake (discovered 1952), Little Pecan Lake (1952), Constance Bayou (1953; no longer active), and Price Lake (1962; no longer active), with the Deep Lake Field being the most productive of the four (1.2 trillion ft^3 of natural gas were produced between 1952 and 1989). Cumulative peak oil/gas revenues (all fields) for RWR approached 1.2 million dollars per month (14.4 million dollars per year) in 1984. Oil/gas revenues have decreased significantly since 1984 to approximately 2.8 million dollars in the 2008-2009 fiscal year. As of 2009, there were 11 active leases on the refuge that totaled 7,573 acres (~9% of refuge; Fig. 4) and six were under production. Active leases

primarily occur in the vicinity of the East End Locks (Units 1, 3, 4), Superior-Deep Lake (Units 5, 6, 8, 10/13), and in the marsh to the southwest of Pecan Island (Unit 15, unmanaged eastern marsh).

Additional information regarding restoration techniques and mitigation is provided in section 6.8.

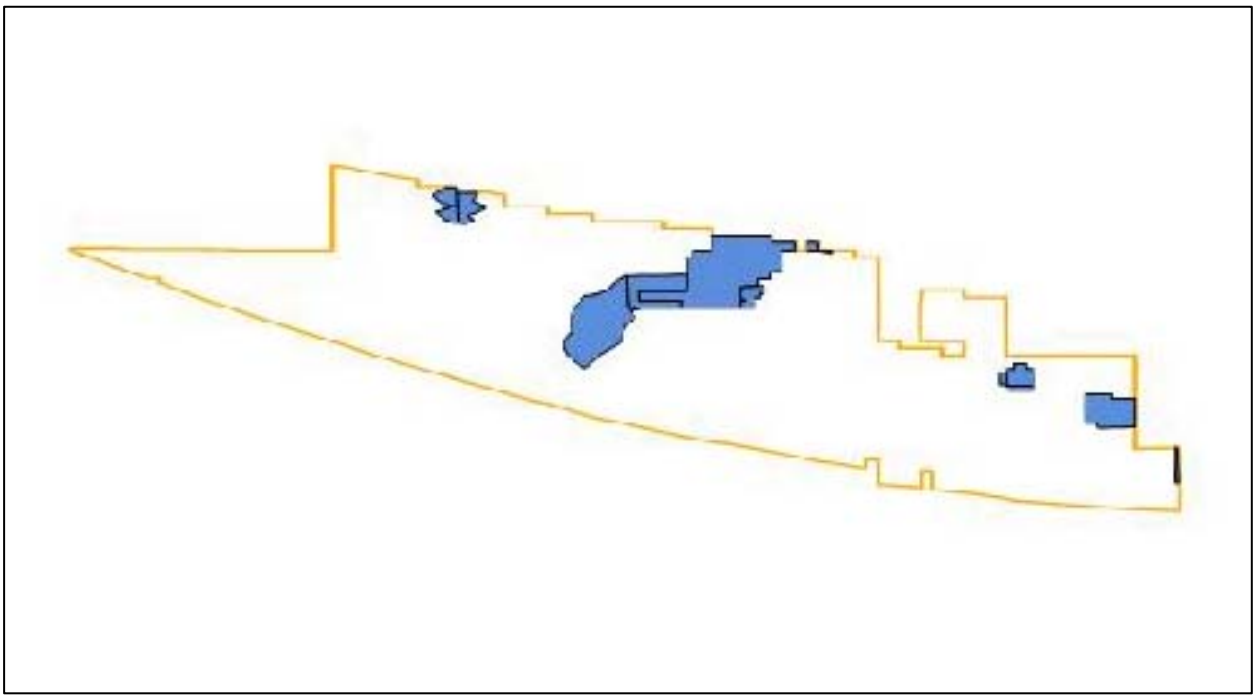

Figure 3: Active oil/gas leases on Rockefeller Wildlife Refuge.

2.5: Cultural or Archaeological Resources

To the best of our knowledge, no cultural or archeological resources occur on RWR. Interestingly, in 1766, the Spanish ship *El Nuevo Constante* shipwrecked off of RWR shoreline while carrying supplies and valuables back to Spain. The shipwreck occurred approximately 1,600 feet from the historical shoreline near Big Constance Bayou and a campsite was completed onshore approximately 2 miles from the wreck. However, shoreline erosion of approximately 5,000 feet has occurred in the interim time period, and therefore, it is unclear if the *El Nuevo Constante* campsite remains. If so, it could occur on RWR.

2.6: Physical Facilities

Hurricanes Rita/Ike and their associated storm surge dramatically reshaped the landscape of southwestern Louisiana and the primary facilities of Rockefeller Wildlife Refuge. Most of the buildings on the refuge have recently been repaired/replaced, are currently being repaired, or are planned to be replaced/repaired (Table 2).

Headquarters.—RWR Headquarters is located near the northwestern corner of the refuge, adjacent to LA Highway 82; it also occurs on the small portion of Rockefeller property that is on

the chenier ridge (Figure 4). It serves as the office space for refuge personnel, meeting space, and library/storage for refuge documentation. The Headquarters was damaged by Hurricanes Rita/Ike, but it has not been repaired. Currently, it needs external repairs as well as interior refurbishing.

General Quarters.— RWR General Quarters is on the eastern side, and adjacent to the headquarters building. It serves as general housing for visiting LDWF employees and for governmental/academic researchers; it can accommodate up to 25 visitors. Marsh Maneuvers, a 4H educational program, uses General Quarters extensively during the summer. Along with housing, general quarters also provides the largest meeting space on the refuge (~60-75 people), with an available cooking and dining area. This building was also damaged by hurricanes Rita/Ike, but has not been repaired. It currently needs external repairs, as well as interior refurbishing.

Biologist Residences 1-4.— RWR residences 1-4 are on the eastern side of General Quarters. They serve as residences for refuge biologists, while also being an incentive to attract quality biologists/researchers to the refuge. All four residences were considerably damaged by Hurricanes Rita/Ike. Currently, all four residences are vacated and need to be demolished. Plans have been made to rebuild the residences near to the original footprint of the old residences. Due to the damage of biologist housing, temporary residences were completed in the fall 2010 near West End dorm and will serve as housing until the biologist residences are demolished and replaced.

West End Dorm.— RWR West End Dorm is a large, suite style dormitory to the west of the Headquarters and near Price Lake Rd. It serves as general housing for visiting LDWF employees and for governmental/academic researchers. This building was damaged beyond repair by Hurricanes Rita/Ike and needs to be demolished. Plans are completed to rebuild West End Dorm near its current location and once completed, it can accommodate up to 23 visitors.

Shop/Boat House.— RWR Shop/Boat House serves as the primary facility where repairs and maintenance are done on refuge vehicles/equipment, while also serving as a fabrication shop and place for storing materials. It also serves as a boat house for larger vessels used on the refuge and has a offices for the Facility Maintenance Manager and Shop Foreman. Repairs on this building were completed in March 2011.

Lumber Shed.— RWR Lumber Shed is to the southwest of the Shop/Boat House and serves as a storage facility for materials and field equipment. Repairs for this building were completed in early 2010.

Table 2: The status of Rockefeller Wildlife Refuge primary facilities following Hurricanes Rita (2005) and Ike (2008).

Building	Damaged	Gone	Repair	Replace	Demolish	Clean Up	Completed
Headquarters	x		x				
General Quarters	x		x				
Biologist Residences 1-4	x			x	x	x	
West End Dorm	x			x	x	x	
Shop/Boat House	x		x				x
Lumber Shed	x		x				x
Airboat Shed	x		x				x
Tractor Shed	x		x				x
Storage/Boat Shed		x		x			
Lab		x		x			

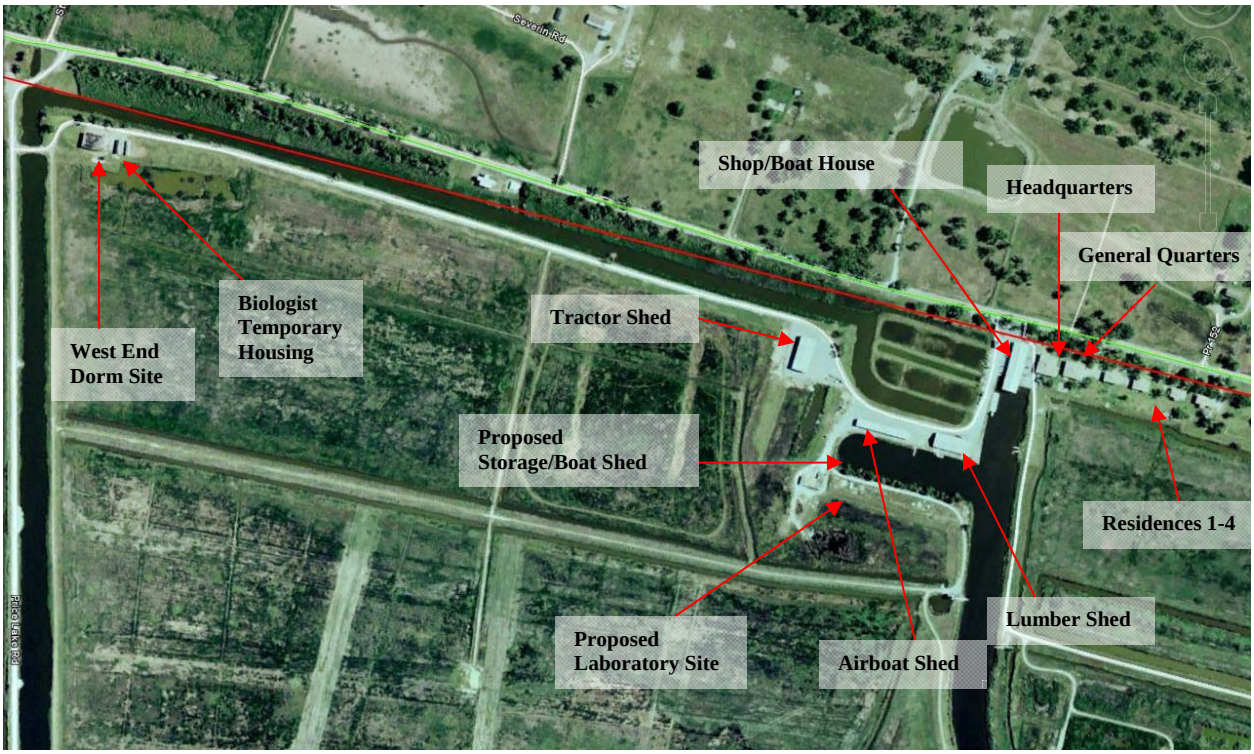

Figure 4: Northwestern corner of Rockefeller Wildlife Refuge and major facilities.

Airboat Shed.— RWR Airboat Shed is to the west and adjacent to the Lumber Shed. It has 11 stalls for storing airboats and/or outboard boats. The repairs were completed in the summer 2010.

Tractor Shed.— RWR Tractor Shed is to the west, northwest of the Airboat Shed. It serves as a refuge storage facility for heavy equipment/tractors.

Storage/Boat Shed.— RWR Storage/Boat Shed was completely destroyed by Hurricane Rita. It serves as additional storage space for refuge boats and materials. It is planned to be rebuilt adjacent to the canal behind the airboat shed.

Laboratory.— RWR Laboratory was completely destroyed by Hurricane Rita. Prior to Hurricane Rita, the lab was on the southeast corner of the east goose pasture. Current plans have it being moved adjacent to the storm platform. It serves as the lab facility for refuge staff and storage facility for specimens/biological samples. The absence of a laboratory on site impedes on the productivity of research activity and will do so until replaced.

3. Existing Uses

3.1: Public Access

Public vehicle access on RWR is limited to six miles of interior roads. These provide dry land access for recreational fishing, with the most popular area being Price Lake Road, located along the western boundary of RWR. Public usage along the refuge is measured with car counting devices. These counters are located at the entrance of the three highest public use areas (Price Lake Road, Joseph Harbor boat launch, East End Locks boat launch) and the number of vehicles using these points is recorded. Those numbers are then used to calculate the number of

man-hours spent on the refuge and consumptive use percentages by the public. It is estimated that the refuge receives on average 100,000 annual visitors.

In order to access the majority of the refuge, there are three boat ramps that are open to public use. Two of these ramps are state owned, maintained by RWR staff, and are free to the public. These ramps, located by Joseph Harbor Canal just off Hwy 82 in Cameron Parish, are very heavily used and received significant damage from Hurricanes Rita and Ike. The launch located by the East End Locks launch was repaired following Ike, while the Joseph Harbor launch improvements have been planned and will soon be initiated. The third ramp, Rollover Bayou Landing, is a private, fee-based launch near Pecan Island, Louisiana (Vermilion Parish), which is located along the eastern most boundary of the refuge.

Approximately 106 miles of canals are available to the public for recreational fishing during the spring, summer, and fall. Around 40% of these canals contain fresh to periodically brackish waters. During the winter months many of these fishing canals are closed, as sections of the refuge are closed to limit disturbance to wintering waterfowl. Around 40 miles of canal remain open year round.

3.2: Hunting, Trapping, and Fishing

Recreational opportunities are one of the largest attractions on the refuge. The majority of public use involves some type of consumptive activity. Generally consumptive use peaks in the summer and again in the fall with migrations of shrimp. Recreational use then diminishes during the winter when the interior portions of the refuge are closed.

Fishing is the most popular public recreational activity on the refuge. There are opportunities available for both freshwater and saltwater/brackish fishing. Freshwater fishing areas, mostly located around and connected to the Superior Canal system, are enhanced each year with supplemental stockings of Florida strain largemouth bass. These bass are delivered to the refuge from LDWF's Booker Fowler Fish Hatchery, then grown out in earthen ponds from the larval stage to the Phase I fingerling stage before stocking.

Saltwater/brackish fishing is more popular on the refuge relative to freshwater fishing. Saltwater/brackish fishing can be divided into two categories: finfish and shellfish. Finfish angling is done year round in efforts to catch species such as red drum, spotted sea trout, and southern flounder, while shellfish include crabs and shrimp. The majority of consumptive use is attributable to sport crabbing, shrimping, and fishing. Oystering has been closed for several years across the refuge due to a contamination concern issued by the Louisiana Department of Health and Hospitals, but crabbing and shrimping still remain very popular. Annual production of blue crabs and white/brown shrimp seems to drive the annual recreational use on RWR today, with more than 75% of the recreational activities being attributed to the harvest of these organisms. The only specific management techniques done for any of these species are the opening of water control structures during the spring to allow adequate numbers of postlarval shrimp, fish, and crabs to enter the units during times of peak abundance in tidal canals. No commercial take of any species is allowed across the refuge, which includes banning the use of crab traps, nets, or trawls.

Figure 5: Locations of public recreational access points on RWR. Sky blue areas indicate vehicle access points and yellow triangles denote boat ramps.

One consumptive activity not conducted on the refuge is hunting. Hunting is not allowed due to the game preserve status given to RWR in the original deed of donation, but some regulated trapping is allowed for furbearers and alligators. The furbearer harvest is targeted at nutria and muskrat, which could potentially damage the marsh if their populations are not controlled. Additionally, alligators are harvested annually from the refuge in locations that are considered high public use areas, in order to reduce human conflict with nuisance alligators.

3.3: Other Compatible Uses

Rockefeller Refuge also provides other opportunities besides consumptive practices. Some of the non-consumptive uses include bird watching, wildlife viewing, and observing chenier habitat, as well as fresh, brackish, intermediate, and saline marsh habitats. The Price Lake observation tower provides ideal opportunities to view many species of marsh, wading, and shorebirds. Neo-tropical migrant passerines use the shrubs/trees on levees and the chenier ridge habitat as stopover sites on their trans-gulf journeys to and from Central and South America; these areas provide exceptional neo-tropical songbird observation during their yearly spring migrations. The diversity of avian species using the refuge is remarkable and it is recorded that over 250 species of birds have occurred on the refuge (Appendix 2). Levee roads across the refuge provide excellent viewing of wildlife including alligators, mink, muskrat, otter, raccoon, and the occasional deer or bobcat. RWR also permits access to bird watchers to the Nunez Woods property, which is located approximately one quarter of a mile west of Price Lake Road; this private property is a quality example of intact chenier habitat with live oaks, hackberries, palmettos, and deciduous hollies.

3.4: Non-compatible Uses

Along with hunting and commercial fishing, RWR considers other activities to be not compatible with the goals/mission of the refuge. Non-compatible uses include overnight camping, horseback riding, ATV riding, geocaching, commercial guiding/tours, swimming, and canoeing/kayaking on the refuge. The latter two are primarily for safety reasons due to the abundance of alligators and the potential for negative interactions with large alligators.

4. Education/Outreach

Refuge personnel contribute greatly to the community through education and outreach programs. Education in wildlife, marsh ecology, history/purpose of RWR, and coastal erosion are taught to various age classes including elementary, high school, and college-level students. One of the largest groups the refuge hosts is the annual LSU 4-H Marsh Maneuvers Camp. Attendees enjoy a weeklong stay at the refuge while learning about the importance of southwestern Louisiana marshes and its inhabitants; the program lasts for four weeks, with different regions of Louisiana represented during the different weeks.

5. Research and Inventory

5.1: Overview

A unique attribute of RWR is the emphasis on wildlife, fisheries, and marsh management research. RWR has extensively disseminated the results of research findings within professional/popular publications, research reports, and published abstracts (563 since 1955). Further, staff provides public/professional presentations, while also integrating this information into the overall departmental conservation program. A list of publications by division personnel and others conducted entirely or partially on RWR can be obtained from either the main office in Baton Rouge or from the RWR; this list is also currently being compiled as an electronic resource for online access to the publication list and online document retrieval.

5.2: Alligator

Research.—RWR is probably best known for its pioneering research on the American alligator (*Alligator mississippiensis*). A five year study on alligator nesting ecology (Joanen 1969b) was the first of many published research studies over the next three decades by Joanen and McNease. Their research on the life history, ecology, food habits, home ranges and habitat preferences, breeding biology, and population status led to the development of a statewide sustainable use management program. This involves a controlled annual harvest of subadult and adult alligators by approximately 2,000 licensed trappers annually.

The species was affected by previously unregulated harvest in the early part of the last century, but during the 1960s and 1970s extensive research and monitoring, as well as a period of time when no harvest was allowed, led to population recovery and alligator numbers recovered to the point where limited harvests (carefully regulated) were again allowed. There are now some 1.5 million alligators in Louisiana, and some 30,000 – 40,000 wild alligators are

harvested statewide in peak years. A limited nuisance harvest is conducted on RWR to avoid human-alligator conflicts in areas of high public use (i.e., recreational fishing, shrimping, and crabbing), primarily with harvests targeted near water control structures.

The research conducted at RWR on alligator egg incubation, culture of juveniles, nutrition, and captive propagation led to the development of a farming/ranching program statewide, which has become a multi-million dollar industry within the state. In some years 250,000 – 300,000 farm hides have entered the international hide market, to be used for high-end luxury leather fashion items. The wild and farm programs have been valued at over $60 million in peak years. These programs and the utilization philosophy are recognized internationally as models for sustained use management and have been applied to crocodilian species worldwide.

Recent alligator research focused on nesting biology, DNA/genetic studies, and culture studies to refine alligator growth (Elsey and Trosclair 2008) and nutrition. The juvenile alligator growth studies are directly applicable for alligator husbandry recommendations to our state's alligator farmers. In addition, we often lend guidance to farmers' methods they use to experiment with various regimes on their alligator farms. We often host visiting researchers and collaborate on projects of mutual interest. Molecular ecology techniques such as use of microsatellites and stable isotopes are beyond the scope of our field site, but working with university professors and graduate students has led to many new findings. Our field studies on-site recently documented multi-year, multiple paternity and nest-site fidelity in some alligators, often over several years (Elsey et al. 2008; Lance et al. 2009). Many researchers from prestigious universities such as Harvard University and Yale University have visited RWR to collect valuable samples for their novel studies. We are pleased we can host visiting graduate students, to assist them in attaining their graduate degrees, and help train the next generation of field biologists.

We are pleased that we have continued to maintain an active alligator research program, despite having lost the field lab in Hurricane Rita in 2005. We converted a storage shed to a very basic lab which was used for sampling specimens until it was lost in Hurricane Ike in September 2008. As our alligator management programs have grown, staff time is increasingly directed to the day-to-day administrative needs of managing the wild alligator harvest, the alligator farm program, and the nuisance alligator program, thus leaving less time available for research. Recent budgetary constraints have required the use of more temporary and seasonal employees, who are difficult to retain and recruit, thus often requiring upper level biologist to travel to conduct mandatory alligator "releases to the wild" and hide inspections. This does limit our ability to conduct labor intensive field studies, but we strive to keep research as a priority when other administrative tasks related to our alligator harvest programs are completed. When a new lab and grow-out facility for alligators is completed, we will continue to conduct research studies on all aspects of alligator biology as scheduling allows.

Inventory.—Inventory for RWR alligator populations has primarily focused on a coastal alligator nesting survey that is completed by the LDWF Alligator Program each year. From 1991-2010, these surveys on RWR have estimated an average of 266, 723.6, and 84.7 alligator nests in brackish, intermediate, and freshwater marsh types, respectively. Furthermore, the refuge maintains a database on the number of alligators harvested annually during the nuisance alligator season, as well as sex and size of harvested individuals.

5.3: Waterfowl and Marsh Management

Research.—Mottled Duck (*Anas fulvigula*) population dynamics is a major waterfowl study that RWR personnel are conducting. Since banding efforts began in 1994, over 35,000 mottled ducks have been banded in Louisiana. During the summer (June-August) Mottled Ducks are banded across coastal Louisiana, with Rockefeller staff focusing efforts primarily within refuge boundaries and also by permission on Miami Corporation property holdings (Cameron/Creole marsh); these banding efforts are critical to determine annual harvest rates and survivorship for Mottled Ducks, as well as to assist in the management of the species (i.e., information for daily bag limits). The timing of banding efforts coincides with brood rearing and molt when ducks are easily captured by hand from an airboat at night. Recently, a Mottled Duck banded in 2007 on Rockefeller Refuge was harvested in Alpena, South Dakota (approximately 1,450 mile trip; Selman et al., in press); this represents the northernmost documented record for this species. In 2007-2009, RWR collaborated on telemetry projects with LSU and Texas A & M on Mottled Ducks to determine habitat use and movements, particularly during brood rearing and remigial molt. RWR and alligator management staff also participates in wintering waterfowl surveys of the coastal refuges/wildlife management areas, as well as spring aerial surveys for breeding Mottled Ducks.

The future of RWR waterfowl research will focus primarily on Mottled Ducks due to the long-term commitment of the refuge to the research/management of this species. Future topics of interest may be the effects of marsh management on nest choice and nest success of female Mottled Ducks, hybridization genetic studies, and harvest and recovery analysis.

Inventory.—Inventory for waterfowl on RWR is primarily in the form of coastal waterfowl surveys conducted by LDWF. Fall and winter surveys regularly encounter 100,000+ waterfowl with historical highs of approximately 600,000 waterfowl (Palmisano 1969, Appendix 3). Data is currently being compiled for yearly and species comparisons.

Two methods allow RWR staff to assess and inventory marsh status: 1) water level and salinity surveys and 2) vegetative surveys. RWR staff monitors water levels and salinities across the refuge on a weekly and monthly basis; these data are currently being compiled in a master dataset. RWR staff also historically and currently monitors vegetative composition of refuge marshes to determine the impacts of management strategies on vegetative communities. A comparative database on RWR vegetative data does not exist due to the long history of collection and variable methods uses. However, historical data on marsh types and vegetation data are found in O'Neil (1949), with future vegetative monitoring planned with contemporary methods (i.e., digital imaging and radar) in collaboration with U.S. Geological Survey. The refuge also plans to implement integrated staff gauges across the refuge to in the near future to allow a more accurate and consistent measurement of water levels across the refuge.

5.4: Fisheries

Past Research.—Fisheries research has been a significant part of the Rockefeller research program since 1965. Biologists have worked closely in the design and implementation of management strategies with positive benefits to marine organisms. Early projects in the 1960s focused on life history studies of catfish, shrimp, and other marine organisms. Later, several species were screened for aquaculture potential to possibly develop an additional source of

revenue for coastal landowners; this was done in an effort to encourage private landowners to continue managing their property as coastal wetlands.

In 1972, Rockefeller staff initiated a program to reintroduce striped bass (*Morone saxatils*) to southwestern Louisiana. Between 1972 and 2000, over 4.5 million striped bass were raised at RWR and released into local water bodies (Mermentau and Calcasieu rivers; Rockefeller Wildlife Refuge; Toledo Bend Reservoir), which was to assist the Inland Fisheries Division achieve goals of their anadromous striped bass project. Following the striped bass project, the ponds were stocked with Florida-strain largemouth bass (*Micropterus salmoides*) from 2000 to present, with exception of 2005-2007 due to hurricane damage to the ponds. Advanced fingerlings from Rockefeller have been stocked into the Refuge's Superior Canal System as well as Lacassine National Wildlife Refuge, Mermentau River, and the Atchafalaya Basin. Local bass fishermen report excellent catches from Rockefeller waters.

In addition to understanding the impacts of management units on waterfowl, it was equally important to understand the impact of management regimes on marine organisms, with several cooperative studies with LSU and ULL initiated in the late 1980s. Rockefeller staff modified the sampling techniques and continued the study to better understand the relationship under different climate/management scenarios; this study was also important to determine the impacts of Hurricane Rita on the local fisheries communities.

Current Research.—RWR staff is currently collaborating with researchers from LSU Ag-Center with the Gulf killifish (*Fundulus grandis*). Known locally in the fishing community as cocahoe minnows, this is a popular bait species with large aquaculture potential for local landowners due to the small investment and low maintenance. Different grow-out trials will be held in research ponds at RWR to try to help find the most favorable growing conditions, while also promoting its economic potential for the community. Further, fisheries staff is collaborating with researchers from Nicholls State University (Thibodaux, LA) in a demographic study of Alligator gar (*Atractosteus spatula*). There is little is known about the biology of this species, and possibly because of this, it has been listed as Rare, Endangered, or Extirpated in many areas on the periphery of its range (Boschung and Mayden 2004). Though populations in Louisiana seem stable, this collaboration should gain additional information about this one of the largest freshwater fish in North America

Future Research.—Though data currently exists on the public consumptive uses at RWR, as well as a breakdown of percentages of the main three species groups (shrimp, fish, and crabs), there is a need to supplement that data with new creel survey data. National trends show a decrease in hunting and fishing license sales, while there have been major decreases in local population due to hurricane displacement; these could have meaningful impacts on consumptive practices, further justifying the need for additional surveys. New surveys should allow us to establish if there have been any changes in consumptive use since the previous study.

Future research is also needed in developing a sampling and monitoring protocol for freshwater game fish throughout the freshwater marshes of the refuge. As previously mentioned, refuge staff have spent considerable time growing out and stocking Florida-strain largemouth bass (*Micropterus salmoides floridanus*) across RWR freshwater areas. Genetic samples from fish collected would allow better determination of the ratio of stocked Florida-strain largemouth (*M. s. floridanus*) to that of the native largemouth bass (*M. s. salmoides*) in these areas. This information could help in justify the future need (or lack thereof) to continue stocking fish.

As RWR continues to rebuild from the damage done by both hurricanes Rita and Ike, new laboratory facilities will allow more in-depth fisheries research and longer spanning aquaculture studies to be conducted.

Inventory.—RWR currently maintains a large database of monthly fish samples collected over many years across the refuge and within the various marsh management schemes. This data is currently being compiled and organized for data analysis. Future inventory needs include a refuge-wide survey for all game and non-game fish species, similar to Perry (1965).

5.5: Brown Pelican

Research.—The eastern Brown Pelican (*Pelecanus occidentalis*) is the Louisiana state bird, but it had virtually disappeared from the state by 1963 (Williams and Martin 1968), with environmental pesticide contamination and subsequent eggshell thinning as a plausible link to declines (Blus et al. 1979). In 1968, LDWF administration and staff biologists at RWR initiated a program to reintroduce Brown Pelicans back into historical localities (i.e., barrier islands for nesting) in southeastern coastal Louisiana. Since the inception of the program, RWR personnel have monitored the incredibly successful reintroduction via aerial surveys. Since 1971, over 350,000 Brown Pelicans have been produced in Louisiana, with 14 active colonies in 2008 producing ~24,620 fledglings. Another important milestone during the program was the natural expansion of Brown Pelicans to Rabbit Island in southwestern Louisiana (Cameron Parish) in 2003. This colony has grown rapidly in seven years to approximately 2000 individuals with 530 nests produced in 2010. Aerial surveys were discontinued in 2009 due to budgetary constraints and the federal delisting of the Brown Pelican.

In 2010, in response to the Deepwater Horizon Oil Spill, RWR staff participated in translocating oil-rehabilitated Brown Pelicans from southeastern Louisiana to Rabbit Island (Calcasieu Lake, Cameron Parish). Following translocation of 182 pelicans, monitoring was completed over three months following the initial release. Preliminary analyses indicate that in the short-term, the translocations were a success; no mortality of rehabilitated pelicans was documented and translocated pelicans integrated into native pelican groups (Selman et al. submitted manuscript). In the future, RWR refuge staff should continue to monitor this population to assess long-term success of the translocation and also monitor the growing population.

Inventory.—Inventory and population/nesting data on Brown Pelicans is available from the initial reintroduction in 1968 to 2008. These data have been presented in previous publications (Nesbitt et al. 1978, McNease et al. 1984, Holm et al. 2003) and recent data are currently being compiled for data analysis and publication. In 2009, population surveys were discontinued due to budgetary constraints. RWR biologists plan to reinitiate these surveys in the spring 2012 due to the potential long-term impacts on the population and nesting of pelicans following the Deepwater Horizon Oil Spill. Furthermore, if reinitiated, these data will be directly comparable to pre-oil spill data.

5.6: Bald Eagle

Research.—The Bald Eagle (*Haliaeetus leucocephalus*) had a similar fate in the 1950s and 1960s as the Brown Pelican: only four active nests were found in Louisiana between 1954 and 1960. In 1972, only six nests were reported and the decline was attributed primarily to the link

between pesticides and eggshell thinning (Grier 1982); other secondary factors also attributed to its decline, including habitat destruction, disturbance of nests, and poaching. Formal Bald Eagle surveys by RWR staff began in 1984 to determine the distribution/abundance of Bald Eagle populations. By 2008, the Bald Eagle had been taken off the federal endangered species list due to recovered populations and Louisiana maintained 387 active nests which produced 530 fledglings (T. Hess, unpubl. data). Due to budget limitations, formal Bald Eagle surveys by RWR staff were discontinued in 2008.

In the future, research is proposed by RWR staff to work on a Bald Eagle satellite telemetry project to determine the movements, habitat use, and migratory paths of Louisiana Bald Eagles.

Inventory.—Inventory and population/nesting data of Bald Eagles is available from the initial reintroduction in 1984 to 2007. These data are currently being compiled for data analysis and publication.

5.7: Whooping Crane

Historically, both migratory and non-migratory Whooping Cranes inhabited the marshes and ridges of southwest Louisiana's Chenier Plain as well as the Cameron Prairie to the north. In May 1939 the presence of a non-migratory population of Whooping cranes in and around the White Lake Wetland Conservation Area (WLWCA) was confirmed during an aerial survey in which 13 Whooping Cranes, including two juveniles were discovered. A hurricane the following year scattered the birds and only 6 returned to the WLWCA after the storm. The population continued to decline until 1947 when only one crane survived. In March 1950, the lone crane was captured and relocated to the Aransas NWR to be with other Whooping Cranes.

Although the idea of reintroducing whooping cranes to LA had been discussed as early as 1977, an approved plan did not come together until over 30 years later. Prior to developing the whooping crane reintroduction project, RWR staff participated in a study to evaluate Whooping Crane foraging/breeding habitat at White Lake (in collaboration with Song-Ryong "Jackie" Kang and Sammy King, LSU). Then in 2009 LDWF began work on a plan to bring Whooping Cranes back to southwestern Louisiana with Rockefeller staff heavily involved in developing the plan and the project. Prior to the release, RWR staff members were primarily responsible for selecting the reintroduction site, constructing the release pen, assisting with public meetings and presentations in order to gain support from the local community and stakeholders. Further, RWR staff, in collaboration with LSU, was responsible for implementing the project and for the monitoring/caring for released whooping cranes. On 16 February, 10 juvenile Whooping Cranes were transported to the WLWCA release pen and put into a top-netted pen. Later in March, the 10 juveniles were released into a larger 1.5 acre open pen, which gave them the ability to fly in and out of the release pen and explore the surrounding marsh. Pelletized food was provided for the next 8 weeks before being discontinued. The birds are regularly monitored and research on the habitat used by the birds has begun. Research projects will continue to develop from this reintroduction project and RWR staff will participate, and be involved in these, as well as other aspects of this project and overall Whooping Crane recovery.

5.8: Miscellaneous Research

RWR staff have conducted or participated in other research topics including alligator snapping turtle (*Macrochelys temminckii*) dietary studies (Elsey 2006), mineral development compatibility with wildlife, effects of in-situ burning as a cleanup tool for small oil spills, development of capture techniques for rails (Perkins et al. 2010), king rail stable isotope analysis (Perkins 2007), and king/clapper rail differentiation via morphometrics (Perkins et al. 2009).

5.9: Future Research/Inventory Opportunities and Goals

With the recent addition of three new staff biologists at RWR, it is likely that new research avenues will be investigated since each biologist comes with a unique research background (i.e., herpetofaunal species, non-game fish species, and non-game small mammals). Fortunately, many of these areas have not been previously explored by Rockefeller staff biologists and more funding sources, including State Wildlife Grants and Section 6: Endangered Species Funding, are available to research rare, threatened, and endangered species that occur on RWR. Future inventory projects that are needed include 1) surveys for rare shorebirds, particularly for wintering plover species; 2) herpetofaunal inventory of RWR; 3) status surveys of Diamondback Terrapins (*Malaclemys terrapin*) on RWR; 4) status surveys for rare non-game fish species on RWR; and 5) status surveys for bats/non-game mammal species. Additional studies on neotropical migrants and stopover ecology on chenier sites would also be of research interest due to the decline of chenier habitat in southwestern Louisiana. In summation, RWR staff will continue to balance individual research projects and cooperative research projects with other agencies and/or academic institutions.

6. Management Practices

6.1: Habitat/Resource Management

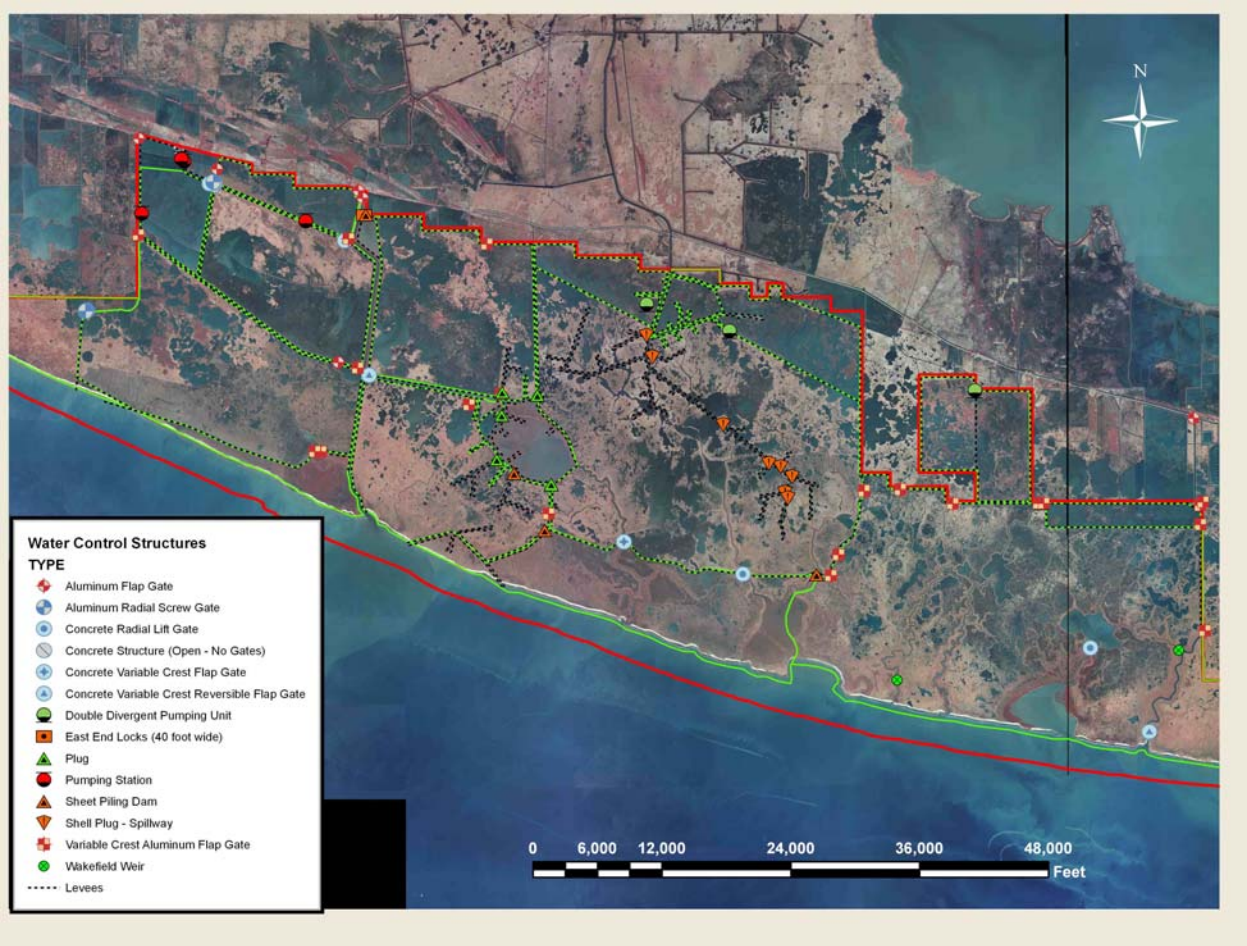

Figure 6: Rockefeller Wildlife Refuge water control structure locations.

Marsh Management.—Today habitat conservation is achieved by water level and salinity manipulation within management units and prescribed marsh burning. The basic management scenario utilized on RWR is to conserve vegetation, stabilize water levels, and manage salinities to encourage growth of submerged aquatic vegetation. In the fresher units, spring and summer draw-downs encourage production of annual emergents. Annual emergent and submerged aquatic plants are prime waterfowl foods.

There are over 40 water control structures and 200 miles of levees maintained by the RWR staff (Figure 6). These levees and structures are strategically placed to form 12 management units which total approximately 43,000 acres of the total 72,650 wetland acres. Management units range in size (740 to over 14,000 acres) and each is classified under one of three major hydrologic management programs (Figure 7). The distinguishing characteristic of each management program is the extent to which water and salinity levels are controlled in response to meteorological conditions. The overall objective of RWR management units is to

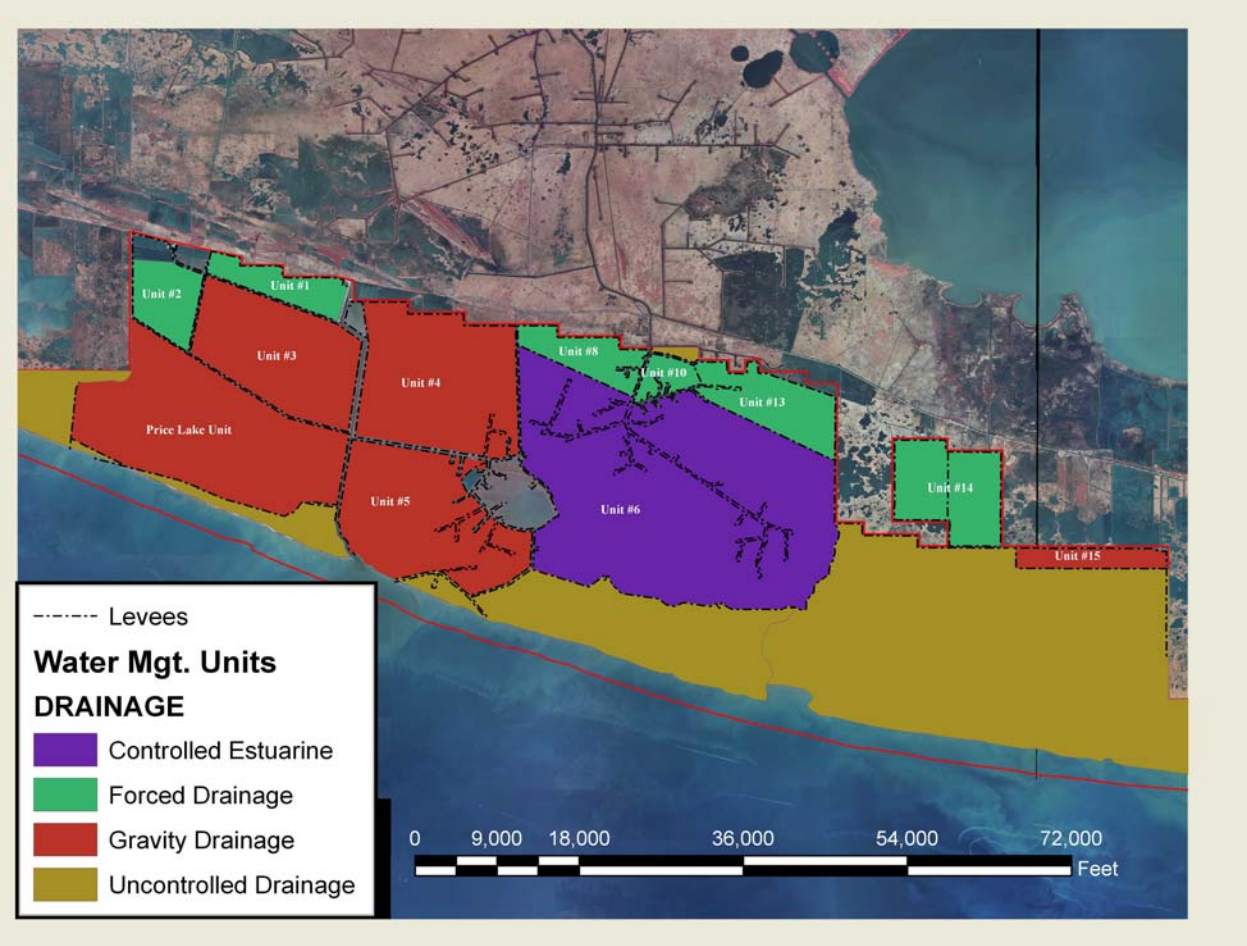

Figure 7: Rockefeller Wildlife Refuge hydrologic management program locations.

to promote specific vegetation communities (i.e., emergent annuals, emergent perennials and aquatics) to support wildlife, especially waterfowl.

Gravity Drainage *(Units 3, 4, 5, 15, Price Lake).*—These five impoundments are located near the chenier ridge and enclose brackish to intermediate marshes. The primary management objective for these units is to control water and salinity for the propagation of important wildlife food plants. Many of the preferred waterfowl foods are herbaceous annual plants that must be reestablished each spring by germination of their seeds. To induce seed germination for the majority of these plants, water levels must be drawn down to near the level of the marsh floor so that a moist, not dry, surface exists. Once germination is achieved and a young stand of annuals is established, it is usually desirable to reflood the unit with a few inches of water to enhance growth and survival. After plant maturity is reached in the fall, the impoundment is allowed to flood further to ensure the availability of foods for wintering waterfowl. The draw-down is initiated in the spring, usually in May, with reflooding scheduled for September. The success of this program requires proper maintenance of the gravity drainage structures (concrete variable crest reversible flap-gates, 36-inch gate culverts and 48-inch marine aluminum flap-gates) and favorable meteorological conditions (Wicker et al. 1983).

Gravity drainage can lower water levels only to the low-tide stage plus additional loss through evaporation. In some years, when heavy rainfall occurs in the spring, complete draw-down is impossible and there is no chance for germination and production of herbaceous

annuals. In such cases, the unit may be maintained as a flooded impoundment with the objective being to produce stands of submergent vegetation such as pond weed (*Potamogeton pusillus*) and widgeongrass (*Ruppia maritima*). Conversely, during periods of drought, there may be insufficient rainfall to reflood the impoundment after germination and establishment of the seed-producing annuals to promote growth and survival. In these instances, it may be necessary to allow brackish water to enter the impoundment through the water control structures. The units under this management are drawn down one year out of three. This is accomplished beginning in February, when stop-logs are removed and the flap-gates are lowered slightly on the structures to begin releasing water. From March through June or July, the structure remains in this draw-down operation mode. Around August the unit is reflooded and stop-logs are added to raise the flap-gates and contain higher water levels. Water is then held at this level for growth of widgeongrass. These management techniques are staggered among the units to produce seed-bearing annuals in some units and aquatic plants in others. In this way, the refuge can provide a food source aimed at the various preferences of the many species of waterfowl throughout most of the wintering season that normally lasts from September through much of March.

For example, Unit 4 is a testament to the success of this type of management program as evident in percent coverage by perennial, annual, and aquatic vegetation. During several years, annual and submerged aquatic plants covered almost 40 percent of the area sampled. The dominant aquatic plant was widgeongrass, and the most abundant annual, due to the normally brackish water conditions present, was dwarf spikerush (*Eleocharis* sp.; Chabreck 1959, 1960b, 1961, 1962, 1963; Chabreck and Joanen 1964, 1965, 1966; Joanen et al. 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974). The leaves, stems, and seeds of both plants are fed upon by waterfowl (Bellrose 1976), and up to 100,000 ducks have been observed in this unit (Ensminger, pers. comm. cited in Wicker et al. 1983). The degree to which the impoundment dries in the spring and summer determines, to a large extent, whether widgeongrass or spikerush is produced. During extremely dry years the production of both annuals and aquatics is low. The impoundment needs to be dewatered approximately every third year to allow consolidation of the bottom in order to reduce turbidity upon reflooding and to encourage widgeongrass production. In years during which water is abundant and widgeongrass production poor, excessive turbidities may cause low productivity. However, because multi-use is emphasized in this unit, less rigid controls of water levels are practiced in order to allow ingress/egress of estuarine aquatic animals such as shrimp and fish.

Refuge biologists monitor postlarval brown and white shrimp recruitment. When high concentrations of postlarvae are discovered in the vicinity of structures, the gates are opened for a short period of time to permit ingress of the postlarval shrimp. Before water levels within the unit begin to rise appreciably, the gates are switched back to the outflow position. Estuarine organisms are able to exit when the flap-gates are discharging at low tide. A report of Davidson and Chabreck (1983) indicated substantial utilization within Unit 4 by brown and white shrimp, blue crab (*Callinectes* sp.), white trout (*Cynoscion arenarius*), black drum (*Pogonias cromis*), Atlantic croaker (*Micropogonias undulatus*), and bay anchovy (*Anchoa mitchilli*). Although more species occurred in the canal outside of Unit 4, usage within the impoundment was substantial for most of the important sport and commercial species. Indications are that Unit 4 is functioning as a viable nursery ground which has, in turn, spawned an enthusiastic cast net fishery for shrimp for local sportsmen (Perry et al. 1993). Perry et al. (1993) reported shrimp production in managed coastal areas of southwest Louisiana to equal approximately 23 lbs./ac., which would total approximately 131,000 pounds for Unit 4. It has been estimated that Unit 4

may produce as much as 300,000 pounds of shrimp in some years (Ensminger, pers. comm. cited in Wicker et al. 1983).

Forced Drainage *(1, 2, 8, 10/13, 14).*—Currently five impoundments are managed with forced drainage. Units under forced drainage management have encircling levees, double divergent, low-lift diesel pumps, and water is controlled on a seasonal basis similar to that practiced under gravity drainage. Forced drainage allows better control of water levels than gravity drainage, but encourages similar plant communities. This is the most expensive management program because of the cost of maintenance and fuel to operate the pumps.

Pumping to remove water begins in a spring month, such as May, and water levels are drawn down during late spring and summer. After annual seed producing plants are well established, water levels are allowed to increase a few inches, thereby maximizing plant growth. Excess water is removed by resuming pumping or, at times, simply by removing stop-logs. During dry years, water can be pumped into the impoundment from the canal system as long as water salinities are not prohibitively high. Reflooding of the impoundment to a depth of 6-9 inches is usually initiated in September to make the mature seed crop available to waterfowl, which begin to arrive during fall migration. In years when spring rains are heavy and it is impossible to dewater the impoundment even with pumping, the unit remains flooded throughout the year for production of widgeongrass or other aquatics.

Controlled Estuarine *(Unit 6).*—Controlled estuarine management is centered around multi-use by both estuarine fisheries species and waterfowl species. The specific objectives are to allow adequate numbers of postlarval shrimp and fish to enter the unit during times of peak abundance and, at the same time, to produce conditions that favor growth of food plants for waterfowl.

A set of 40-foot locks and two radial arm, steel-gated cement structures are also used to manage water levels and salinities in the Unit 6 area of RWR. These three large water control structures on the refuge also impact adjacent privately owned marshes of the Mermentau Basin. Management of these structures mainly strives to relieve flooding and allow metered saltwater introductions, while maintaining sufficient water levels during times of drought.

The controlled and passive estuarine management units are nearer the Gulf of Mexico and contain brackish-to-saline marsh zones as opposed to the lower salinity intermediate-to-fresh marsh zones more common to the forced drainage and gravity drainage units. The major distinction between the passive and controlled estuarine management programs is that under passive management no scheduled effort is expended in achieving management objectives. In the controlled estuarine management unit, large scale control structures, implanted in the levees, can be manipulated on a seasonal basis to permit multi-use of the units by estuarine organisms and wildlife species.

Uncontrolled Drainage.—Approximately 30,000 acres of RWR are considered “unmanaged” by water control structures and/or levees. These areas include southeastern parts of the refuge (mostly in Vermilion Parish), areas south of Unit 6, and areas south and west of Price Lake Unit. Unmanaged areas on RWR consist primarily of brackish/saline marshes with interspersed tidal creeks, which are dominated by oystergrass (*Spartina alterniflora*), saltgrass (*Disticlus spicata*), and black needle rush (*Juncus roemerianus*). These areas are one of the few remaining examples of “pristine” brackish-salt marsh within the Chenier Plain, primarily due to the lack of human modifications (i.e., canals, dredging, levees). This area is important to some species of wintering waterfowl (i.e., Northern Shoveler, Gadwall, Mottled Ducks, Mergansers) and it provides further habitat diversity to the refuge. It also provides optimal habitat to other salt-marsh dependent

species, including Seaside Sparrows (*Ammodramus maritimus*), Clapper Rails (*Rallus longirostris*), and Diamondback Terrapins (*Malaclemys terrapin*; W. Selman, pers. obs.).

6.2: Water Unit Management

Unit 1

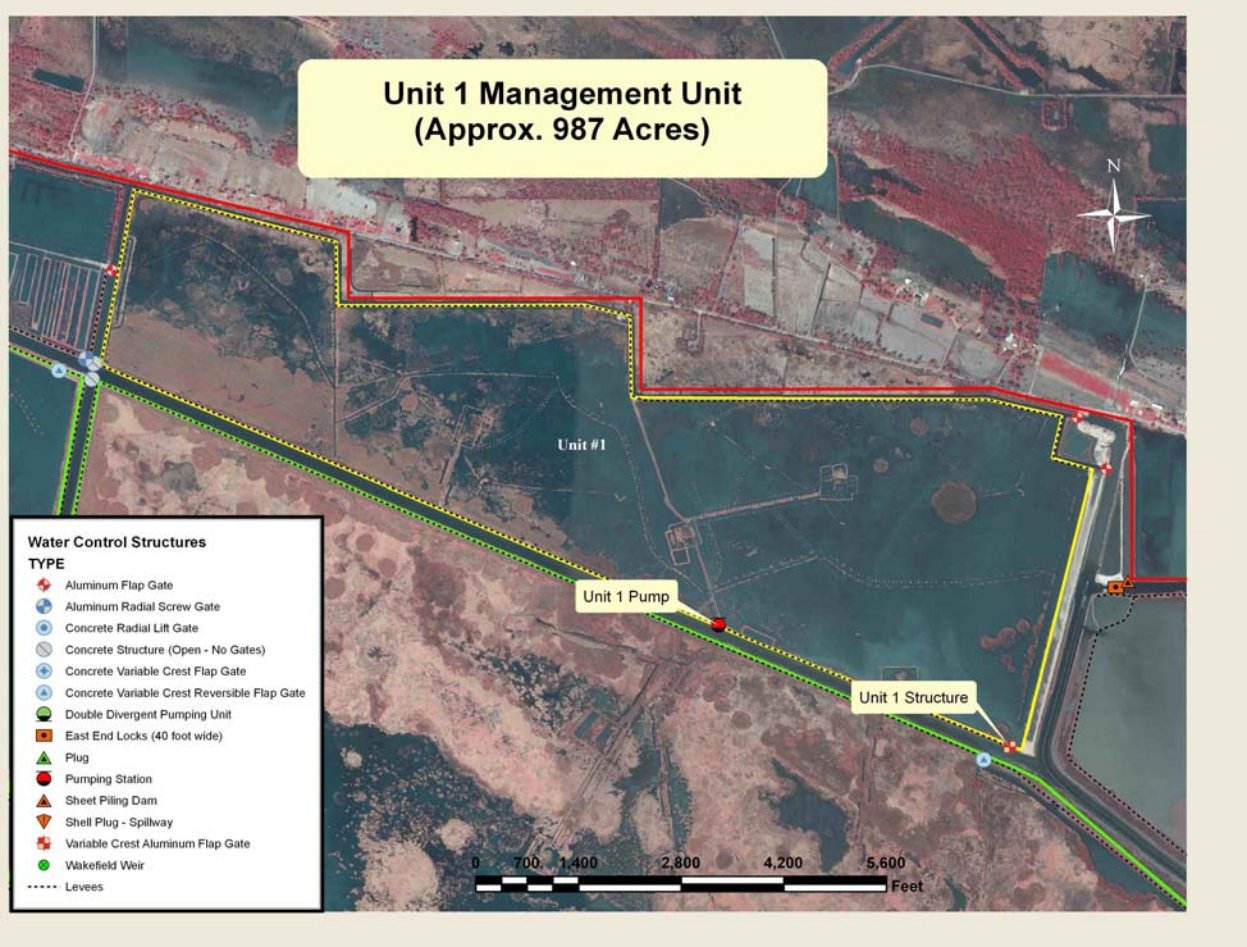

Figure 8: RWR Management Unit 1.

Size – 987 acres **Marsh Type** – Brackish/Intermediate
Water Management – Forced/Gravity Drainage
Pump: 30 inch Lo-lift – This pump is operational and used to remove water from the unit.
Water Control Structure: 1 – 48'' aluminum, stop-log, flap-gated structure
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Repair Structures/Levees

2. Improve Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Maintain desirable land to water ratios
   2. Maintain intermediate/brackish marsh communities
   3. Produce conditions favorable for submerged aquatic vegetation growth
   4. Produce conditions favorable for production of annual emergent vegetation

5. Produce conditions to facilitate feeding

Course of Action:
1. Restore levee elevations
2. May operate flap-gate and add stop-logs to structure in spring and summer to elevate salinity and water levels when necessary to maintain desirable land water ratios
3. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
4. Stop-logs may be set at levels to maintain water levels at or below marsh level to prevent excessive marsh flooding and minimize wind driven wave fetch in open water bodies
5. In late summer, stop-logs may be removed from water control structure to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
6. Pumping may be initiated during flooding periods to rapidly remove excess water
7. In early spring all stop-logs may be removed and pumping activities initiated to expose bare soil for production of annual emergent vegetation when practical or needed

Secondary

Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

Course of Action:
1. Flap of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
2. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
3. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment

Past Management – The unit has been managed since the 1960s. The area has been managed for both annual emergent and submerged aquatic vegetation. Primary annual plants included Walter's millet (*Echinochloa walteri*), sprangletop (*Leptochloa fusca*), and flatsedge (*Cyperus* sp.). Southern naiad (*Najas* sp.) and pondweed (*Potamogeton pusillus*) were present during years when excessive rainfall inhibited the ability to dewater the unit. Forced drainage allowed complete control of water levels during average rainfall periods and promoted the growth of waterfowl foods. Optimum water levels were maintained at six to nine inches in ponds for optimum puddle duck feeding opportunities. This unit has experienced heavy growth of emergent vegetation including wiregrass (*Spartina patens*), bulrush (*Scirpus californicus*), and roseau cane (*Phragmites australis*) over the past 20 years. Very little open water area was available for wintering waterfowl. A decision was made to attempt to reduce the emergent

vegetation coverage within the impoundment and create a 50:50 emergent marsh to open water ratio. The impoundment was drawn down and burned during the fall of 1999. In the spring of 2000 the flap-gate was opened to flood the impoundment with brackish/saline water to set back intermediate marsh succession. Water salinities ranging from 5 ppt to 20 ppt and water depths ranging from 24" to 36" in ponds and approximately 12" over emergent marsh have caused a die-off of wiregrass and bulrush. Widgeon grass (*Ruppia maritima*) has become established in the open water areas, which is attractive to migrating waterfowl and mottled ducks. The flap-gate is opened during the spring of each year and remains open until late summer. Water levels have been kept artificially high during the fall and early winter, but lowered for the remainder of the winter (December, January, and February) for optimum waterfowl utilization. This management scenario continued through February 2005.

Estuarine organism production has been high as a result of these actions. The unit has experienced high production of blue crab (*Callinectes* sp.), brown shrimp (*Penaeus astecus*), and white shrimp (*Pinaeus setiferus*) populations under this management.

Present Management – Satisfactory results were experienced with recent management actions. Waterfowl survey data show waterfowl utilization has improved, and estimates of land to water ratios are nearly optimal. Current plans are to manage this unit for optimum growth of intermediate marsh communities (i.e., *Spartina patens*, *Schoenoplectus americanus*, and *Scirpus californicus*). Salinity and water levels will be maintained at lower levels to encourage production of intermediate emergent marsh plants and submerged aquatic plants. Estuarine organism production will generally be slightly lower during this type of management scenario due to the tighter controls on salinity levels.

Future Management – Operate structures to establish and maintain desirable land to water ratios and maintain optimum water levels for wintering waterfowl

Marsh Burning – Three year burn cycle

Problems – Invading roseau cane is increasingly becoming a problem in the western half of the unit. If allowed to persist it may eventually close in productive waterfowl habitat. Control measures may be implemented in the future to deal with this issue.

Unit 2

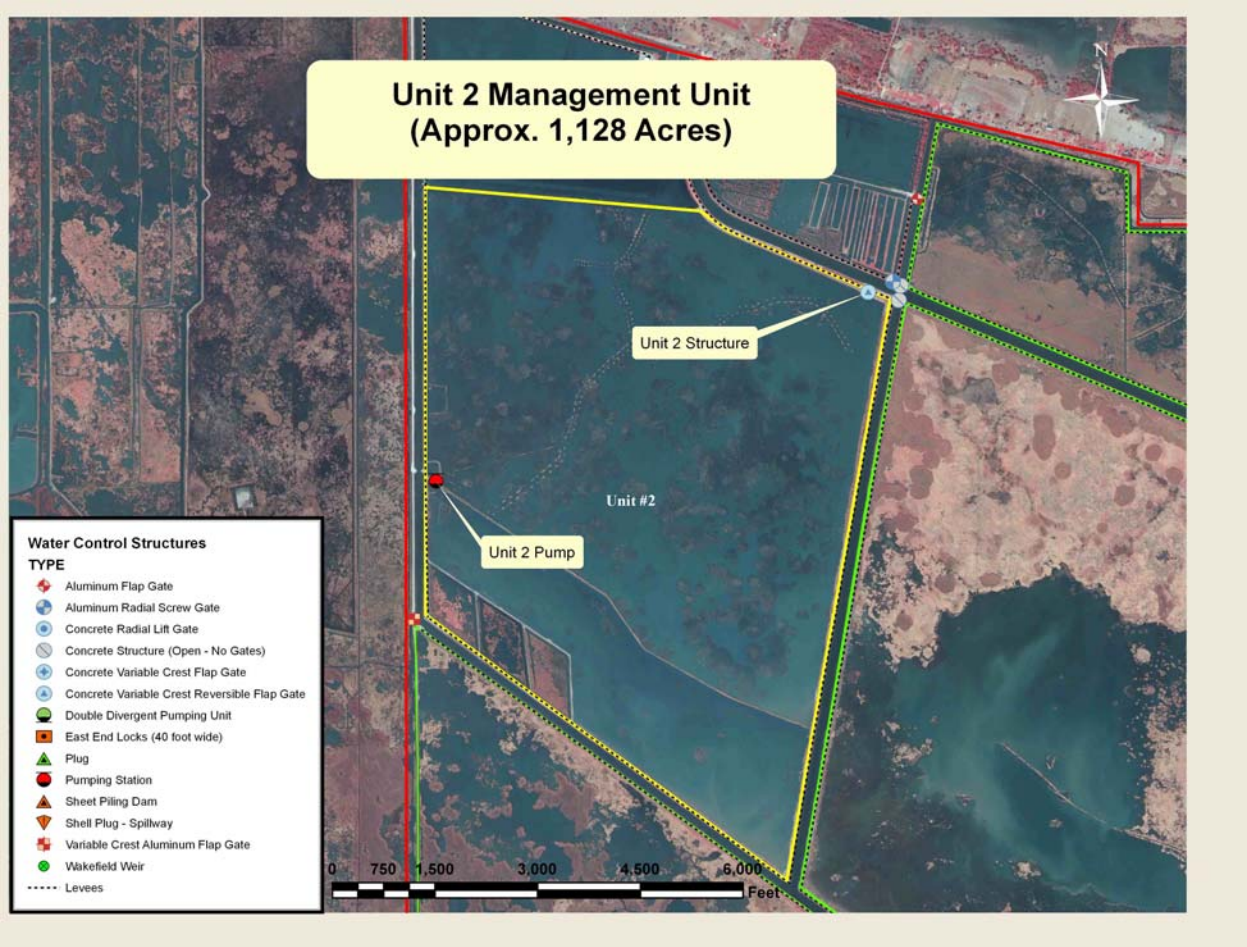

Figure 9: RWR Management Unit 2.

Size – 1,128 acres **Marsh Type** – Brackish
Water Management – Forced/Gravity Drainage
Pump: 30 inch Lo-lift – This pump is operable and used to remove water from the unit.
Water Control Structure: Concrete, variable crest, 3 bay – 4' X 8', structure with reversible aluminum flaps
Management Goals
Primary:

1. Hurricane Rita Recovery
   Strategies: 1. Restore Brackish/Intermediate Vegetation
   2. Repair Structures/Levees

2. Provide Summer Brood and Molting Habitat for Mottled Ducks
   Strategies: 1. Produce conditions to facilitate feeding
   2. Produce conditions favorable for submerged aquatic vegetation growth

3. Improve Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Restore desirable land to water ratios

2. Produce conditions to facilitate feeding
3. Maintain brackish marsh communities
4. Produce conditions favorable for submerged aquatic vegetation growth
5. Produce conditions favorable for production of annual emergent vegetation

Course of Action:
1. In early spring, all stop-logs may be removed and pumping activities initiated to expose bare soil for production of annual emergent vegetation when practical or needed
2. Flap gates may be positioned outward to control salinity
3. Stop logs may be set at levels to maintain water levels at or below marsh level to prevent excessive marsh inundation and minimize wind driven wave fetch in open water bodies
4. In late summer, stop-logs may be removed from water control structure to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
5. Pumping may be initiated during flooding periods to rapidly remove excess water

Secondary

Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

Course of Action:
1. Flap of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
2. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
3. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment

Past Management – This area was made into a management unit by construction of a south levee in 1963 and 24" pump in 1965. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, and flatsedge. Southern naiad and pondweed were present during years when excessive rainfall inhibited the ability to dewater the unit. Forced drainage allowed complete control of water levels during average rainfall periods and promoted the growth of waterfowl foods. Optimum water levels were maintained at six to nine inches in ponds for optimum puddle duck feeding opportunities. Generally, the area was dewatered by gravity flow and completed by forced drainage (pumping). The unit grew up with emergent vegetation, primarily bulrush, over the past 20 years. The area was burned during the fall of 2001 and flooded with brackish/saline water to set back intermediate marsh succession. Water depths after the burn ranged from 24" to 32" in ponds and

approximately 12” over emergent marsh, which has caused a die-off of wiregrass and bulrush. Water depth was kept high for approximately one year after the burn. Water levels have been maintained at 12” or less and water salinities less than 10 ppt during 2002/2003 to encourage dense stands of widgeon grass which is attractive to migrating waterfowl and mottled ducks.

Present Management – Current management is directed toward reestablishing emergent vegetation within the impoundment, but management is beginning to be directed toward increasing water levels for submerged aquatic vegetation due to higher levels of *Spartina alterniflora*.

Future Management – Operate structures to establish and maintain desirable land to water ratios and maintain optimum water levels for wintering waterfowl

Marsh Burning – As needed

Problems – Increased levels of *Spartina alterniflora* have occurred following previous management decisions and should be monitored for excessive encroachment in the unit.

Unit 3

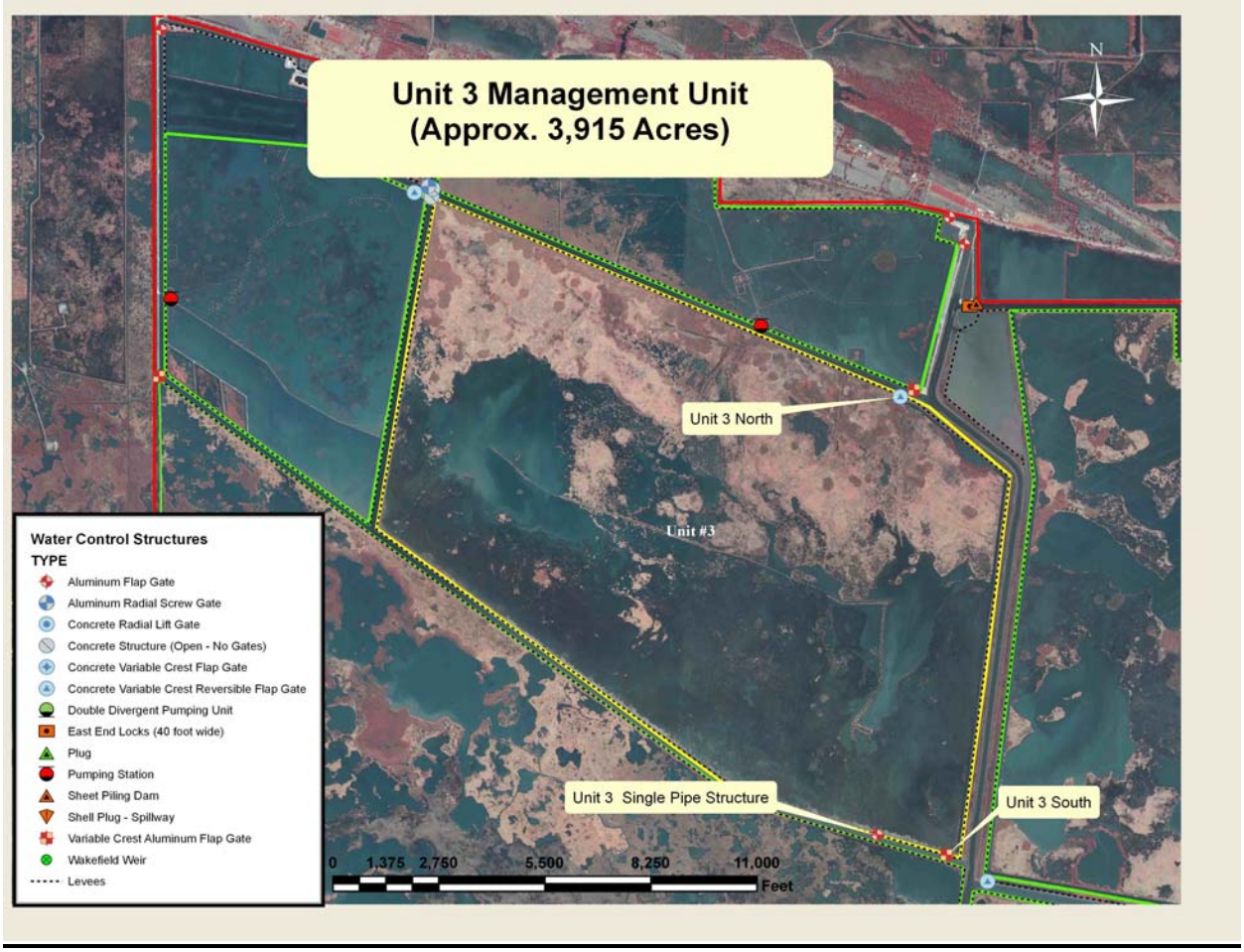

Figure 10: RWR Management Unit 3.

Size – 3,915 acres **Marsh Type** – Brackish
Water Management – Gravity Drainage/Controlled Estuarine Management
Water Control Structures – Concrete, variable crest, 5 bay – 4' X 8', structure with reversible aluminum flaps; 3 – pipe, aluminum, stop-log, flap-gate structure (not operational, continuous outgoing flow); 2 – pipe, aluminum, stop-log, flap-gate structure (plugged)
Management Goals
Primary:

1. Hurricane Rita Recovery
   Strategies: 1. Repair Structures/Levees

2. Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Maintain desirable land to water ratios
   2. Maintain intermediate/brackish marsh communities
   3. Produce conditions favorable for submerged aquatic vegetation growth
   4. Produce conditions favorable for production of annual emergent vegetation

5. Produce conditions to facilitate feeding

Course of Action:
1. Conduct necessary repairs to flap-gate structures
2. Restore levee elevations
3. Maintain flaps in a closed position to hold freshwater and reduce salinities within impoundment
4. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
5. Stop-logs may be set to maintain water levels at or below marsh level to prevent excessive marsh flooding and minimize wind driven wave fetch in open water bodies
6. In late summer, stop-logs may be removed from water control structures to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
7. Flap gates maintained in a closed or an out flow position to control salinity levels (unless briefly opened during peak migrations of estuarine organisms)
8. In early spring, all stop-logs may be removed to achieve a draw down and expose bare soil for production of annual emergent vegetation when practical or needed

Secondary

Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

Course of Action:
1. Flap of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
2. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
3. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment

Past Management – This area has been under management since the mid-1950s with the construction of levees and gated culverts. These were replaced with a concrete structure in 1967. In the mid-1980s, additional structures were constructed of corrugated pipe with flapgates and stoplogs on the southern end of the impoundment. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, spikerush (*Eleocharis* sp.) and flatsedge. Southern naiad, widgeongrass, and pondweed have been the predominant plant species within the unit. Target water levels were 6" to 12" in ponds. These levels were difficult to maintain due to the large unit size. Large numbers of waterfowl have utilized the area over the past three decades.

Present Management – (Limited) Three-pipe structure located on south-east side of unit does not function properly, because the variable crest weir board ends of the pipes were torn off during Hurricane Rita. The flap gates are functioning properly and there is control of water salinities within the impoundment with the northern structure.

Future Management – Operate structures to establish and maintain desirable land to water ratios and maintain optimum water levels for wintering waterfowl

Marsh Burning – Three year burn cycle

Problems – The three pipe structure needs to be replaced on the south end of the unit.

Unit 4

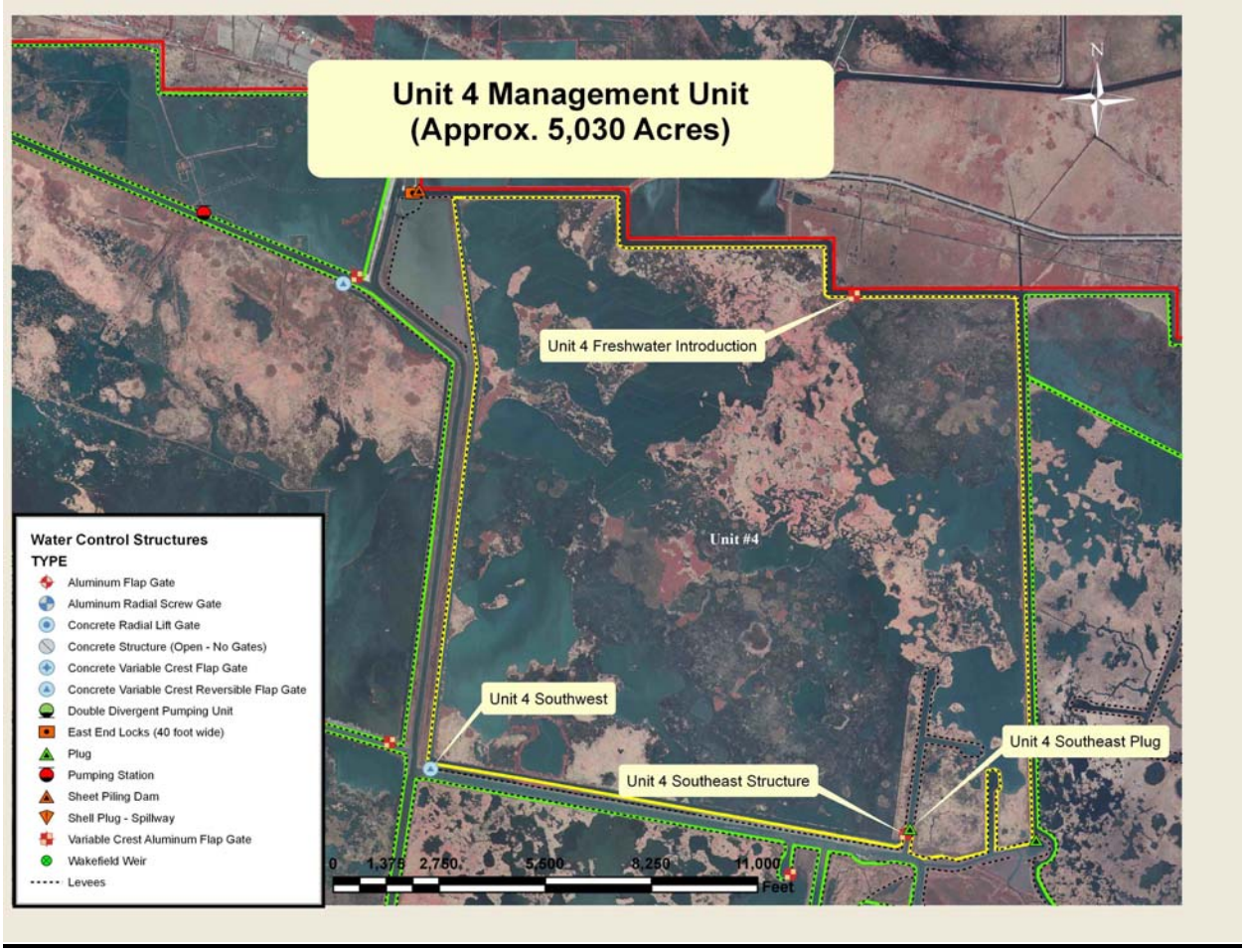

Figure 11: RWR Management Unit 4.

Size – 5,030 acres **Marsh Type** – East 2/3, intermediate; West 1/3, brackish
Water Management – Gravity Drainage/Controlled Estuarine Management
Water Control Structures – Concrete, variable crest, 7 bay – 4' X 8', structure with reversible aluminum flaps. Four–pipe, 48 inch, aluminum, stop-log, flap-gate structure. Two-pipe, aluminum, stop-log, flap-gate fresh water introduction structure.
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Restore Brackish/Intermediate Vegetation
   2. Repair Structures/Levees

2. Increase Emergent Vegetative Communities
   Strategies: 1. Reduce salinities to promote submerged aquatic vegetation
   2. Implement restoration projects that promote emergent vegetation
   3. Reduce shoreline erosion

3. Winter Waterfowl Habitat and Food Availability

Strategies:
1. Establish desirable land to water ratios
2. Restore intermediate/brackish marsh communities
3. Produce conditions favorable for submerged aquatic vegetation growth
4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

Course of Action:
1. Conduct necessary repairs to flap-gate structures
2. Restore levee elevations
3. Maintain flaps in a closed position to hold freshwater and reduce salinities within impoundment
4. Set logs on freshwater introduction structure to provide maximum flow into unit
5. Restore vegetation on terraces
6. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
7. Stop-logs may be set to maintain water levels at or below marsh level to prevent excessive marsh flooding and minimize wind driven wave fetch in open water bodies
8. In late summer, stop-logs may be removed from water control structures to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
9. Flap gates maintained in a closed or an out flow position to control salinity levels (unless briefly opened during peak migrations of estuarine organisms)
10. In early spring, all stop-logs may be removed to achieve a draw down and expose bare soil for production of annual emergent vegetation when practical or needed
11. Terrace construction or dedicated use of dredged material to create emergent marsh and reduce wave fetch in open water areas

Secondary

Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

Course of Action:
1. Flap of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
2. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
3. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment

Past Management - The unit has been managed since the mid-1950s. The unit originally had gated culverts for water management. This was replaced by a concrete structure in 1967 and flapgate stoplog structures in 1980s and 1990s. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, spikerush and flatsedge. Southern naiad, widgeongrass, and pondweed have been the predominant plant species within the unit. Target water levels were 6" to 12" in ponds. These levels were difficult to maintain due to the large unit size. During normal to high rainfall periods pond depths ranged from 18" to 30". The marsh was allowed to dry and produced annual plants during drought periods. Large numbers of waterfowl have utilized the area over the past three decades.

Historically, the flap-gated structures have been opened to allow shrimp, crab, and larval fish access during peak migration periods. This unit has been a high use recreational area.

A fresh water introduction structure was installed in the north levee in the 1980s. The structure is used to divert fresh water from the Superior System into the unit to promote plant species diversity and maintain an intermediate marsh type.

Present Management - Water control structures are set to evacuate water from the area during most of the annual cycle and the northern structures allow continuous freshwater flow for submerged aquatic vegetation/lowering salinity levels. The majority of stop-logs are removed from the structures to facilitate full water flow at low tide. This action promotes the growth of annual vegetation on higher marsh areas and submerged aquatics in ponds which provide excellent habitat for mottled ducks and wintering waterfowl. Optimum water levels are 6" to 12" in ponds, but water levels range from 18" to 24" due to the large area draining through two structures. Approximately 50,000 feet of terraces were constructed and planted with oystergrass (*Spartina alterniflora*), but almost completely destroyed by Hurricanes Rita and Ike.

Future Management - The area will continue to be managed for wintering waterfowl, and estuarine organisms. Target water levels will continue to be 6" to 12" in ponds. The area will be subjected to a spring/summer drawdown if drought conditions occur to consolidate bottom sediments which will promote the growth of annual plants and aquatic vegetation upon reflooding. Plans are currently being developed to reestablish terraces or other plantings to control wave erosion.

The flap-gated structures will continue to be opened to allow shrimp, crab, and larval fish access during peak migration periods. This unit continues to be a high use recreational area.

Marsh Burning – Three year burn cycle

Problems – It is difficult to maintain marsh pond water levels at 6" to 12". Water control structures will be operated at full outflow capacity to maintain low water levels within the management unit.

Unit 5

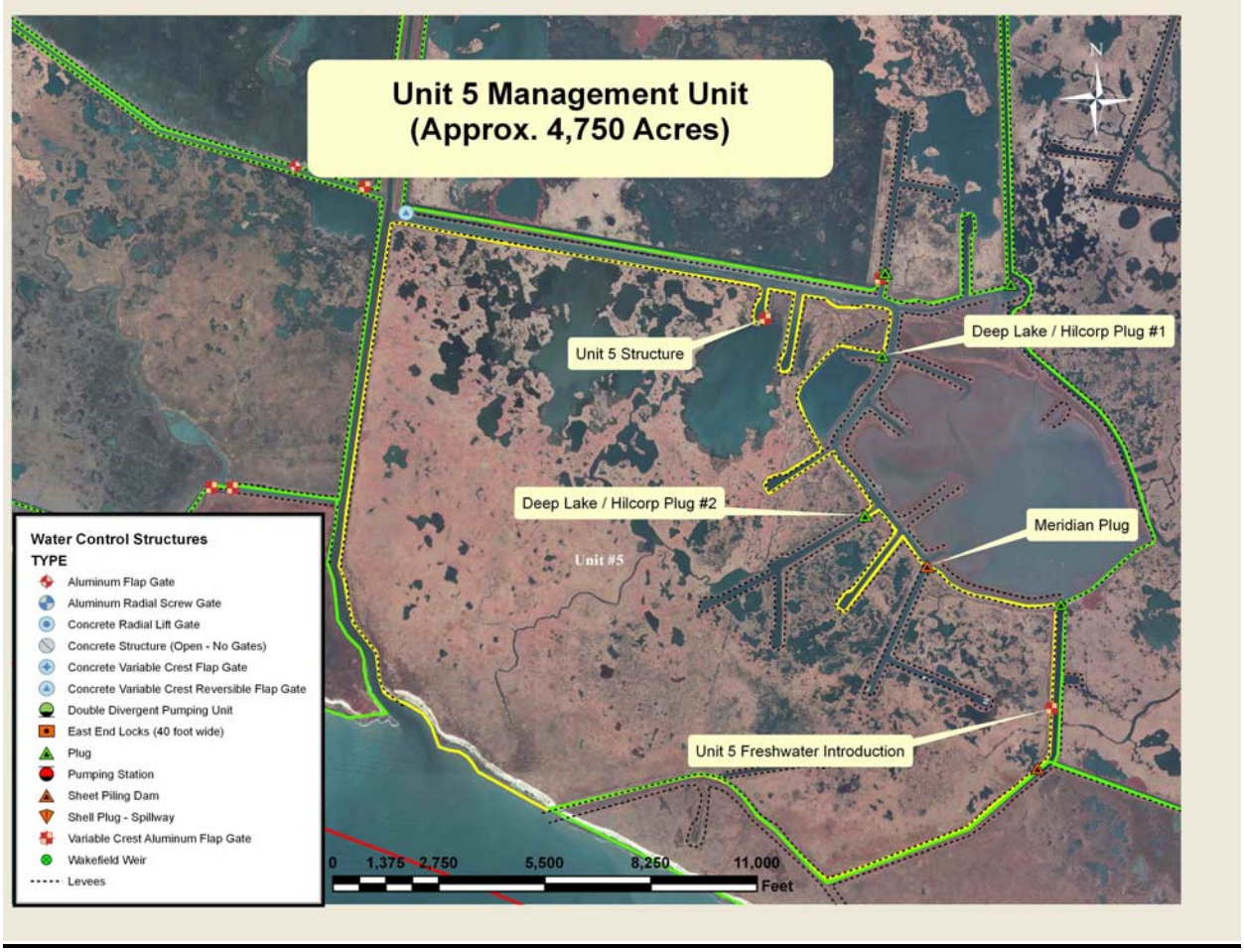

Figure 12: RWR Management Unit 5.

Size – 4,750 **Marsh Type** – Brackish
Water Management – Gravity Drainage/Controlled Estuarine Management
Water Control Structures - 4 – pipe, aluminum, stop-log, flap-gate structure. 1-pipe, aluminum, stop-log, flap-gate fresh water introduction structure.
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Restore Brackish Vegetation

2. Maintain Emergent Vegetative Communities
   Strategies: 1. Maintain salinities which promote healthy emergent and submerged aquatic vegetation
   2. Manage water levels to achieve a healthy brackish marsh
   3. Reduce shoreline erosion

3. Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods
2. Produce conditions favorable for survival and growth of juvenile estuarine organisms

Course of Action:
1. Conduct necessary repairs to flap-gate structures
2. Restore levee elevations
3. Flaps of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
4. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
5. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment
6. Stop-logs may be set to maintain water levels at or below marsh level to prevent excessive marsh flooding and minimize wind driven wave fetch in open water bodies

Secondary

Winter Waterfowl Habitat and Food Availability

Strategies:
1. Maintain/improve desirable land to water ratios
2. Maintain brackish marsh communities
3. Produce conditions favorable for submerged aquatic vegetation growth
4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

Course of Action:
1. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
2. In late summer, stop-logs may be removed from water control structures to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
3. Flap gates maintained in a closed or an out flow position to control salinity levels
4. In early spring, all stop-logs may be removed to achieve a draw down and expose bare soil for production of annual emergent vegetation when practical or needed
5. Terrace construction or dedicated use of dredged material to create emergent marsh and reduce wave fetch in open water areas

Past Management - The unit has been managed since the early 1960s. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, spikerush and flatsedge. Southern naiad, widgeongrass, and pondweed have been the predominant plant species within the unit. Target water levels were 6" to 12" in ponds. These levels were difficult to maintain due to the large unit size. During normal to high rainfall periods pond depths ranged from 18" to 30". The marsh was allowed to dry and produced

annual plants during drought periods. Large numbers of waterfowl have utilized the area over the past three decades. A 6 foot wide, lift – gate structure was used during the 1960s, 1970s, and 1980s to manage water levels and salinities and allow boat access to the unit.

Historically, the flap-gated structures have been opened to allow shrimp, crab, and larval fish access during peak migration periods. This unit has been a high use recreational area.

A fresh water introduction structure was installed in the east levee in the 1980s. The structure is used to divert freshwater from the Superior System into the unit to promote plant species diversity by reducing marsh water salinities.

Present Management – Structure is operated to maintain optimum water levels within impoundment during specific seasons. The flap-gate structure continues to be opened to allow shrimp, crab, and larval fish access during peak migration periods.

Future Management - The area will continue to be managed for wintering waterfowl, and estuarine organisms. Target water levels will continue to be 6" to 12" in ponds. The area will be subjected to a spring/summer drawdown if drought conditions occur to consolidate bottom sediments which will promote the growth of annual plants and aquatic vegetation upon reflooding.

Marsh Burning – Three year burn cycle

Problems –The south end of the unit is bordered by the Gulf of Mexico. High tides preceding cold fronts, tropical storms, and hurricanes overtop the beach rim and flood the unit with saline water. Also, the southern border of the unit is losing 35' to 40' per year due to Gulf of Mexico shoreline erosion. Gulf of Mexico shoreline erosion could compromise management capabilities in the future. In the future, the washout of flap-gate structure needs to be remedied. Two levee gaps need to be filled on oil-field spur canals (on the northeast side of the unit) to prevent excessive saltwater encroachment into the unit.

Price Lake

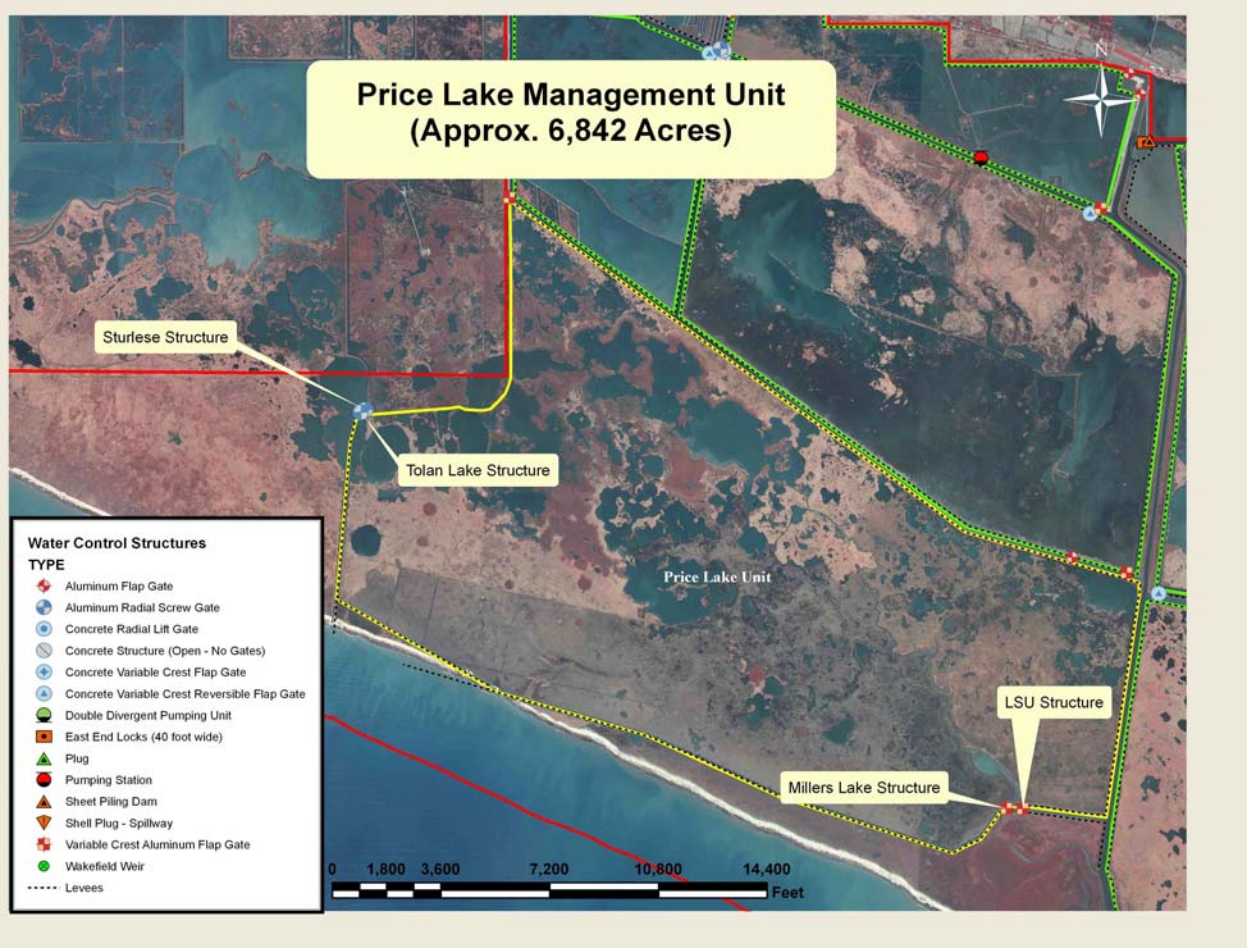

Figure 13: RWR Price Lake Management Unit.

Size – 6,842 acres **Marsh Type** – Brackish
Water Management – Gravity Drainage
Water Control Structures – Two, aluminum, 48", 5 – pipe structures (on Miller's Lake structure, 2 of 5 pipes are plugged). Each structure has 4, stop-log, flap-gate pipes and a 48" pipe with an open ended inlet and a screw gate on the outlet. One, aluminum, 48", 4-pipe, open end flow thru structure with 4 screw gates connect Price Lake with Tolan Lake.
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1.Repair Structures/Levees

2. Maintain Emergent Vegetative Communities
   Strategies: 1. Maintain salinities which promote healthy emergent and submerged aquatic vegetation

2. Manage water levels to achieve a healthy brackish marsh
3. Reduce shoreline erosion

3. Winter Waterfowl Habitat and Food Availability

Strategies:
1. Maintain/improve current land to water ratio
2. Maintain brackish marsh communities
3. Produce conditions favorable for submerged aquatic vegetation growth
4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

4. Improve Water Quality

Strategies:
1. Increase flow of water into and out of impoundment
2. Improve water movement throughout impoundment

Course of Action:
1. Conduct necessary repairs to flap-gate structures
2. Restore levee elevations
3. Maintain flaps in a closed position to hold freshwater and reduce salinities within impoundment
4. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
5. In late summer, stop-logs may be removed from water control structures to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
6. Flap gates maintained in a closed or an out flow position to control salinity levels
7. In early spring, all stop-logs may be removed to achieve a draw down and expose bare soil for production of annual emergent vegetation when practical or needed
8. Maintain screw gate on east structure in the open position to allow controlled influx of nutrient and oxygen rich waters
9. Control *Phragmites* sp. stands to improve water movement within impoundment
10. Develop plans to add additional control structures to manipulate water within the impoundment

Secondary

Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

Course of Action:
1. Flap of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
2. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
3. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment.

Past Management - The unit has been managed since the 1940s. Earthen plugs were placed in main tributaries to maintain adequate water in the marsh for wintering waterfowl and access for trapping. Earthen plugs were replaced by Wakefield weirs in 1967, with weir crests set at 6 inches below marsh level. Weirs promoted the growth of aquatic vegetation, primarily widgeongrass. Target water levels were 6" to 12" in ponds. These levels were difficult to maintain due to the large unit size. During normal to high rainfall periods pond depths ranged from 18" to 30". The marsh was allowed to dry and produced annual plants during drought periods. Large numbers of waterfowl have utilized the area over the past four decades.

Historically, the flap-gated structures have been opened to allow shrimp, crab, and larval fish access during peak migration periods. This unit has been a high use recreational area.

Present Management - Water control structures are set to evacuate water from the area during most of the annual cycle. Due to the large size of the unit, the majority of stop-logs are removed from the structures to facilitate full water flow at low tide. This action promotes the growth of annual vegetation on higher marsh areas and submerged aquatics in ponds which provide excellent habitat for Mottled Ducks and wintering waterfowl. Optimum water levels are 6" to 12" in ponds, but water levels generally range from 18" to 24" due to the large area draining through two structures. The two structures in the southeast corner of the unit have one 48 inch culvert fitted with a screw-type sluice gate. These pipes are opened periodically throughout the annual cycle to facilitate estuarine organism access. The four pipe screw gate structure on the western border of the unit is used to allow water flow from Tolan Lake/Hog Bayou into Price Lake. The structure allows historic flows to enter Price Lake during normal periods and serves as a flood control structure during flood events. The unit continues to be a high use recreational area.

Future Management - The area will continue to be managed for wintering waterfowl and estuarine organisms. Target water levels will continue to be 6" to 12" in ponds. The area will be subjected to a spring/summer drawdown if drought conditions occur to consolidate bottom sediments which will promote the growth of annual plants and aquatic vegetation upon reflooding. Historic water flow from Tolan Lake/Hog Bayou into Price Lake will continue to promote SAV growth and estuarine organism access.

Marsh Burning – Three year burn cycle

Problems – It is difficult to maintain marsh pond water levels at 6" to 12". Water control structures will be operated at full outflow capacity to maintain low water levels within the management unit. Roseau cane is invading the area and is beginning to encroach on high quality

open water waterfowl habitat and will likely be difficult to control. The south end of the unit is bordered by the Gulf of Mexico. High tides preceding cold fronts, tropical storms, and hurricanes overtop the beach rim and flood the unit with saline water. The southern border of the unit is losing 35' to 40' per year due to Gulf of Mexico shoreline erosion; some form of future beach stabilization will reduce this persistent problem. Gulf of Mexico shoreline erosion could compromise management capabilities in the future.

Unit 6

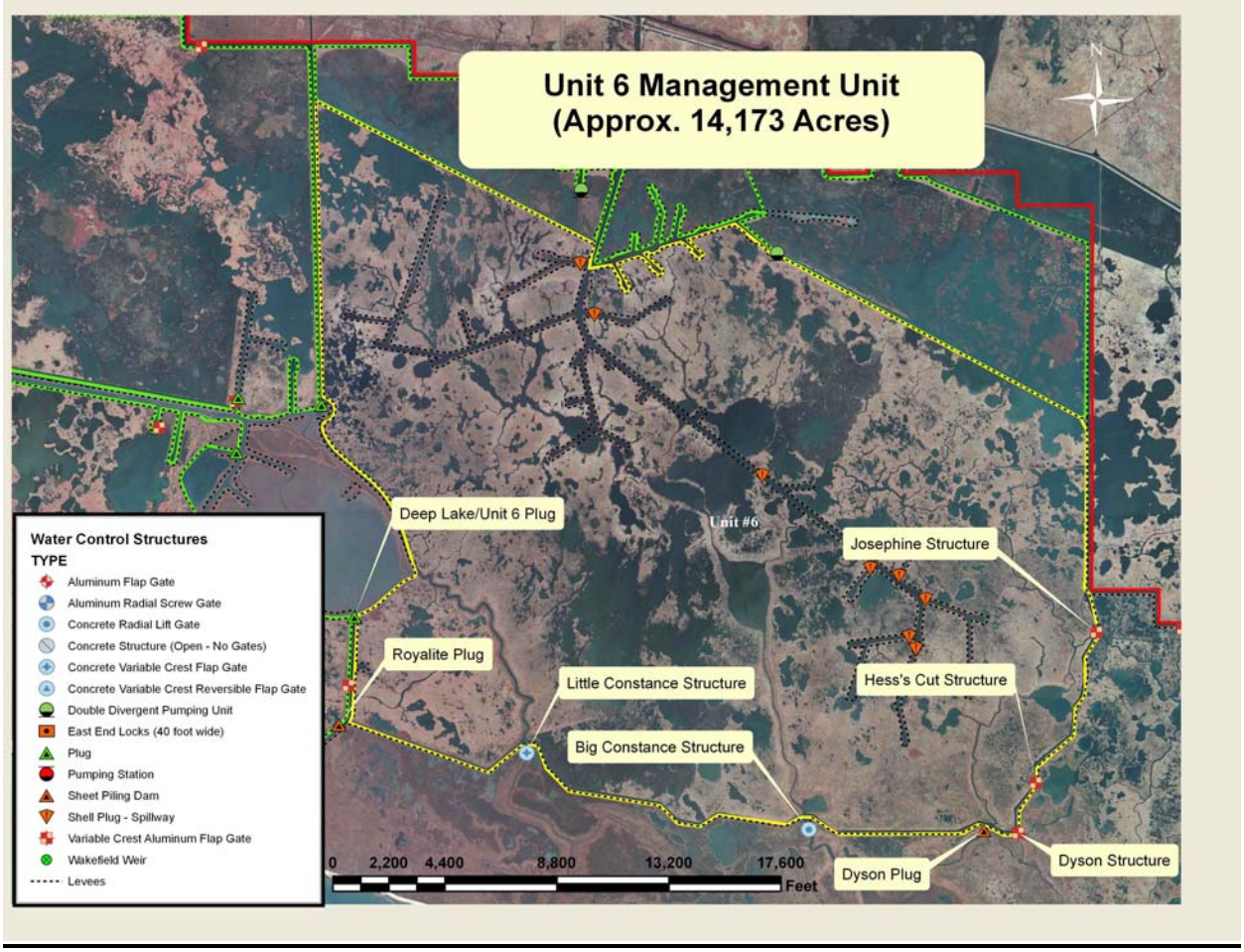

Figure 14: RWR Management Unit 6.

Size – 14,173 **Marsh Type** – Intermediate
Water Management – Controlled Estuarine
Water Control Structures – East End Locks: 40 foot X 8 foot hydraulic lock; Big Constance: Cement, 3 bay, 10 foot X 10 foot, stop-log, flap-gate structure; Little Constance: Cement, 3 bay, 10 foot X 10 foot, flap-gate stop-log; Josephine: Four–pipe, 48 inch, aluminum, stop-log, flap-gate structure; Hess's Cut Structure: 4 pipe, 48 inch, stop-log, flap-gate structure; Dyson: Four–pipe, 48 inch, aluminum, stop-log, flap-gate structure; Fresh Water Introduction Structure: Two–pipe, 48 inch, aluminum, stop-log, flap-gate structure; Dyson, Sheet Pile Dam; Royalite, Sheet Pile Dam.
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Restore Intermediate/Brackish Vegetation
   2. Repair Structures/Levees

2. Maintain Emergent Vegetative Communities

Strategies: 1. Maintain salinities which promote healthy emergent and submerged aquatic vegetation.
2. Implement restoration projects that promote emergent vegetation
3. Reduce shoreline erosion

3. Maintain Healthy Alligator Nesting Habitat

Strategies: 1. Produce conditions favorable to the production of wiregrass
2. Maintain water levels at optimum levels during the nesting season

Course of Action: 1. Conduct necessary repairs to flap-gate structures
2. Restore levee elevations on southern end of unit
3. Maintain flaps in a closed position to hold freshwater and reduce salinities within impoundment
4. Stop-logs may be set at levels to maintain water levels at or below marsh level to prevent excessive marsh flooding and minimize wind driven wave fetch in open water bodies.
5. Add or remove stop-logs in structures as necessary to provide optimum waters during alligator nesting season (May through August)
6. Operate control structures to maintain current isohaline lines and production of wiregrass

Secondary

1. Winter Waterfowl Habitat and Food Availability

Strategies: 1. Establish optimum land to water ratio
2. Maintain intermediate/brackish marsh communities
3. Produce conditions favorable for submerged aquatic vegetation growth
4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

2. Maintain or Improve Estuarine Organism Production

Strategies: 1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

3. Maintain or Improve Freshwater Fishery Production

Strategies: 1. Continue supplemental stocking of large-mouth bass
2. Produce optimum water conditions during the spawning season

Course of Actions: 1. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation

2. In late summer, stop-logs may be removed from water control structures to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks.
3. Flap gates maintained in a closed or an outflow position to control salinity levels (unless briefly opened during peak migrations of estuarine organisms).
4. In early spring, all stop-logs may be removed to achieve a draw down and expose bare soil for production of annual emergent vegetation when practical or needed
5. Flaps of control structures may be opened during peak spring migration periods to allow ingress of estuarine organisms
6. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
7. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment

Past Management – The unit has been managed since the early 1960s. Water control structures were built to stop saltwater intrusion into the Mermentau Basin. The primary regional water resource management goals are to provide an adequate freshwater supply for rice irrigation and maintain adequate water levels for barge shipping interests. The area has been managed as an intermediate/brackish marsh.

Present Management – Refuge personnel closely monitor water levels and attempt to maintain regional water levels at 0.8-1.0 NAVD, since Rockefeller structures directly affect approximately 100,000 acres south of Grand Lake. Structures are operated to maintain Rockefeller marshes south of Super Bridge as intermediate/brackish with water salinities less than 10 ppt at the Superior Bridge. Refuge personnel have concluded that this scenario does not compromise rice irrigation goals to the north. Grand Lake water salinities must remain below 64 grains/gallon for rice irrigation.

Pond water levels generally range in depth from 8 to 20 inches. The area produces an abundance of SAVs which includes: Eurasian watermilfoil (*Myriophyllum spicatum*), southern naiad, pondweed, and widgeongrass. Wild millet, sprangletop, and nutgrass are present in emergent marsh during drought periods.

Florida Largemouth Bass have been introduced into the area for the past three years. Water salinities are generally maintained at <5 ppt during the spring spawning period to promote reproduction.

Structures are opened to allow ingress/egress of estuarine organisms as long as management goals are not compromised.

Future Management – Same as Present Management and also includes excavation of bayous for increased drainage.

Marsh Burning – Approximately 1/3 of the unit is burned annually

Problems – The major problem with Unit 6 is drastic water level fluctuations over short time periods. Over the years, properties in the northern portion of the Mermentau Basin have improved drainage. Canals were deepened and straightened with floodwaters draining on the lower basin quicker than the narrow window of drainage opportunity offered by moderate and low tides. During the last decade over 1.5 feet of water has covered the normally vegetated marsh five times, twice exceeding depths of two feet. In all instances, it took 2.5 to 3 months for waters to recede. A direct impact was ponding of 13,500 acres of refuge in the Superior Canal System and thousands of acres of neighboring properties. A proposal to construct a 60' spillway in the vicinity of Deep Lake has been submitted for Capital Outlay funding. This structure would be operated to evacuate large volumes of water from the basin during flood periods. An infrastructure of canals already exists therefore lessening damage to marsh. Engineers have advised that source and outflow canals are more than adequate to handle the volume of water passing over the structure.

Unit 8

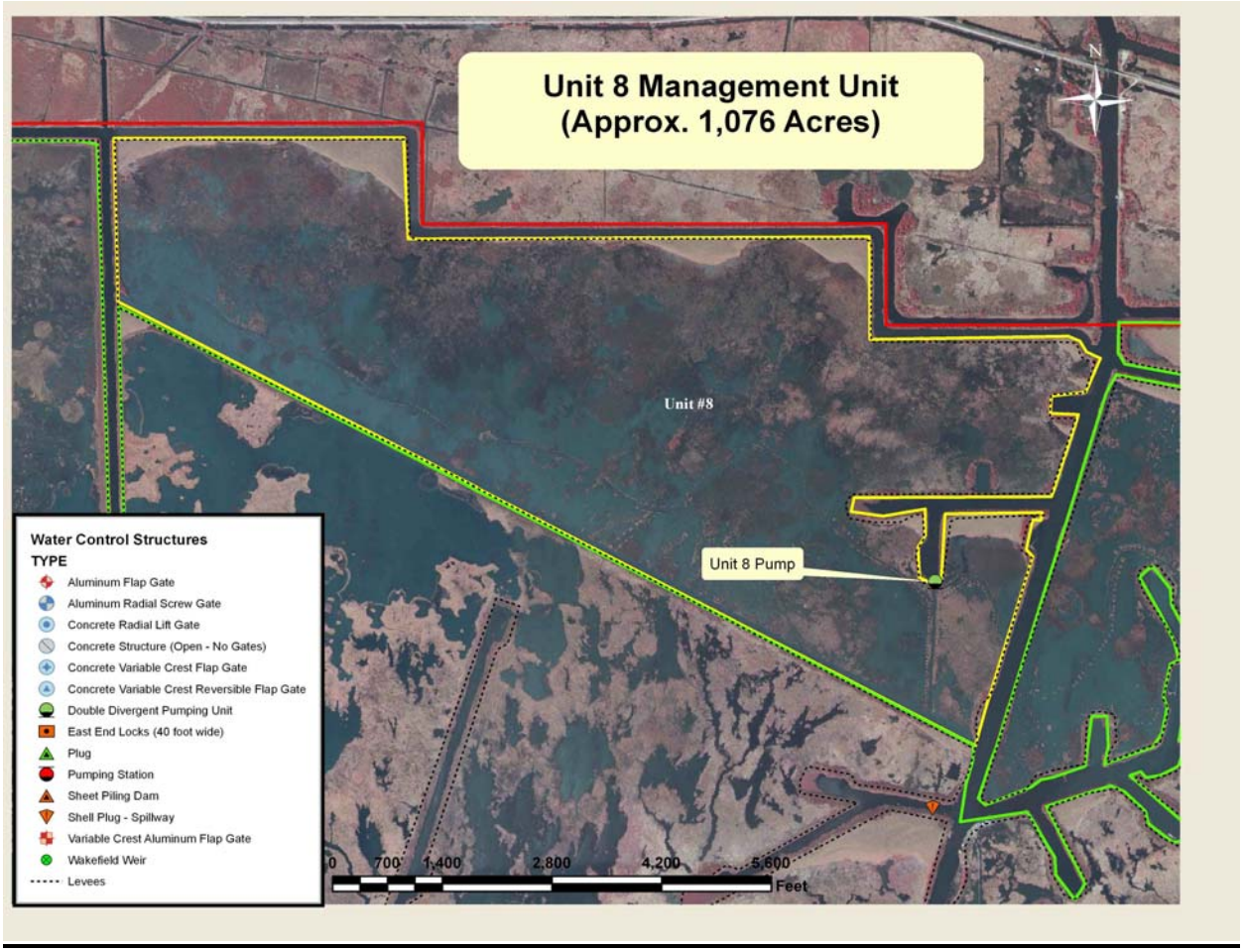

Figure 15: RWR Management Unit 8.

Size – 1,076 acres **Marsh Type** – Intermediate
Water Management – Forced/Gravity Drainage
Pump – 30 inch Lo-lift, Double Divergent Pumping Unit – This pump is operable and can be used to remove water from the unit or pump water into the unit from the Superior Canal System. The structure is also fitted with stop-logs which allow gravity water flow in or out of the unit.
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Restore Intermediate Vegetation
   2. Repair Structures/Levees

2. Improve Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Maintain desirable land to water ratios
   2. Maintain intermediate/brackish marsh communities

3. Produce conditions favorable for submerged aquatic vegetation growth
4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

Course of Action:

1. Restore levee elevations
2. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
3. In late summer, stop-logs may be removed from water control structure and pumping initiated to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
4. Pumping may be initiated during flooding periods to rapidly remove excess water
5. In early spring, all stop-logs may be removed and pumping activities initiated to expose bare soil for production of annual emergent vegetation when practical or needed
6. Vegetation control may be required to maintain the desirable land to water ratios. (i.e., winter burning, summer flooding, and herbicide application)

Past Management – The unit has been managed since the mid-1950s. Initially, gated culverts were used to manage water within the unit. The structures fell into disrepair and were replaced with the double divergent pumping unit in 1969. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, and flatsedge which grew when a drawdown occurred. Southern naiad and pondweed were present during years when excessive rainfall inhibited the ability to dewater the unit. Forced drainage allowed complete control of water levels during average rainfall periods and promoted the growth of waterfowl foods. Optimum water levels were maintained at six to nine inches in ponds for optimum puddle duck feeding opportunities.

Present Management – We have optimum water to land ratios and will continue to hold water levels at a high level to promote submerged aquatic vegetation

Future Management – Establish and maintain desirable land to water ratios and maintain optimum water levels for wintering waterfowl

Marsh Burning – As needed

Problems – Levees have subsided to a level that may compromise our management capabilities

Unit 10/13

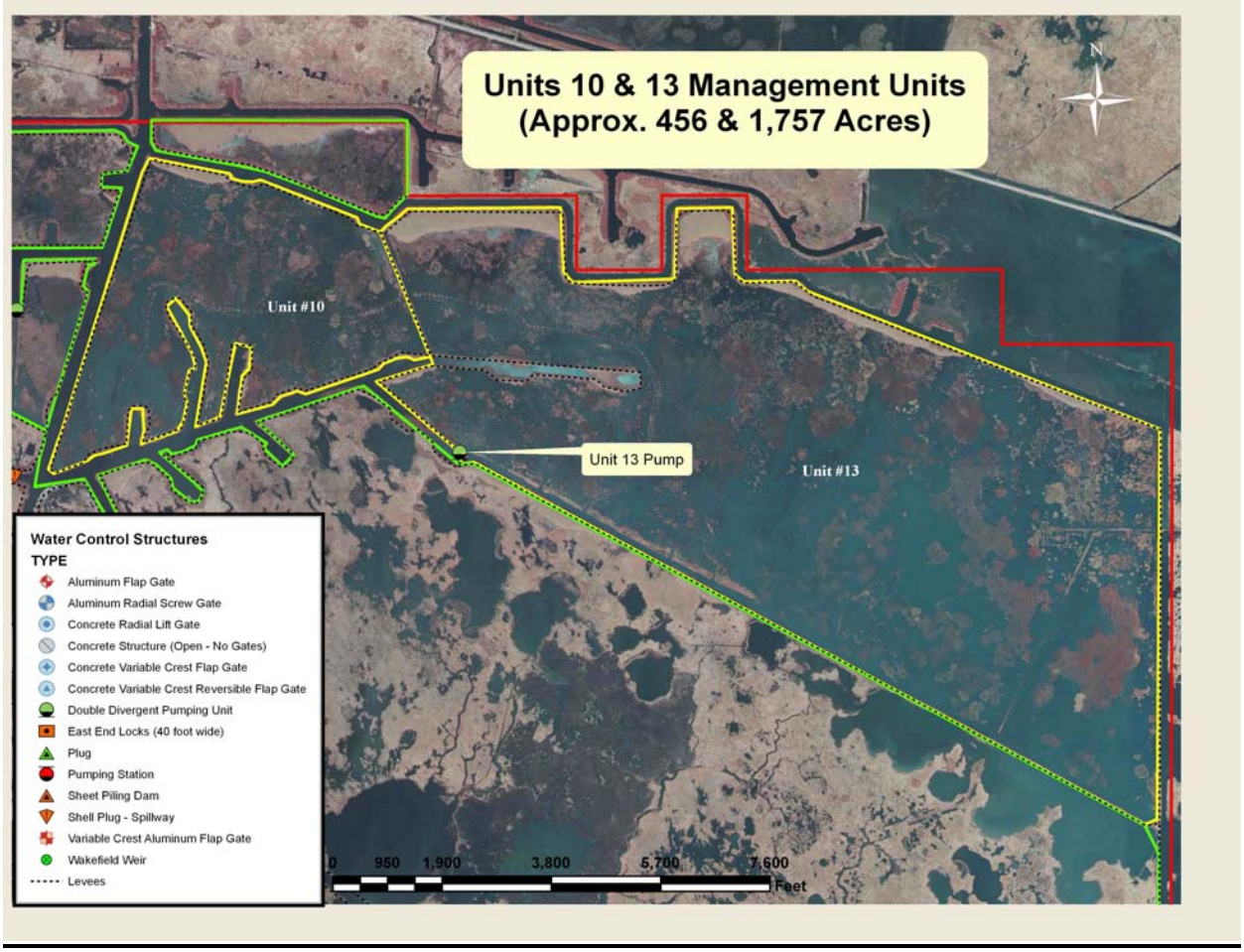

Figure 16: RWR Management Unit 10/13.

Size (Unit 10) – 456 acres **Marsh Type** – Fresh
(Unit 13) – 1,757 acres
Water Management – Forced/Gravity Drainage
Pump – 30 inch Lo-lift, Double Divergent Pumping Unit – This pump is operable and can be used to remove water from the unit or pump water into the unit from the Superior Canal System. The structure is also fitted with stop-logs allowing gravity water flow in or out of the unit.
Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Restore Intermediate Vegetation
   2. Repair Structures/Levees

2. Improve Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Maintain desirable land to water ratios
   2. Maintain intermediate/brackish marsh communities
   3. Produce conditions favorable for submerged aquatic vegetation growth

4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

Course of Action:

1. Restore levee elevations
2. Controlled burns may conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
3. In late summer, stop-logs may be removed from water control structure and pumping initiated to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
4. Pumping may be initiated during flooding periods to rapidly remove excess water
5. In early spring, all stop-logs may be removed and pumping activities initiated to expose bare soil for production of annual emergent vegetation when practical or needed
6. Vegetation control may be required to maintain the desirable land to water ratios. (i.e., winter burning, summer flooding, and herbicide application)

Past Management – The unit has been managed since the mid-1950s. Initially, gated culverts were used to manage water within the unit. The structures fell into disrepair and were replaced with the double divergent pumping unit since 1969. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, and flatsedge which grew when a drawdown occurred. Southern naiad and pondweed were present during years when excessive rainfall inhibited the ability to dewater the unit. Forced drainage allowed complete control of water levels during average rainfall periods and promoted the growth of waterfowl foods. Water levels were maintained at six to nine inches in ponds for optimum puddle duck feeding opportunities.

Unit 10 and 13 were connected by a drainage ditch in the 1980s when a water control structure separating the units deteriorated. The areas are managed as one hydrologic unit.

Present Management – We have optimum water to land ratios and will continue to hold water levels at a high level to promote submerged aquatic vegetation.

Future Management – Establish and maintain desirable land to water ratios and maintain optimum water levels for wintering waterfowl.

Marsh Burning – As needed

Problems – Levees have subsided to a level that may compromise our management capabilities.

Unit 14

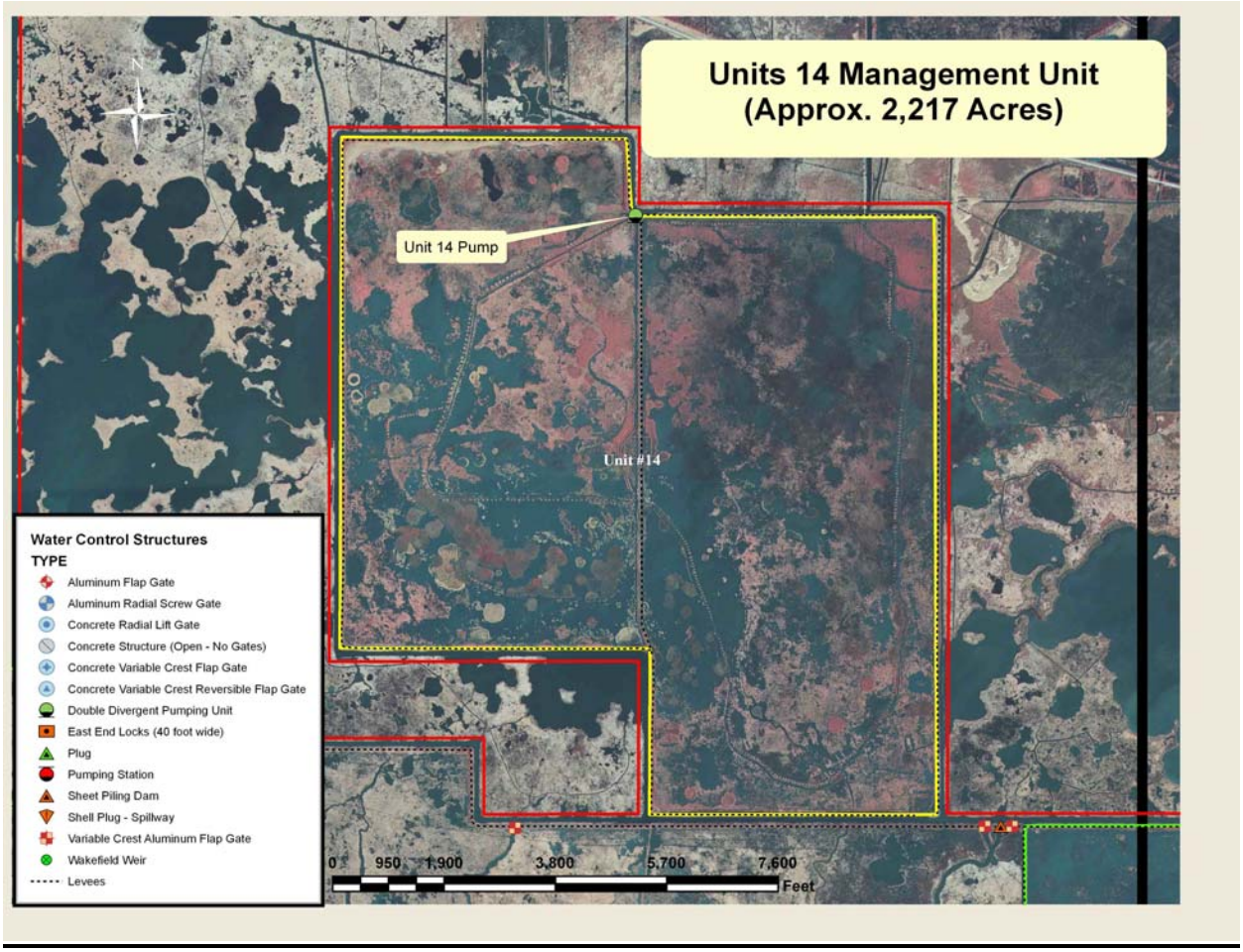

Figure 17: RWR Management Unit 14.

Size– 2,217 acres **Marsh Type** – Intermediate
Water Management – Forced/Gravity Drainage
Pump – 30 inch Lo-lift, Double Divergent Pumping Unit – This pump can be used to remove water from the unit or pump water into the unit from the existing canal system. The structure is also fitted with stop-logs allowing gravity water flow in or out of the unit.

Management Goals
Primary

1. Hurricane Rita Recovery
   Strategies: 1. Structures/Levees

2. Improve Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Establish desirable land to water ratios
   2. Maintain intermediate/brackish marsh communities
   3. Produce conditions favorable for submerged aquatic vegetation growth

4. Produce conditions favorable for production of annual emergent vegetation
5. Produce conditions to facilitate feeding

Course of Action:

1. Restore levee elevations
2. May operate pump in spring and summer to elevate salinity and water levels when necessary to maintain optimum land water ratio.
3. Vegetation control may be required to maintain the optimum land to water ratio. (i.e., winter burning, summer flooding, and herbicide application)
4. Controlled burns may be conducted in fall and winter to promote new growth for geese and other waterfowl or to reduce excessive emergent vegetation
5. In late summer stop-logs may be removed from control structure and pumping initiated to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks
6. Pumping may be initiated during flooding periods to rapidly remove excess water
7. In early spring all stop-logs may be removed and pumping activities initiated to expose bare soil for production of annual emergent vegetation when practical or needed

Past Management – The unit has been managed since the mid-1950s. In 1969, gated culverts were used to manage water within the unit. The structures fell into disrepair and were replaced with the double divergent pumping unit. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, and flatsedge which grew when a drawdown occurred. Southern naiad and pondweed were present during years when excessive rainfall inhibited the ability to dewater the unit. Forced drainage allowed complete control of water levels during average rainfall periods and promoted the growth of waterfowl foods. Optimum water levels were maintained at six to nine inches in ponds for optimum puddle duck feeding opportunities.

Since the early 1970s the unit has closed in with wiregrass, bulltongue (*Sagittaria lancifolia*) cutgrass, bulrush, and cattail. The area was dewatered and burned in March 2002 and was reflooded to a depth of 12 to 18 inches above emergent marsh level to suppress emergent plant growth and promote the growth of SAV's.

Present Management –A prescribed burn was completed in the late winter of 2011, but the area was not able to be flooded to suppress emergent vegetation due to drought conditions.

Future Management – Continue to establish desirable land to water ratios and maintain optimum water levels for wintering waterfowl

Marsh Burning – Three year burn cycle

Problems –No problems

Unit 15

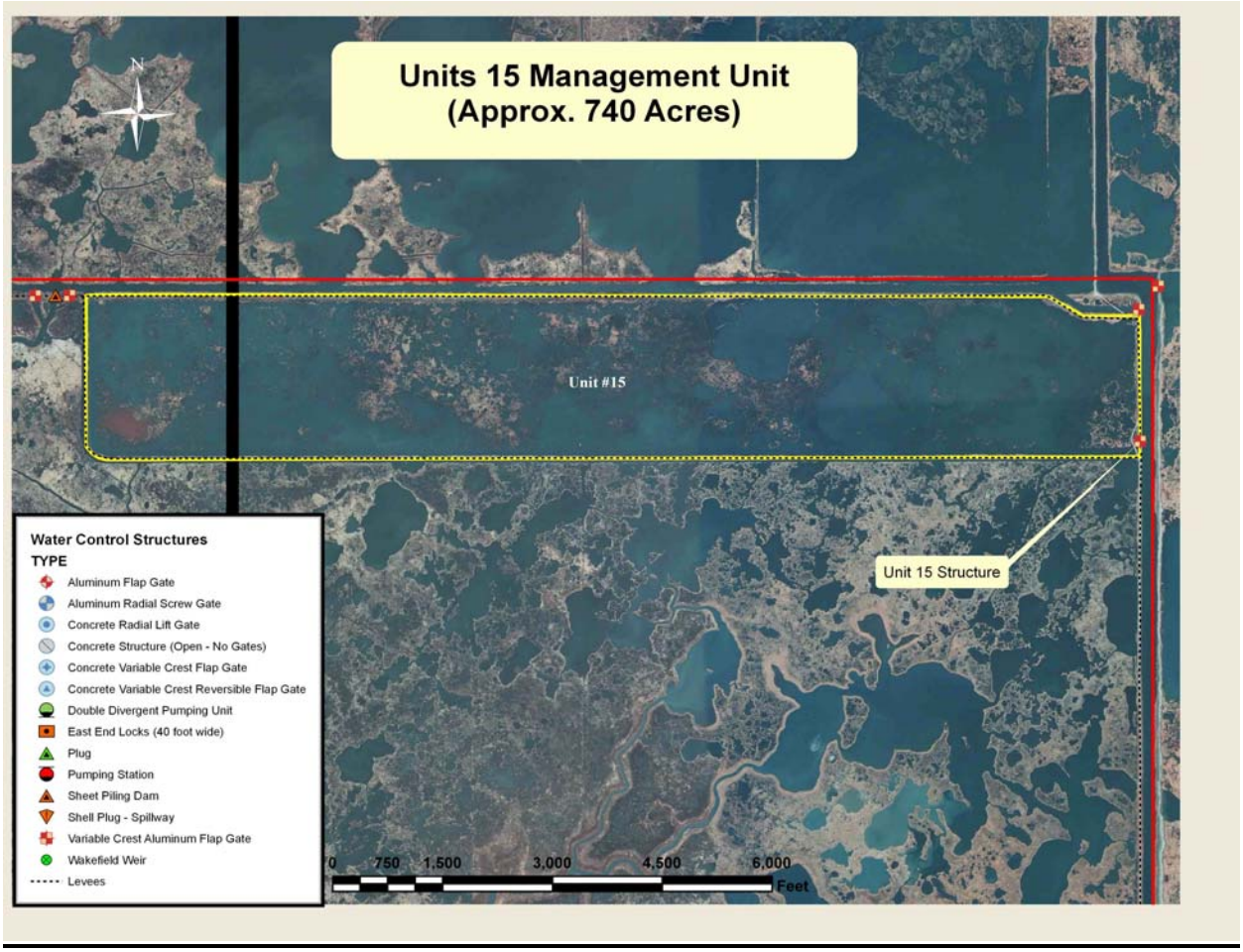

Figure 18: RWR Management Unit 15.

Size – 740 **Marsh Type** – West ¾, brackish; East ¼, intermediate
Water Management – Gravity Drainage/Controlled Estuarine Management
Water Control Structures - 2 – pipe, 48 inch, aluminum, stop-log, flap-gate structure (currently inoperable).
Management Goals
Primary:

1. Hurricane Rita Recovery
   Strategies: 1. Restore Brackish/Intermediate Vegetation
   2. Repair Structures/Levees

2. Improve Winter Waterfowl Habitat and Food Availability
   Strategies: 1. Establish desirable land to water ratios
   2. Produce conditions to facilitate feeding
   3. Maintain brackish marsh communities
   4. Produce conditions favorable for submerged aquatic and annual emergent vegetative growth

Course of Action:
1. Conduct necessary repairs to flap-gate structure
2. Restore levee elevations
3. Maintain flaps in a closed position to hold freshwater and reduce salinities within impoundment
3. In early spring, all stop-logs may be removed to expose bare soil for production of annuals and emergent vegetation.
4. Flap gates may be positioned outward to control salinity for production of SAVs
5. In late summer, stop-logs may be removed from water control structure to produce shallow water conditions for facilitating feeding activities of wintering dabbling ducks

Secondary

Maintain or Improve Estuarine Organism Production

Strategies:
1. Allow ingress/egress of estuarine organisms during peak migration periods when primary objectives are not compromised
2. Produce conditions favorable for survival and growth of estuarine organisms

Course of Action:
1. Flap of control structure may be opened during peak spring migration periods to allow ingress of estuarine organisms
2. Water levels may be maintained within impoundment at or slightly above marsh level to provide better foraging habitat for juvenile organisms and reduce low-oxygen situations
3. Stop-log levels may be lowered in late summer to facilitate migration out of impoundment

Past Management - The unit has been managed since the mid-1950s. Originally gated culverts were used for water management. These were replaced in the mid-1980s with a flapgated stoplog structure. The area has been managed for both annual and aquatic vegetation. Primary annual plants included Walter's millet, sprangletop, spikerush and flatsedge. Southern naiad, widgeongrass, and pondweed have been the predominant plant species within the unit. Target water levels were 6" to 12" in ponds. These levels were difficult to maintain due to the large unit size. During normal to high rainfall periods pond depths ranged from 18" to 24". The marsh was allowed to dry and produced annual plants during drought periods. Large numbers of waterfowl have utilized the area over the past three decades. Historically, the flap-gated structures have been opened to allow shrimp, crab, and larval fish access during peak migration periods.

Present Management – None (water control structure is inoperable)

Future Management - Target water levels will continue to be 6"-12" in ponds. The area will be subjected to a Spring/Summer drawdown if drought conditions occur to consolidate bottom sediments and promote the growth of annual plants and aquatic vegetation upon reflooding.

Marsh Burning – As needed

Problems – Completely unmanaged due to condition of water control structure. Structure needs to be replaced and levees need to be refurbished.

Unmanaged Area

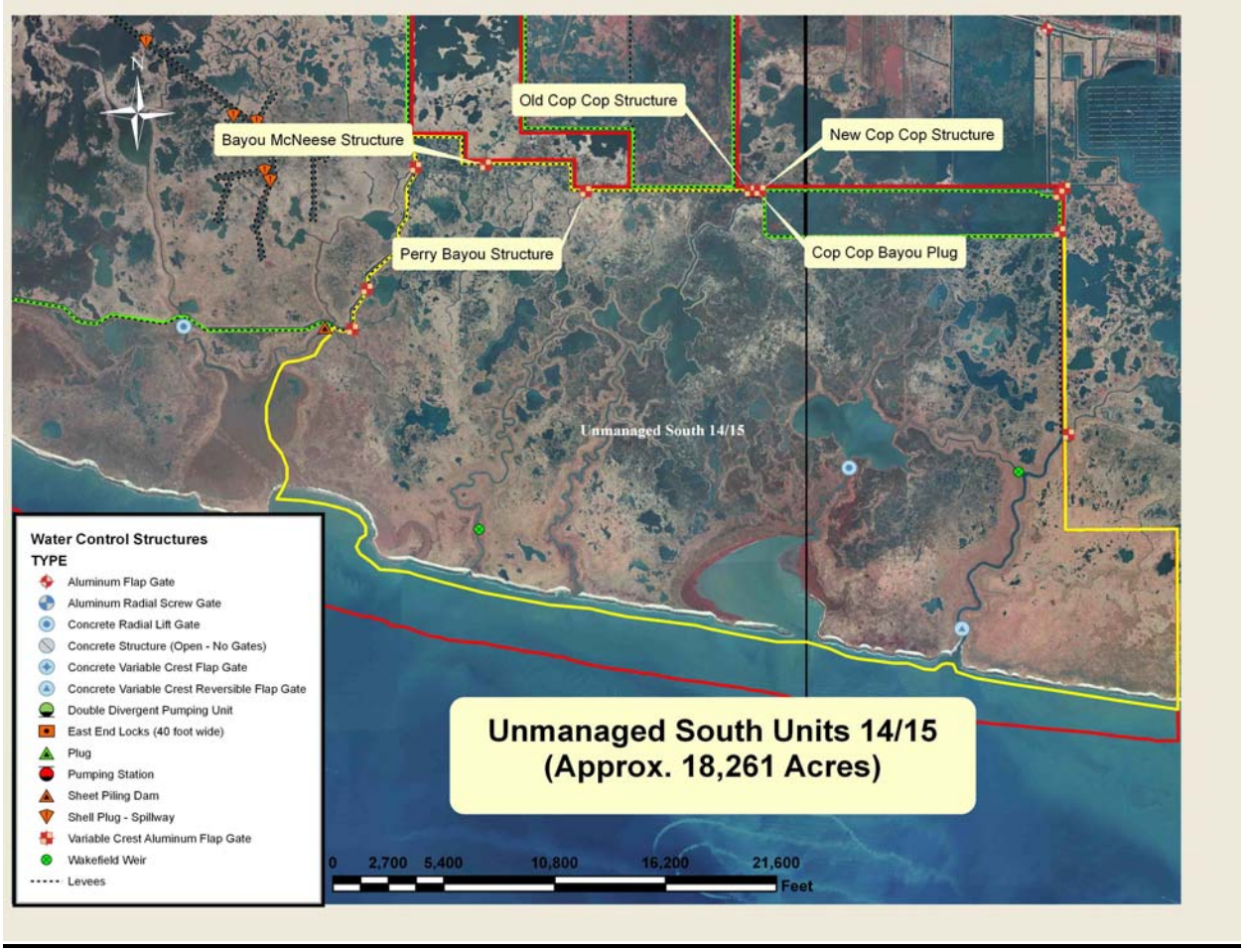

Figure 19: RWR Unmanaged south areas.

Size – 18,261 acres **Marsh Type** – 2/3 brackish; 1/3 saline
Water Management – Tidal/No management
Management Goal – Maintain area as a tidal marsh.
Water Control Structures – One active Wakefield Weir at the intersection of Rollover Bayou and Rollover Lake Bayou. One inactive Wakefield Weir at Pigeon Bayou. One inactive Cement Radial Arm Gate north of Flat Lake. One inactive Cement Radial Arm Gate at Rollover Canal and the Gulf of Mexico. Four separate water control structures are located north along the property-line canal and three on the southeastern side of Unit 6.

Past Management – In the 1950s and 1960s small Wakefield Weirs were placed in bayous and ditches throughout the area to hold water for fur trapping access. The weirs also kept water from draining out of waterfowl ponds promoting SAV growth. Two weirs were constructed in the late 1980s. The Pigeon Bayou weir was built to hold water in marsh ponds to promote the growth of SAVs and improve waterfowl habitat. The weir at the intersection of Rollover Canal and Rollover bayou north of Flat Lake was built to keep water moving in Rollover Canal to the Gulf of Mexico.

Present Management - There are no plans to refurbish the Pigeon Bayou weir since the bayou has closed at its intersection with the Gulf of Mexico. The bayou was dredged in the late 1990s at its intersection with the Gulf of Mexico. The bayou silted in shortly after dredging. The flow of Pigeon Bayou has been captured by Cop-Cop Bayou which is the major tributary for the area. New structures associated with the Hwy 82 Freshwater Introduction CWPPRA Project will be operated in accordance with permit regulations.

Marsh Burning – Approximately 1/3 burned annually

Problems – The area experienced vegetation death attributed to "brown marsh" conditions which occurred across Louisiana's Coastal Zone in 1999-2000 drought years. The vegetation is beginning to recover at this time. Staff will continue yearly vegetation monitoring in the area.

6.3: Agricultural Land Management

Currently, there is no property within RWR that supports agricultural activities. No future agricultural activities are planned.

6.4: Forest Management

Since almost all of the 72,650 acres of RWR encompasses coastal marshes, there is little property that maintains any valuable timber resource. The only trees on the property are located near the headquarters along the chenier and along marsh levees, with primary species including live oak (*Quercus virginiana*), "hackberry" (*Celtis laevigata* [sugarberry]), and tallow tree (*Triadica sebifera*). No current or future forest management plans are anticipated, except possible management of the invasive tallow tree. RWR staff is in the planning stages of a Chenier Restoration Initiative for Cameron and Vermillion parishes due to the ability for the cheniers to mitigate storm surges/damages and for their important wildlife values.

6.5: Threatened or Endangered Species

Mammals.—There are no federally Threatened/Endangered mammal species that occur on the refuge. It is possible that the federally Endangered finback (*Balaenoptera physalus*), Sei (*Balaenoptera borealis*), blue (*Balaenoptera musculus*), and sperm (*Physeter macrocephalus*) whales occur within the Gulf of Mexico waters bordering the refuge. Other than previous research of furbearers on the refuge (i.e., nutria, muskrat, otter), little is known about the non-game mammal species on the refuge (Appendix 5). A comprehensive survey for bats and small mammals on RWR would be a valuable research project to undertake by Rockefeller staff biologists.

Birds.—Only one federally Threatened bird species, the Piping Plover (*Charadrius melodus*), occurs on Rockefeller Wildlife Refuge. Piping Plovers overwinter on the beaches and mudflats of the Gulf of Mexico, including the 26 miles of undisturbed beaches of RWR. The only refuge management practice that benefits Piping Plovers is that RWR beaches are off-limits to public access, which is only possible by gated levee road via Price Lake Road. This practice decreases human disturbance, as well as habitat destruction by motorized vehicles. The number of Piping Plovers that currently utilize RWR beaches during the winter is unknown, but recent preliminary shorebird surveys noted three individuals immediately west of the Price Lake Road beach access levee (W. Selman, pers. obs.).

In addition to Piping Plovers, 48 birds that are Louisiana Species of Special Concern (SSC) have been observed on RWR (Appendix 2). Many of these species are shorebirds which inhabit similar environs as the Piping Plover, and therefore, management practices also benefit these species. Other bird SSC that inhabit RWR include several wading birds and five waterfowl species (Canvasback, Lesser Scaup, Mottled Duck, Northern Pintail, Redhead). Most of the management activities within the units managed benefit both waterfowl and wading bird species.

Reptiles and Amphibians.—No federally Threatened/Endangered reptile or amphibian species occurs on RWR, but five federally Threatened/Endangered sea turtle species occur in waters of the Gulf of Mexico (Leatherback Sea turtle [*Dermochelys coriacea*, E], Loggerhead Sea turtle [*Caretta caretta*, T], Green Sea turtle [*Chelonia mydas*, E], Atlantic Hawksbill Sea

turtle [*Eretmochelys imbricata*, E], and Kemp's Ridley Sea turtle [*Lepidochelys kempii*, E]). The only sea turtle species that may use RWR beaches for nesting is the Loggerhead Sea turtle, which has been noted to nest in the eastern part of the state (Breton and Chandeleur Islands); this, however, is an improbable occurrence. Both Loggerhead and Kemp's Ridley carcasses are occasionally found on Rockefeller beaches (W. Selman, pers. obs.).

Outside of alligator documentation, little is known on the distribution of other herpetofaunal species on RWR besides incidental encounters. Louisiana Species of Special Concern that may occur on the refuge/nearby cheniers include the Diamondback Terrapin (*Malaclemys terrapin*) and the Slender Glass Lizard (*Ophisaurus attenuatus*). The former is found in saline/brackish marshes and tidal creeks, while the latter is considered "more abundant on the coastal cheniers of Cameron Parish than in any other part of Louisiana" (Dundee and Rossman 1989). A systematic survey of the herpetofauna of RWR and the surrounding coastal cheniers is needed.

Freshwater/Marine Fish.—No federally Threatened/Endangered freshwater or marine fish species are known to occur on RWR. Three SSC have been documented on RWR, including the violet goby (*Gobioides broussoneti*), gulf pipefish (*Syngnathus scovelli*), and largescale spinycheek sleeper (*Eleotris amblyopsis*), with many other species likely occurring within the brackish/saline marshes of RWR. A comprehensive study of the fish assemblage of RWR would be a worthwhile project for Rockefeller staff biologists to undertake since the last comprehensive survey completed was by Perry et al. (1965); a taxonomic listing of fish species on RWR is presented in Appendix 4.

6.6: Exotic, Invasive, and Nuisance Species

The impact of exotic, invasive, and nuisance species is estimated to be one of the leading causes of species decline in the United States (Czech et al. 2000). The invasive species that occur on RWR are primarily Chinese tallow tree (*Triadica sebifera*), water hyacinth (*Eichornia crassipes*), *Salvinia* sp., roseau cane (*Phragmites australis*), and nutria (*Myocaster coypus*). Chinese tallow trees primarily occur along the chenier ridge and levees within the marsh, but there is no current plan to control/eradicate the species on RWR. Infestations of water hyacinth and *Salvinia* species were common prior to the hurricanes during 2005 (Rita) and 2008 (Ike). These hurricanes brought high levels of salinity to freshwater marshes and effectively eradicated any infestations on the refuge. In the future, it is likely that these species will return and be a problem to the refuge via the freshwater waterways to the north; the outbreaks can be controlled by saltwater introductions into units without compromising the isohaline line in Grand Lake. Infestations of roseau cane have increased within the Price Lake unit and herbicidal applications may be needed in future management of this species. Nutria is considered an exotic species from South America, but it has become naturalized in Louisiana; it was originally introduced into the marshes of Louisiana in 1930s for its then valuable pelt for the fur industry. The presence of this species on the refuge is minimal following the saltwater inundation of the refuge by hurricanes Rita and Ike.

6.7: Restoration Techniques and Mitigation

Coastal Erosion.—As previously mentioned, RWR is losing ~ 28.5 ft. per year of coastal wetlands due to coastal erosion (Byrnes et al. 1995). RWR has worked extensively with visiting groups to showcase and discuss the extent of coastal erosion on the refuge. The refuge was also

selected for a Coastal Impact Assessment Program (CIAP) project to evaluate different test scenarios for shoreline stabilization. These test scenarios will be evaluated and are planned to be expanded into a larger Coastal Wetland Protection and Restoration Act (CWPRA) project which will extend along the western 9-10 miles of RWR shoreline.

Marsh Restoration/Reclamation.—RWR has actively worked to reestablish marsh vegetation in "ponded" areas of the refuge, including within Price Lake and Units 4, 5 via terracing; this improves waterfowl habitat and stabilizes the marsh by reducing wave action. Marsh grasses (primarily *Spartina alterniflora*) have been planted along the canals within RWR to reduce wave action and associated levee erosion. Further, "marsh creation" mitigation projects have been completed (and are planned) to use dredge spoil to positively impact marsh health. In marshes that have subsided and/or been degraded to open-water conditions, dredge spoil is pumped into marshes in order to bring elevations back to "marsh level." The areas targeted for marsh creation projects include a 4.7 acre site (completed), a 66 acre site near Deep Lake (near completion), and a 100 acre site south of the East End Locks (planned). Other avenues for marsh creation that may be considered in the future would be reclaiming abandoned oil field canals; this would reduce the ability for water to quickly move across the landscape, while also reducing levee mileage and concurrently the amount of maintenance needed on levees. Lastly, RWR has worked with CWPRA to establish a freshwater introduction project, primarily using additional water control structures, on the eastern part of the refuge in order to restore more natural flow conditions south of Hwy 82.

7. Future Threats and Acquisition Needs

The greatest single threat to the refuge is the persistent problem of coastal erosion. Due to the receded shorelines and lost of vegetative marshes, the refuge has lost over 14,000 acres since it was deeded to the state in 1914 (~150 acres per year). RWR has an imminent need to develop techniques and secure funding to implement projects to lessen this state-wide concern. Recently, RWR was fortunate to be selected for a CIAP project to evaluate different test scenarios for shoreline stabilization. Sponsored by Department of Natural Resources, the $9.3 million project began in June 2009 with construction of a low profile reef breakwater section. This was followed by placement of a section of beach fill constructed of crushed stone and the last test was a rock reef breakwater placed on a lightweight aggregate core.

An important acquisition need includes purchasing property towards the eastern end of the refuge to provide staff with access to the refuge from Hwy 82. Currently, all access runs across private property or through a private boat launch at the western end of Pecan Island. Further, RWR should also pursue acquiring nearby chenier habitat due to its importance as a migratory bird stopover habitat and a storm barrier; this action was also recommended by the USFWS in the 2009 programmatic review of RWR. Compared to its historical extent, only 2-10% (2,000 to 10,000 acres) of chenier habitat remains due to clearing, development, and overgrazing (Lester et al. 2005).

Other potential future needs, include a public education interpretive center, to rebuild the nature/scenic trail, and to maintain public access through the refuge.

8. Plan Implementation

8.1: Funding

Although RWR has a substantial trust fund accumulated from past/present mineral exploration revenues from the refuge, the pursuance of grant money for research/applied science projects will always be beneficial.

8.2: Staff

Current Staff.—Technical management and research expertise on the refuge is provided by five RWR biologists, including a Biologist Manager and Refuge Program Manager. These biologists work on various monitoring, research, and inventory projects cited herein. Additional support staff at RWR include 3 administrative assistants (one is a job appointment), 3 technicians/technician supervisors (one appointment), and one housekeeper. The maintenance crew (9 RWR positions) repairs boats and equipment, maintains levees and water control structures, maintains refuge roads, and various other items necessary for the daily operations of the refuge. RWR staff is also responsible for maintenance at White Lake Wetlands Conservation Area (WLWCA), which is a 170,000 acre property situated to the north of White Lake (Vermilion Parish). Two Alligator Program biologists and three Alligator Program technicians are also housed at RWR.

Staff Needs.—Additional staff members are needed on RWR to advance the research/inventory program to previously productive levels during the 1970s and 1980s. Staff needs include adding another permanent secretary position due to the increasing demands of the public, hurricane rebuilding, and RWR/Alligator program staff. An additional permanent biologist is also needed (preferably a wetland ecologists/botanist) to address research questions related to marsh management, coastal erosion, and vegetative loss on RWR and southwestern Louisiana. Furthermore, additional permanent field technicians are needed to assist biologists in field and laboratory research. The 2009 USFWS programmatic review of RWR also recommended that the refuge should provide one full-time law enforcement agent who is fully dedicated to the refuge. RWR also encourages the summer student internship program which provides an opportunity for additional summer assistance on the refuge and a great learning experience for the students on the conservation/management of Louisiana coastal wetlands.

8.3: Partnerships

The many partnerships that RWR has established throughout the years remain as important today as they have ever been. Past and future partnerships may involve other state (LSU Veterinary School, LSU Ag Center) and federal agencies (USFWS Southwest Louisiana Refuge Complex), as well as universities (McNeese State University, Louisiana State University, University of Louisiana-Lafayette) and environmental organizations (The Nature Conservancy, Audubon Society). Furthermore, it is imperative that RWR staff maintains partnerships with local governments (Cameron and Vermilion Parish Police Juries) and neighboring landowners to provide a wide variety of marsh and coastal research, restoration, and educational projects.

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Appendix 1: Plant species commonly found on Rockefeller Wildlife Refuge

Local common name (USDA Common Name 2010; * – exotic, invasive)	Scientific Name (Genus species, unless noted otherwise)
Alligator Weed *	*Alternanthera philoxeroides*
American Lotus	*Nelumbo lutea*
American Pokeweed	*Phytolacca americana*
American White Waterlily	*Nymphaea odorata*
Bagscale (American Cupscale)	*Sacciolepsis striata*
Bearded Sprangletop	*Leptochloa fusca*
Belle-dame (Southern Amaranth)	*Amaranthus australis*
Black Needle Rush	*Juncus roemerianus*
Black Willow	*Salix nigra*
Bulltongue	*Sagittaria lancifolia*
Bullwhip (California Bulrush)	*Schoenoplectus californicus*
Bushy Bluestem	*Andropogon glomeratus*
Carolina Mosquitofern	*Azolla caroliniana*
Cattail	*Typha* sp.
Climbing Hempweed	*Mikania scandens*
Common Bladderwort	*Utricularia macrorhiza*
Common Frogbit (American Spongeplant)	*Limnobium spongia*
Common Ragweed	*Ambrosia artemisiifolia*
Aster	Family Asteraceae
Coon's Tail	*Ceratophyllum demersum*
Coffeeweed (Bigpod Sesbania)	*Sesbania herbacea*
Deer Pea (Hairypod Cowpea)	*Vigna luteola*
Delta Duck Potato (Delta Arrowhead)	*Sagittaria platyphylla*
Duckweed	*Lemna* sp.
Eastern Annual Saltmarsh Aster	*Symphyotrichum subulatum*
Fall Panicgrass (Fall Panicum)	*Panicum dichotomiflorum*
Flea-bane	*Pluchea* sp.
Floating Marshpennywort	*Hydrocotyle ranunculoides*
Floating Waterprimrose (Floating Primrose-willow)	*Ludwigia peploides*
Florida Mudmidget	*Wolffiella gladiata*
Four Square Sedge (Squarestem Spikerush)	*Eleocharis quadrangulata*
Fourchette (Smooth Beggartick)	*Bidens laevis*
Giant Cutgrass	*Zizaniopsis miliacea*
Giant Foxtail (Giant bristlegrass)	*Setaria magna*
Glasswort	*Salicornia sp.*
Hackberry (Sugarberry)	*Celtis laevigata*
Hog Cane	*Spartina cynosuroides*
Iva (Jesuit's Bark)	*Iva frutescens*
Joint Grass (Seashore Paspalum)	*Paspalum vaginatum*
Leafy Three-square (Sturdy Bulrush)	*Schoenoplectus americanus*
Live Oak	*Quercus virginiana*
Maidencane	*Panicum hemitomon*
Marshmallow (Rosemallow)	*Hibiscus lasiocarpos*
Marsh Pennywort	*Hydrocotyle* sp.
Marsh Purslane (Shoreline Seapurslane)	*Sesuvium portulacastrum*
Morning-glory	*Ipomoea* sp.
Muskgrass	Family Characeae
Nut Grass (Flatsedge)	*Cyperus* sp.
Oystergrass (Smooth Cordgrass)	*Spartina alterniflora*
Parrot's Feather (Eurasian watermilfoil) *	*Myriophyllum spicatum*
Pigweed	*Amaranthus* sp.
Pink Hibiscus (Virginia Saltmarsh Mallow)	*Kosteletzkya virginica*

Appendix 1 (cont.): Plant species commonly found on Rockefeller Wildlife Refuge

Local common name (USDA Common Name 2010; * – exotic, invasive)	**Scientific Name (Genus species, unless noted otherwise)**
River Seedbox (Anglestem Primrose-willow)	*Ludwigia leptocarpa*
Rattlebox (Poisonbean)	*Sesbania drummondii*
Roseau Cane (Common Reed) *?	*Phragmites australis*
Round pennywort (Manyflower Marshpennywort)	*Hydrocotyle umbellata*
Saltgrass	*Distichlis spicata*
Salt Heliotrope	*Heliotropium curassavicum*
Saltwort (Turtleweed)	*Batis maritima*
Sawgrass (Jamaica swamp sawgrass)	*Cladium mariscus*
Sea Ox-eye Daisy (Bushy Seaside Tansy)	*Borrichia frutescens*
Seaside Goldenrod	*Solidago sempervirens*
Sedge	*Carex* sp.
Slender Pondweed	*Potamogeton pusillus*
Smartweed	*Polygonum* sp.
Soft Rush (Common Rush)	*Juncus effusus*
Southern Waternymph	*Najas guadalupensis*
Spikerush	*Eleocharis* sp.
Three-corner Grass (Chairmaker's Bulrush)	*Schoenoplectus americanus*
Vetch	*Vicia* sp.
Walter’s Millet (Coast Cockspur Grass)	*Echinochloa walteri*
Water Hyacinth *	*Eichhornia crassipes*
Water Hyssop (Herb of Grace)	*Bacopa monnieri*
Watermeal	*Wolffia* sp.
Water Primrose (Large-flower Primrose-willow)	*Ludwigia grandiflora*
Water Spangles *	*Salvinia minima*
Waterspider Bog Orchid	*Habenaria repens*
Whorled Marshpennywort	*Hydrocotyle verticillata*
Widgeongrass	*Ruppia maritima*
Wiregrass (Saltmeadow Cordgrass)	*Spartina patens*
Yankee Weed (Dogfennel)	*Eupatorium capillifolium*

Appendix 2: Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat. Adapted from Palmisano (1969) and Bettinger (1984).

Common Name and Conservation Status (T- Federally Threatened, * - Louisiana Species of Special Concern, + - exotic)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Swimmers (i.e., Waterfowl, Coots, Cormorants)					
American Coot	*Fulica americana*	A	A	C	A
American Wigeon	*Anas americana*	A	U		A
Anhinga	*Anhinga anhinga*			U	
Black Duck	*Anas rubripes*	R			R
Black Scoter	*Melanitta nigra*	R			
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*			U	C
Blue-winged Teal	*Anas discors*	A	C	R	A
Bufflehead	*Bucephala albeola*	U			
Canada Goose	*Branta canadensis*	C	U	U	U
Canvasback *	*Aythya valisineria*	R			
Cinnamon Teal	*Anas cyanoptera*	R			
Common Goldeneye	*Bucephala clangula*	U			
Common Loon	*Gavia immer*	U			
Common Merganser	*Mergus merganser*	U			
Common Moorhen	*Gallinula chloropus*	C	A	A	C
Double-crested Cormorant	*Phalacrocorax auritus*	A	A	C	A
Eared Grebe	*Podiceps nigricollis*	U			
Fulvous Whistling-Duck	*Dendrocygna bicolor*			C	U
Gadwall	*Anas strepera*	A	U		A
Greater Scaup	*Aythya marila*	U			
Greater White-fronted Goose, Specklebelly	*Anser albifrons*	C			U
Green-winged Teal	*Anas crecca*	A	U		A
Hooded Merganser	*Lophodytes cucullatus*	C			C
Horned Grebe	*Podiceps auritus*	U			
Lesser Scaup *	*Aythya affinis*	A	C		A
Mallard	*Anas platyrhynchos*	A	U	R	A
Mottled Duck *	*Anas fulvigula*	C	A	A	C
Neotropical Cormorant	*Phalacrocorax brasilianus*	C	C	C	C
Northern Pintail *	*Anas acuta*	A	U		A
Northern Shoveler	*Anas clypeata*	A	U		A
Oldsquaw, Long-tailed Duck	*Clangula hyemalis*	R			
Pied-billed Grebe	*Podilymbus podiceps*	A	U	U	C
Purple Gallinule	*Porphyrio martinica*		C	C	
Redhead *	*Aythya americana*	U			
Red-breasted Merganser	*Mergus serrator*	U			
Ring-necked Duck	*Aythya collaris*	C			
Ross's Goose	*Chen rossii*	R			
Ruddy Duck	*Oxyura jamaicensis*	C			
Snow Goose	*Chen caerulescens*	A			C
White-winged Scoter	*Melanitta fusca*	R			
Wood Duck	*Aix sponsa*	U	U	U	U
Wading Birds and Upland Waterbirds (i.e., rails, herons, egrets)					
American Bittern *	*Botaurus lentiginosus*	C	C		C

Appendix 2 (cont.): Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat

Common Name and Conservation Status (T- Federally Threatened, *- Louisiana Species of Special Concern, + - exotic)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Wading Birds and Upland Waterbirds (cont.)					
American Woodcock *	*Scolopax minor*	U			
Black Rail *	*Laterallus jamaicensis*	R	R		R
Black-crowned Night-Heron	*Nycticorax nycticorax*	C	A	A	C
Cattle Egret	*Bubulcus ibis*	C	A	A	C
Clapper Rail *	*Rallus longirostris*	A	A	A	A
Common Snipe	*Gallinago gallinago*	A	A		A
Glossy Ibis	*Plegadis falcinellus*	C	C	C	C
Green Heron	*Butorides virescens*	C	A	A	C
Great Blue Heron	*Ardea herodias*	A	A	A	A
Great Egret	*Ardea alba*	C	C	C	C
King Rail *	*Rallus elegans*	A	A	A	A
Least Bittern	*Ixobrychus exilis*		C	A	
Little Blue Heron	*Egretta caerulea*		A	A	
Roseate Spoonbill	*Platalea ajaja*	C	C	C	C
Snowy Egret	*Egretta thula*	C	A	A	A
Sora	*Porzana carolina*	A	U		C
Tricolored Heron	*Egretta tricolor*	C	A	A	A
Virginia Rail	*Rallus limicola*	C	U		C
White Ibis	*Eudocimus albus*	A	A	A	A
White-faced Ibis	*Plegadis chihi*	C	C	C	C
Wood Stork *	*Mycteria americana*		U	U	U
Yellow-crowned Night-Heron *	*Nyctanassa violacea*	C	A	A	A
Shorebirds (i.e, gulls, pelicans, plovers, sandpipers, terns)					
American Avocet	*Recurvirostra americana*	C	C		U
American Golden-Plover	*Pluvialis dominica*		A		U
American Oystercatcher *	*Haematopus palliatus*	U	R	R	R
American White Pelican	*Pelecanus erythrorhynchos*	A	C	U	C
Baird's Sandpiper	*Calidris bairdii*				U
Black Skimmer *	*Rynchops niger*	C	C	C	C
Black Tern	*Chlidonias niger*		C	A	
Black-bellied Plover	*Pluvialis squatarola*	C	C	U	C
Black-necked Stilt	*Himantopus mexicanus*	C	C	A	A
Bonaparte's Gull	*Chroicocephalus philadelphia*	U	U		
Brown Pelican *	*Pelecanus occidentalis*	U	U	A	A
Buff-breasted Sandpiper	*Tryngites subruficollis*		U		U
Caspian Tern *	*Hydroprogne caspia*	C	C	C	C
Common Tern *	*Sterna hirundo*	U	U		U
Dunlin *	*Calidris alpina*	A	A		A
Forster's Tern *	*Sterna forsteri*	C	C	C	C
Franklin's Gull	*Leucophaeus pipixcan*				U
Greater Yellowlegs	*Tringa melanoleuca*	C	C		C
Gull-billed Tern *	*Sterna nilotica*	C	C	U	C
Herring Gull	*Larus argentatus*	C	C		U
Killdeer	*Charadrius vociferus*	A	A	A	A

Appendix 2 (cont.): Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat

Common Name and Conservation Status (T- Federally Threatened, *- Louisiana Species of Special Concern, + - exotic)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Shorebirds (cont.)					
Laughing Gull	*Leucophaeus atricilla*	A	A	A	A
Least Sandpiper	*Calidris minutilla*	A	C		A
Least Tern	*Sternula antillarum*		A	A	
Lesser Yellowlegs	*Tringa flavipes*	C	C	U	C
Long-billed Curlew	*Numenius americanus*	U	C	U	C
Long-billed Dowitcher	*Limnodromus scolopaceus*	U	C		C
Magnificent Frigatebird	*Fregata magnificens*			U	U
Marbled Godwit *	*Limosa fedoa*		U		U
Pectoral Sandpiper	*Calidris melanotos*		C		C
Piping Plover, **T***	*Charadrius melodus*		U		U
Red Knot	*Calidris canutus*		R		R
Reddish Egret *	*Egretta rufescens*			U	
Ring-billed Gull	*Larus delawarensis*	C	C		C
Royal Tern *	*Thalasseus maximus*	C	C	C	C
Ruddy Turnstone	*Arenaria interpres*	U	C	U	C
Sanderling	*Calidris alba*	C	C	C	C
Sandwich Tern *	*Thalasseus sandvicensis*	U	C	C	U
Semipalmated Plover	*Charadrius semipalmatus*		C		C
Semipalmated Sandpiper	*Calidris pusilla*	U	C	U	C
Short-billed Dowitcher *	*Limnodromus griseus*	C	C	U	C
Solitary Sandpiper	*Tringa solitaria*		C		C
Snowy Plover *	*Charadrius alexandrinus*		C		C
Spotted Sandpiper	*Actitis macularius*	U	C	U	C
Stilt Sandpiper	*Calidris himantopus*		U		U
Upland Sandpiper	*Bartramia longicauda*		U		U
Western Sandpiper	*Calidris mauri*	C	C		C
Whimbrel	*Numenius phaeopus*		U		
White-rumped Sandpiper	*Calidris fuscicollis*		U		
Willet	*Tringa semipalmata*	C	C	C	C
Wilson's Pharalope	*Phalaropus tricolor*		U		U
Wilson's Plover *	*Charadrius wilsonia*	U	C	U	C
Wilson's Snipe	*Gallinago delicata*	U			
Raptors (i.e., hawks, owls, vultures)					
American Kestrel	*Falco sparverius*	A	C	R	A
Barred Owl	*Strix varia*	C	C	C	C
Black Vulture	*Coragyps atratus*	C	C	C	C
Broad-winged Hawk	*Buteo platypterus*		U	U	
Common Barn Owl	*Tyto alba*	U	U	U	U
Cooper's Hawk	*Accipiter cooperii*				
Eastern Screech-Owl	*Megascops asio*	U	U	U	U
Great Horned Owl	*Bubo virginianus*	C	C	C	C
Merlin, Pigeon Hawk	*Falco columbarius*	R			R
Mississippi Kite	*Ictinia mississippiensis*			U	
Northern Harrier *	*Circus cyaneus*	A	U		A

Appendix 2 (cont.): Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat

Common Name and Conservation Status (T- Federally Threatened, *- Louisiana Species of Special Concern, + - exotic)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Raptors (cont.)					
Osprey	*Pandion haliaetus*			U	
Peregrine Falcon	*Falco peregrinus*	U			
Red-shouldered Hawk	*Buteo lineatus*	C			C
Red-tailed Hawk	*Buteo jamaicensis*	C	U	U	C
Sharp-shinned Hawk	*Accipiter striata*	U			U
Turkey Vulture	*Carthartes aura*	C	C	C	C
Ground Walkers					
Bobwhite Quail	*Colinus virginianus*	U	U	U	U
Tree Climbers (i.e., woodpeckers)					
Brown Creeper	*Certhia americana*	U	U		U
Downy Woodpecker	*Picoides pubescens*	C	C	C	C
Hairy Woodpecker	*Picoides villosus*	C	C	C	C
Northern Flicker	*Colaptes auratus*	C	C	U	C
Red-bellied Woodpecker	*Melanerpes carolinus*	C	C	C	C
Red-headed Woodpecker	*Melanerpes erythrocephalus*	U	U	U	U
Yellow-bellied Sapsucker	*Sphyrapicus varius*	C			C
Neotropical and Passerine Migrants (i.e. flycatchers, hummingbirds, warblers)					
Acadian Flycatcher	*Empidonax virescens*		U	U	
American Goldfinch	*Spinus tristis*	C			U
American Pipit	*Anthus rubescens*	U			
American Redstart	*Setophaga ruticilla*		C		C
American Robin	*Turdus migratorius*	C			
Baltimore Oriole	*Icterus galbula*		C		U
Bank Swallow	*Riparia riparia*		U		U
Barn Swallow	*Hirundo rustica*		C	A	C
Bay-breasted Warbler	*Dendroica castanea*		C		U
Blackburnian Warbler	*Dendroica fusca*		U		U
Blackpoll Warbler	*Dendroica striata*		C		
Black-and-white Warbler	*Mniotilta varia*		C		U
Black-billed Cuckoo	*Coccyzus erythropthalmus*		U		U
Black-throated Blue Warbler	*Dendroica caerulescens*		U		
Black-throated Green Warbler	*Dendroica virens*		C		C
Blue Grosbeak	*Passerina caerulea*		C		C
Blue-winged Warbler	*Vermivora pinus*		U		U
Bobolink	*Dolichonyx oryzivorus*		C		
Brewer's Blackbird	*Euphagus cyanocephalus*	C			
Canada Warbler	*Wilsonia canadensis*		U		U
Cape May Warbler	*Dendroica tigrina*		U		
Cedar Waxwing	*Bombycilla cedrorum*	C	C		U

Appendix 2 (cont.): Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat

Common Name and Conservation Status (T- Federally Threatened, *- Louisiana Species of Special Concern)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Neotropical and Passerine Migrants (cont.)					
Cerulean Warbler	*Dendroica cerulea*		C		C
Chesnut-sided Warbler	*Dendroica pensylvanica*		C		U
Chimney Swift	*Chaetura pelagica*		C	C	C
Chipping Sparrow	*Spizella passerina*				
Chuck-wills-widow	*Caprimulgus carolinensis*		C	C	
Cliff Swallow	*Petrochelidon pyrrhonota*		C		U
Common Yellowthroat	*Geothlypis trichas*	C	A	A	C
Dark-eyed Junco	*Junco hymenalis*	U			
Dickcissel *	*Spiza americana*		U	U	
Eastern Kingbird	*Tyrannus tyrannus*		C	A	C
Eastern Phoebe	*Sayornis phoebe*	C	U	U	C
Eastern Wood-Pewee	*Contopus virens*		C	C	C
Fox Sparrow	*Passerella iliaca*		U		
Golden-crowned Kinglet	*Regulus satrapa*		U		U
Golden-winged Warbler	*Vermivora chrysoptera*		U		U
Grasshopper Sparrow *	*Ammodramus savannarum*		C		C
Gray Catbird	*Dumetella carolinensis*	U	A	C	A
Gray-cheeked Thrush	*Catharus minimus*		C		U
Great Crested Flycatcher	*Myiarchus crinitus*		C	C	C
Hermit Thrush	*Catharus guttatus*	C	C		C
Hooded Warbler *	*Wilsonia citrina*		C	C	C
House Wren	*Troglodytes aedon*	C	C		C
Indigo Bunting	*Passerina cyanea*		C		C
Kentucky Warbler *	*Oporornis formosus*		C		C
Lark Sparrow	*Chondestes grammacus*		U	U	
Least Flycatcher	*Empidonax minimus*		U		U
Le Conte's Sparrow *	*Ammodramus leconteii*				
Lincoln's Sparrow	*Melospiza lincolnii*		C		U
Louisiana Waterthrush *	*Seiurus motacilla*		C		C
Magnolia Warbler	*Dendroica magnolia*		C		C
Mourning Warbler	*Oporornis philadelphia*		R		R
Nashville Warbler	*Vermivora ruficapilla*		U		U
Nelson's Sharp-tailed Sparrow *	*Ammodramus nelsoni*	C	C		C
Northern Parula *	*Parula americana*		C		C
Northern Waterthrush	*Seiurus noveboracensis*		U		U
Olive-sided Flycatcher	*Contopus cooperi*				U
Orange-crowned Warbler	*Vermivora celata*	C	C		C
Orchard Oriole *	*Icterus spurius*		C	C	C
Ovenbird	*Seiurus aurocapilla*		U		U
Painted Bunting *	*Passerina ciris*		C		C
Palm Warbler	*Dendroica palmarum*		U		U
Philadelphia Vireo	*Vireo philadelphicus*		U		U
Prairie Warbler	*Dendroica discolor*		U		
Prothonotary Warbler *	*Prothonotary Warbler*		C		U
Purple Martin	*Progne subis*		C	C	C
Red-eyed Vireo	*Vireo olivaceus*		C	C	C

Appendix 2 (cont.): Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat

Common Name and Conservation Status (T- Federally Threatened, *- Louisiana Species of Special Concern, + - exotic)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Neotropical and Passerine Migrants (cont.)					
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		C		C
Ruby-crowned Kinglet	*Regulus calendula*	C	C		C
Ruby-throated Hummingbird	*Archilochus colubris*		C	C	C
Rusty Blackbird *	*Euphagus carolinus*	C			
Savannah Sparrow	*Passerculus sandwichensis*	C	C		C
Scarlet Tanager	*Piranga olivacea*		C		U
Scissor-tailed Flycatcher *	*Tyrannus forficatus*		U	U	U
Sedge Wren *	*Cistothorus platensis*	A	A		A
Song Sparrow	*Melospiza melodia*	C	C		C
Summer Tanager	*Piranga rubra*		C		C
Swainson's Thrush	*Catharus ustulatus*		C		U
Swamp Sparrow	*Melospiza georgiana*	C	C		C
Tennessee Warbler	*Vermivora peregrina*		C		U
Tree Swallow	*Tachycineta bicolor*	C	C	U	C
Veery	*Catharus fuscescens*		C		U
Vermilion Flycatcher	*Pyrocephalus rubinus*	U			U
Vesper Sparrow	*Pooecetes gramineus*	C	C		C
Warbling Vireo	*Vireo gilvus*		U		U
Western Kingbird	*Tyrannus verticalis*		U	U	U
Western Tanager	*Piranga ludoviciana*		U		
Whip-poor-will	*Caprimulgus vociferus*				
White-crowned Sparrow	*Zonotrichia leucophrys*		C		U
White-throated Sparrow	*Zonotrichia albicollis*	C	C		C
White-winged Dove	*Zenaida asiatica*	U	U		U
Wilson's Warbler	*Wilsonia pusilla*		R		U
Winter Wren	*Troglodytes troglodytes*	C	C		C
Wood Thrush *	*Hylocichla mustelina*		C		C
Worm-eating Warbler *	*Helmitheros vermivorum*		U		U
Yellow Warbler	*Dendroica petechia*		C		C
Yellow-bellied Flycatcher	*Empidonax flaviventris*				U
Yellow-billed Cuckoo *	*Coccyzus americanus*		C	C	C
Yellow-breasted Chat	*Icteria virens*		C	C	C
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*		R		
Yellow-rumped Warbler	*Dendroica coronata*	A	A		A
Yellow-throated Vireo *	*Vireo flavifrons*		C		C
Yellow-throated Warbler	*Dendroica dominica*		U		U
Resident Passerines (i.e., cardinals, doves, mockinbirds)					
American Crow	*Corvus brachyrhynchos*	A	A	A	A
Belted Kingfisher	*Megaceryle alcyon*	C	C	C	C
Blue Jay	*Cyanocitta cristata*	A	A	A	A
Blue-gray Gnatcatcher	*Polioptila caerulea*	U	C	C	C
Boat-tailed Grackle	*Quiscalus major*	A	A	A	A
Brown Thrasher	*Toxostoma rufum*	C	C	C	C
Brown-headed Cowbird	*Molothrus ater*	A	A	A	A

Appendix 2 (cont.): Bird species found on Rockefeller Wildlife Refuge and Adjacent Chenier Habitat

Common Name and Conservation Status (T- Federally Threatened, *- Louisiana Species of Special Concern, + - exotic)	Scientific Name (Genus species; 2010 taxonomic status)	Seasonal RWR Status (A-abundant, C- common, U-Uncommon, R- Rare)			
		Winter	Spring	Summer	Fall
Resident Passerines (cont.)					
Carolina Chickadee	*Poecile carolinensis*	C	C	C	C
Carolina Wren	*Thryothorus ludovicianus*	C	C	C	C
Common Grackle	*Quiscalus quiscula*	A	A	A	A
Common Ground-Dove	*Columbina passerina*	U	U	U	U
Common Nighthawk	*Chordeiles minor*		A	A	C
Eastern Meadowlark	*Sturnella magna*	A	A	A	A
Eastern Towhee	*Pipilo erythrophthalmus*	U	U	U	U
European Starling +	*Sturnus vulgaris*	A	A	A	A
Fish Crow	*Corvus ossifragus*	U	U	U	U
Groove-billed Ani	*Crotophaga sulcirostris*		U		U
House Sparrow +	*Passer domesticus*	A	A	A	A
Loggerhead Shrike *	*Lanius ludovicianus*	U	U	U	U
Marsh Wren	*Cistothorus palustris*	A	A	A	A
Mourning Dove	*Zenaida macroura*	A	A	A	A
Northern Cardinal	*Cardinalis cardinalis*	A	A	A	A
Northern Mockingbird	*Mimus polyglottos*	A	A	A	A
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	U	C	C	U
Red-winged Blackbird	*Agelaius phoeniceus*	A	A	A	A
Seaside Sparrow *	*Ammodramus maritimus*	A	A	A	A
White-eyed Vireo	*Vireo griseus*		C	C	C

Appendix 3: Wintering waterfowl surveys of Rockefeller Wildlife Refuge. Data on dominant species, dominant species number, and Mottled Duck numbers are not available 1992-1995. e = early, l = late.

Year	Month	Total (all species)	Dominant Species	Dom species #	Mottled Duck #
1992	October	148000			
	November (e)	100000			
	November (l)	150000			
	January	82000			
	March	78000			
1993	September	21000			
	November (e)	85000			
	November (l)	69000			
	December	35000			
	January	62000			
	February	45000			
	March	65000			
1994	September	18000			
	November (e)	135000			
	November (l)	98000			
	December	65000			
	January	120000			
	March	42000			
1995	September	5000			
	November (e)	39000			
	November (l)	40000			
	December	108000			
1999	November	230721	Gadwall	116037	793
	December	84805	Gadwall	47800	417
2000	January	44882	GW Teal	23504	151
	February	23306	GW Teal	10497	193
	November	15475	Gadwall	12238	88
	December	72784	Gadwall	41754	115
2001	January	43608	GW Teal	16656	220
	November	67946	Gadwall	33391	479
	December (e)	72784	Gadwall	41754	115
	December (l)	24804	GW Teal	12026	234
2002	January	66929	Gadwall	39156	313
	December	90657	Gadwall	56748	391
2003	November (e)	31186	Gadwall	21003	165
	November (l)	50276	Gadwall	42320	165
	December (e)	43216	Gadwall	26279	897
	December (l)	142057	Gadwall	101442	1102
2004	January	56028	Gadwall	23408	462
	February	25957			
	November (e)	22258	GW Teal	10903	717
	November (l)	29953	Gadwall	13772	321
	December (e)	30414	Gadwall	17407	526
	December (l)	119568	Gadwall	54229	1207
2005	January	57462	Gadwall	22679	304
	November (e)	3842	Gadwall	2704	448
	November (l)	41270	GW Teal	18066	828
	December	36485	GW Teal	10695	703
2006	January	94720	GW Teal	60988	214
	February	29672	GW Teal	13722	306

Appendix 3 (cont.): Wintering waterfowl surveys of Rockefeller Wildlife Refuge. Data on dominant species, dominant species number, and Mottled Duck numbers are not available 1992-1995. For 1992- 1995, e = early, l = late.

Year	Month	Total (all species)	Dominant Species	Dom species #	Mottled Duck #
2006	September	896	BW Teal	489	407
	November	118825	Gadwall	76230	400
	December	113174	GW Teal	33609	846
2007	January	38882	GW Teal	25555	442
	November	178123	Gadwall	116852	1451
	December	115146	Gadwall	51441	733
2008	January	71996	Gadwall	24975	608
	November	69201	Gadwall	55160	833
	December	47775	GW Teal	26828	1151
2009	January	66133	GW Teal	30033	573
	November	19364	Gadwall	6972	550
	December	25460	Gadwall	23684	311
2010	January	110180	Gadwall	55865	2160
	November	66308	Gadwall	40393	2614
	December	154646	Gadwall	104495	1138
2011	January	74864	GW Teal	30614	2092

Appendix 4: Fish species found on Rockefeller Wildlife Refuge; adapted from Perry et al. 1965.

Common Name and Conservation Status (*- Louisiana Species of Special Concern, + - exotic)	**Scientific Name (Genus species; 2010 taxonomic status)**
Dasyatidae- stingrays	
Atlantic Stingray	*Dasyatis sabina*
Lepisosteidae- gars	
Spotted Gar	*Lepisosteus oculatus*
Alligator Gar	*Atractosteus spatula*
Amiidae- bowfin	
Bowfin	*Amia calva*
Elopidae- tarpons	
Ladyfish	*Elops saurus*
Clupeidae- herrings	
Skipjack Herring	*Alosa chrysochloris*
Gulf Menhaden	*Brevoortia patronus*
Gizzard Shad	*Dorosoma cepedianum*
Threadfin Shad	*Dorosoma petenense*
Engraulidae- anchovies	
Bay Anchovy	*Anchoa mitchilli*
Synodontidae- lizardfishes	
Inshore Lizardfish	*Synodus foetens*
Cyprinidae- minnows and carp	
Golden Shiner	*Notemigonus crysoleucus*
Common Carp+	*Cyprinus carpio*
Arridae- sea catfish	
Gaftopsail Catfish	*Bagre marinus*
Sea Catfish	*Ariopsis felis*

Appendix 4 (cont.): Fish species found on Rockefeller Refuge

Common Name and Conservation Status (*- Louisiana Species of Special Concern, + - exotic)	**Scientific Name (Genus species; 2010 taxonomic status)**
Ictaluridae- freshwater catfishes	
Blue Catfish	*Ictalurus furcatus*
Channel Catfish	*Ictalurus punctatus*
Black Bullhead Catfish	*Ameiurus melas*
Anguillidae- freshwater eels	
American Eel	*Angullia rostrata*
Opichthidae- snake eels	
Speckled Worm Eel	*Myrophis punctatus*
Belonidae- needlefishes	
Atlantic Needlefish	*Strongylura marina*
Cyprinodontidae- killifishes	
Sheepshead Minnow	*Cyprinodon variegatus*
Fundulidae- topminnows	
Longnose Killifish	*Fundulus similus*
Rainwater Killifish	*Lucania parva*
Poeciliidae- livebearers	
Western Mosquitofish	*Gambusia affinis*
Sailfin Molly	*Poecilia latipinna*
Syngnathidae- pipefishes and seahorses	
Gulf Pipefish*	*Gyngnathus scovelli*
Moronidae- sea basses	
Yellow Bass	*Morone mississippiensis*

Appendix 4 (cont.): Fish species found on Rockefeller Refuge

Common Name and Conservation Status (*- Louisiana Species of Special Concern, + - exotic)	**Scientific Name (Genus species; 2010 taxonomic status)**
Centrarchidae- sunfishes	
Warmouth	*Lepomis gulosis*
Bluegill	*Lepomis macrochirus*
Redear Sunfish	*Lepomis microlophus*
Bantam Sunfish	*Lepomis symmetricus*
Largemouth Bass	*Micropterus salmoides*
Black Crappie	*Pomoxis nigromaculatus*
Carangidae- jacks, scads, and pompanos	
Yellow Jack	*Caranx bartholomaei*
Crevalle Jack	*Caranx hippos*
Leather Jack	*Oligoplites saurus*
Atlantic Bumper	*Cholorscombrus chrysurus*
Lookdown	*Selene vomer*
Atlantic Moonfish	*Selene setapinnis*
Sciaenidae- drums	
Freshwater Drum	*Aplodinotus grunniens*
Silver Perch	*Bairdiella chrysoura*
Sand Seatrout	*Cynoscion arenarius*
Spotted Seatrout	*Cynoscion nebulosus*
Banded Drum	*Larimus fasciatus*
Spot	*Leiostomus xanthurus*
Southern Kingfish	*Menticirrhus americanus*
Atlantic Croaker	*Micropogonias undulatus*
Black Drum	*Pogonias cromis*
Red Drum	*Sciaenops ocellatus*
Sparidae- porgies	
Sheepshead	*Archosargus probatocephalus*
Pinfish	*Logodon rhomboides*
Ephippidae- spadefishes	
Atlantic Spadefish	*Chaetodipterus faber*
Trichiuridae- cutlassfishes	
Atlantic Cutlassfish	*Trichiurus lepturus*

Appendix 4 (cont.): Fish species found on Rockefeller Refuge

Common Name and Conservation Status (*- Louisiana Species of Special Concern, + - exotic)	**Scientific Name (Genus species; 2010 taxonomic status)**
Scombridae- mackerels and tuna	
Spanish Mackerel	*Scomberomorus maculatus*
Eleotridae- sleepers	
Fat Sleeper	*Dormitator maculates*
Largecaled Spinycheek Sleeper*	*Eleotris amblyopsis*
Gobiidae- gobies	
Lyre Goby	*Evorthodus lyricus*
Violet Goby*	*Gobioides broussonneti*
Darter Goby	*Ctenogobius boleosoma*
Highfin Goby	*Gobionellus oceanicus*
Clown Goby	*Microgobius gulosus*
Naked Goby	*Gobiosoma bosc*
Triglidae- searobins	
Blackwing Searobin	*Prionotus rubio*
Bighead Searobin	*Prionotus tribulus*
Uranocopidae- stargazers	
Southern Stargazer	*Astroscopus y-graecum*
Blenniidae- combtooth blennies	
Freckled Blenny	*Hypsoblennius ionthas*
Stromateidae- butterfishes	
Southern Harvestfish	*Peprilus paru*
Gulf Butterfish	*Poronotus burti*
Mugilidae- mullets	
Striped Mullet	*Mugil cephalus*
White Mullet	*Mugil curema*

Appendix 4 (cont.): Fish species found on Rockefeller Refuge

Common Name and Conservation Status (*- Louisiana Species of Special Concern, + - exotic)	**Scientific Name (Genus species; 2010 taxonomic status)**
Atherinopsidae- silversides	
Rough Silverside	*Membras martinica*
Inland Silverside	*Menidia beryllina*
Polynemidae- threadfins	
Atlantic Threadfin	*Polydactylus octonemus*
Paralichthyidae- lefteye flounders	
Fringed Flounder	*Etropus crossotus*
Smallmouth Flounder	*Etropus microstomus*
Southern Flounder	*Paralichthys lethostigma*
Achiridae- soles	
Lined Sole	*Achirus lineatus*
Hogchoker	*Trinectes maculatus*
Cynoglossidae- tonguefishes	
Blackcheek Tonguefish	*Symphurus plagiusa*
Gobiesocidae- clingfishes	
Skilletfish	*Gobiesox strumosus*
Tetradontidae- puffers	
Southern Puffer	*Sphaeroides nephelus*
Diodontidae- porcupinefish	
Striped Burrfish	*Chilomycterus schoepfi*
Batrachoididae- toadfishes	
Atlantic Midshipmen	*Porichthys plectrodon*

Appendix 5: Mammal species commonly found on Rockefeller Wildlife Refuge and adjacent chenier habitats, including those with historical or probable occurrence.

Common name (* – exotic, introduced)	Scientific Name (Genus species, unless noted otherwise)
Confirmed Mammal Species	
Beaver	*Castor canadensis*
Bobcat	*Lynx rufus*
Black Rat*	*Rattus rattus*
Coyote	*Canis latrans*
Feral Cat*	*Felis catus*
Fulvous Harvest Mouse	*Reithrodontomys fulvescens*
Grey Squirrel	*Sciurus carolinensis*
Hispid Cotton Rat	*Sigmodon hispidus*
House Mouse*	*Mus musculus*
Least Shrew	*Cryptotis parva*
Marsh Rice Rat	*Oryzomys palustris*
Mink	*Neovison vison*
Muskrat	*Ondatra zibethicus*
Nine-banded Armadillo	*Dasypus novemcinctus*
Nutria*	*Myocastor coypus*
Raccoon	*Procyon lotor*
River Otter	*Lutra canadensis*
Sika Deer*	*Cervus nippon*
Striped Skunk	*Mephitis mephitis*
Swamp Rabbit	*Sylvilagus aquaticus*
Virginia Opossum	*Didelphis marsupialis*
Whitetail Deer	*Odocoileus virginianus*
Wild Boar*	*Sus scrofa*
Historical Species to Cameron Parish (Lowery, 1974) and Other Probable Species that may Occur on Rockefeller Wildlife Refuge	
Black Bear	*Ursus americanus*
Eastern Cottontail	*Sylvilagus floridanus*
Fox Squirrel	*Sciurus niger*
Eastern Yellow Bat	*Lasiurus intermedius*
Norway Rat*	*Rattus norvegicus*
Plains Pocket Gopher	*Geomys bursarius*
Red Bat	*Lasiurus borealis*
Red Fox	*Vulpes fulva*
Seminole Bat	*Lasiurus borealis*
Spotted Skunk	*Spilogale putorius*

We, the administrative staff of Coastal and Non-Game Resources Division and the Office of Wildlife for Louisiana Department of Wildlife and Fisheries, approve of the contents in the Rockefeller Wildlife Refuge management plan and approve of its use as a tool to guide research/management decisions on the property.

Buddy Baker, CNR Assistant Division Administrator

Bob Love, CNR Division Administrator

Jimmy Anthony, Assistant Secretary for the Office of Wildlife