# CHAPTER 3: AFFECTED ENVIRONMENT

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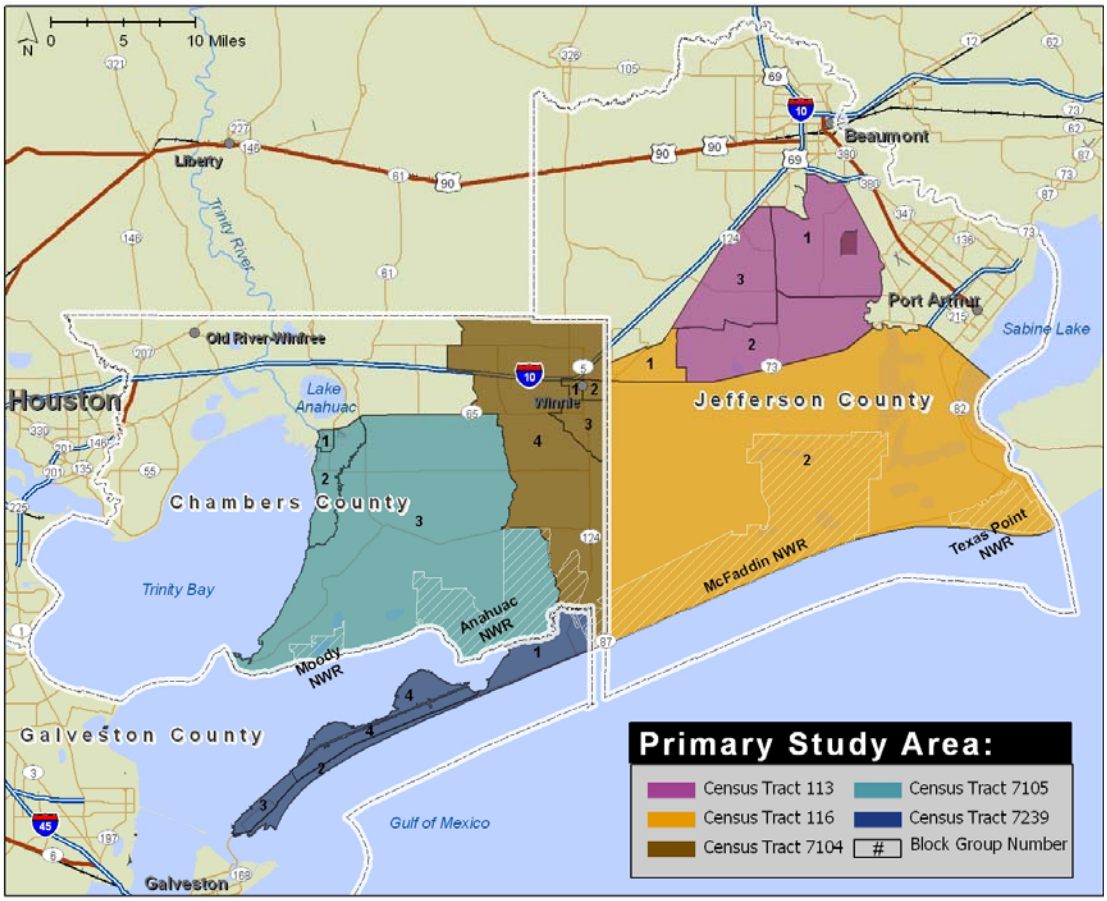



## Introduction

This chapter describes the environment within the project area which may be affected by the activities or actions proposed in the Refuge Management and the Refuge Boundary Expansion alternatives. The project area for this analysis includes the lands within the current Refuge Complex plus those areas within the Refuge Boundary Expansion alternatives under consideration in this EIS. The study area goes beyond the project area when it is necessary to accurately describe the resources which may be affected by the proposed actions and to understand the ecosystem and regional perspectives. The descriptions of natural resources within this section provide a baseline to be used for identification and evaluation of potential environmental impacts from the various Refuge Management and Refuge Boundary Expansion alternatives under consideration in this EIS/CCP/LPP.

This chapter is divided into two main sections. The first section describes the physical environment which includes climate, air, geology, soils, and hydrology, biological resources which include vegetation/habitats, wildlife, fisheries, and Threatened and Endangered species, cultural resources and Refuge Complex management programs (habitat management, biological inventory and monitoring, and public use management). The second section describes the socioeconomic environment which includes the following elements: land use, economic characteristics, demographics, housing, infrastructure services, fiscal conditions, and social conditions/issues. A general or regional description is presented for each element, and, where relevant, a more specific description is provided for the lands or activities within the Refuge Complex.

*General Setting*

The project area encompasses portions of Chambers, Jefferson and Galveston counties in southeastern Texas within the coastal plain of the Gulf of Mexico. Collectively, these coastal counties (and Orange County) are referred to as the Upper Texas Gulf Coast. The project area includes lands from the Bolivar Peninsula in Galveston County eastward along the Gulf of Mexico to the Sabine River and the Texas-Louisiana state line, and northward to Interstate Highway 10. The project area is bounded on the west by Galveston Bay and the Trinity River Delta.

Table 3-1
National Wildlife Refuges within the Texas Chenier Plain Refuge Complex

| Refuge | Acreage | Date of Establishment | Ownership |
|---|---|---|---|
| Anahuac | 34,339 | 1963 | Fee Title |
| McFaddin | 58,861 | 1980 | Fee Title and Conservation Easements |
| Texas Point | 8,952 | 1979 | Fee Title |
| Moody | 3,516 | 1961 | Conservation Easement |

The Texas Chenier Plain Refuge Complex currently includes over 105,000 acres of public land managed and administered by the USFWS. The primary native habitats found on the Refuge Complex and within the proposed refuge boundary expansion areas include coastal wetlands, coastal prairies, and coastal woodlands.

The Refuge Complex includes four refuges: Anahuac NWR, McFaddin NWR, Texas Point NWR and Moody NWR (Table 3-1).

- Moody NWR is located in along East Galveston Bay in south central Chambers County. The town of Smith Point is approximately 5 miles west of this Refuge. The USFWS holds a perpetual non-development conservation easement on the Moody NWR, which is otherwise entirely privately-owned and managed.

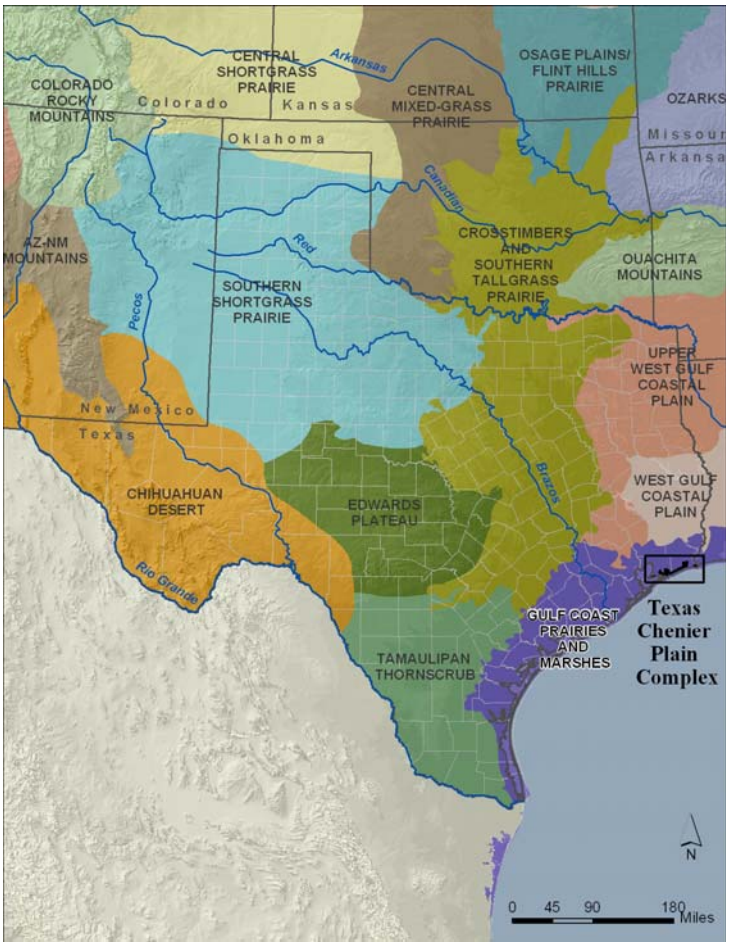
- Anahuac NWR is located on the north shore of East Galveston Bay. Almost all of the Refuge lies within Chambers County, with a small portion lying south of the GIWW in Galveston County. The Refuge is bounded by Robinson Bayou on the west, State Highway 124 on the east, several private farms and ranches and F.M. Road 1985 on the north, and East Bay and the GIWW on the south. Anahuac NWR staff are now officed on the Refuge, with Refuge Complex staff headquartered in the city of Anahuac, located 18 miles northwest of the Refuge.

- McFaddin and Texas Point NWRs are located on the southeastern tip of the Upper Texas Coast, adjacent to the Gulf of Mexico. All of Texas Point NWR and most of McFaddin NWR are located in Jefferson County. Texas Point and McFaddin NWRs are bounded on the south by the Gulf of Mexico, and the refuges contain approximately 6 and 17 miles of Gulf of Mexico shoreline, respectively. The GIWW dissects McFaddin NWR and divides once contiguous watersheds into two distinct units. Texas Point NWR is adjacent to the town of Sabine Pass, and McFaddin NWR lies 12 miles further west. The town of High Island is located along the Gulf near the McFaddin NWR's western boundary, which lies within Galveston County. Office facilities for the staffs of the McFaddin and Texas Point NWRs and some Refuge Complex staff (Fire Management) are located on the McFaddin NWR.

*Ecosystem Setting*

The project area and the Refuge Complex lie within the Gulf Prairie and Marsh ecological regions as delineated by Gould *et al*. (1960). Geographically, these regions lie along the Texas Gulf Coast from the Sabine River south to the Rio Grande. The prominent features of this coastal ecosystem include tidal, micro-tidal and freshwater coastal marshes; bays and lagunas which support extensive seagrass beds,

tidal flats and reef complexes; barrier islands; tallgrass prairie which includes small depressional wetlands; and forested riparian corridors, mottes and coastal woodlots, and dense brush habitats.




Natural forces which shape the system include dominate south to southeast winds, tropical weather systems, and a substantial gradient in rainfall from over 60 inches per year on the Upper Texas Coast to less than 20 inches per year on the Lower Coast. Flooding and freshwater inflows are key systemic processes which buffer salinity and provide nutrients and sediments. Prior to colonization, fire and grazing by buffalo were key factors influencing native plant communities, particularly in the prairie grasslands.

While highly impacted by human activities, this ecosystem remains very productive for a wide variety of fish and wildlife species. Estuaries are a vital habitat for over 75% of the fish and shellfish species found in the Gulf of Mexico. The marshes and rice prairies of Texas Gulf Coast are a major wintering area for waterfowl of the Central Flyway. On average, 1.3-4.5 million ducks, or 30-71% of the total Flyway population, annually winter on the Texas Gulf Coast (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). On average, 180,000 pairs of colonial-nesting waterbirds, of which there are 25 species, nest annually in Texas coastal habitats. Near coastal forests are critically important for the nation's songbird resources as the vast majority of these species utilize this habitat during their trans-Gulf and circum-Gulf migrations.

A diversity of listed and rare species of animals and plants occur across the variety of habitats along the Texas Gulf Coast. The Attwater's Prairie Chicken and North America's principal migrating population of Whooping Cranes, both Federally-listed as Endangered, are completely dependent upon coastal habitats in Texas. Beaches and tidal flats along the Texas Gulf Coast provide important wintering and migrational habitat for the Piping Plover, Federally-listed as Threatened. The Texas Gulf Coast population of the Endangered Brown Pelican is currently increasing. Five species of endangered sea turtles are found in the near coastal waters of the Gulf, and historically all five nested on beaches and dunes along the Texas Gulf Coast. The native brush habitats of the Lower Coast make up the northeast range of the endangered ocelot. Recovery of all of these species is highly dependent upon habitat conservation and restoration activities.

*Chenier Plain Region*

The project area and Refuge Complex lie within a bio-geographical region known as the Chenier Plain (Gosselink *et al*. 1979). Geographically, the Chenier Plain region extends from Vermillion Bay in southwestern Louisiana to East Galveston Bay in southeastern Texas. A distinguishing feature of the region are the cheniers, ridges representing ancient Gulf shorelines which are generally aligned parallel to the Gulf or as fan-shaped alluvial deposits at the mouths of rivers. The higher cheniers support woody vegetation, hence the name chenier, a French word which means "place of oaks." Cheniers are more prevalent in Louisiana than in Texas, perhaps because of the alignment of the Gulf shoreline and its proximity to the Mississippi River, the Chenier Plain region's primary sediment source. Given the region's significant annual rainfall, wetlands isolated from the Gulf by the cheniers developed into highly productive and diverse freshwater coastal marsh habitats.

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. These habitats are an important part of the primary wintering area for Central Flyway ducks and geese. Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several identified by the USFWS as Avian Species of Conservation Concern (USFWS 2005). Coastal prairie and coastal woodlots within the project area support over 150 migratory and resident landbird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). The wetland, prairie and woodland habitats on the Refuge Complex provide important habitat for 35 of the 48 avian species listed by the USFWS as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (BCR 37) (USFWS 2005).

Sea level rise and land subsidence are contributing to coastal land loss and habitat degradation in the region, and pose significant threats to the future viability of these important coastal habitats. Development and land use changes have also resulted in loss of native habitats, loss of biological diversity, and decreased habitat quality for migratory birds and other native wildlife. Coastal marshes have been impacted by major alterations of historic hydrology including loss of freshwater and sediment inflows and increased saltwater intrusion. The Gulf Intracoastal Waterway (GIWW), the Galveston Ship Channel and the Sabine-Neches Ship Channel are major public works projects that have greatly affected hydrology of coastal marshes in the project area. Collectively, altered hydrological regimes resulting in saltwater intrusion, reduction of mineral sediment supply to littoral and marsh systems, sea level rise and land subsidence are resulting in coastal erosion and shoreline retreat along the Gulf of Mexico and bay shorelines and the conversion of interior vegetated marshes to open water.

Almost all of the region's historic native coastal tallgrass prairie and its associated prairie wetlands have been lost through conversion to agricultural uses and urban development. Remnant stands of native prairie, coastal woodlots and forested wetlands are imminently threatened by development and other land use changes. Several highly invasive exotic plant species are replacing native habitats and severely impacting biological diversity. Air and water quality issues in the region pose a potential contaminant threat to fish and wildlife resources, as do accidental spills and discharges from the major petrochemical shipping, storage and processing facilities located in close proximity to sensitive habitats.

Habitat losses to date and ongoing threats are such that intensive management of remaining habitats in combination with large-scale restoration will be required to ensure conservation of the Chenier Plain region's valuable coastal natural resources.

# I. PHYSICAL ENVIRONMENT

## A. Climate and Air Quality

### 1. Climate

The region has a subtropical climate. Summers are hot and humid with prevailing southerly winds from offshore; winters are cool and wet. The seasonal precipitation based on a 40-year average of 51.7 inches is fairly uniform with the months of October, November, and March being drier than other months. The spring season along with September are the wettest months. July receives the greatest amount of precipitation. The wettest year in the areas history had over 70 inches of rainfall (Gosselink *et al*. 1979).

The region's climate is highly variable and exerts both short-term and long-term influences. Sea level rise to its approximate present position resulted from long-term climatic influences. The dynamic nature of precipitation, temperature, and wind are the climatic factors influencing water and sediment movement and subsequently the development of the Chenier Plain region.

The mean annual average temperature is about 68 degrees Fahrenheit (F), mean maximum annual average is about 77 degrees F, and the mean minimum annual average is about 58 degrees F. The average growing season is 250 days. Temperatures are rarely lower than 25 degrees F. Major freezes are extremely infrequent, with frost occurring only on a few days during an average winter. Tropical weather disturbances occur from late spring through late fall. Hurricanes and tropical storms cause both wind and water erosion. Storm surges and heavy rains produce abnormally large volumes of water that exit to the Gulf through natural and constructed waterways.

### 2. Air Quality

The Texas Commission on Environmental Quality (TCEQ) is the state agency responsible for regulating air quality in Texas. Anahuac and Moody NWRs are within Region 12 and Texas Point and McFaddin NWRs are within Region 10 of the TCEQ Air Quality Control Area. The major sources of air pollution in these regions are petroleum production, chemical production, shipping, and agriculture. Non-attainment areas are areas that have failed to meet federal standards for ambient air quality. The Refuge Complex and project area are within two non-attainment areas for Eight-Hour ground level ozone (Houston-Galveston-Brazoria and Beaumont-Port Arthur)(TCEQ, Texas Attainment Status by Region).

Burning is widely used as an agricultural management tool in the region to improve pasturage and control undesirable vegetation. The TCEQ administers the Outdoor Burning Rule (Title 30, Texas Administrative Code, Sections 111.201 – 111.221), which regulates prescribed burning within the state. TCEQ is responsible for issuing authorization to burn, defining the conditions when burning will be permitted, and determining what materials may be burned.

Minimizing negative impacts to air quality and transportation safety are primary considerations for the USFWS fire management program on the Refuge Complex. Current and potential air quality impacts occur primarily from smoke generated from unplanned wildland fires and prescribed fires on the refuges and burning on private lands. The USFWS considers smoke management in both planning and implementation of wildland fire suppression and prescribed burning on the Refuge Complex. Smoke generated by prescribed fires is managed in compliance with the legal requirements of the Clean Air Act (42 U.S.C. 1857 et seq.) and TCEQ regulations. Smoke produced by prescribed burn and wildland fires is monitored and mitigated to the extent possible.

## B. Geology and Soils

The existing physiography, soils, and geomorphology of the region are a result of complex interactions of hydrological, meteorological, and geological processes that occurred during two epochs of the

Quaternary period. River, Gulf, and subsurface aquatic systems are the primary medium for transporting and mixing sediment and nutrients. Rivers transport sediments and nutrients from inland catchment basins to the mixing and receiving basins of the estuaries, marshlands, and the Gulf of Mexico. The main source of sediment for the Chenier Plain region was reworked former delta sediments of the Mississippi River, combined with sediments of adjacent active distributaries (channels) of the Mississippi. In the Texas portion of the Chenier Plain region, sediments were also supplied by the Sabine, Neches and Trinity rivers. Depositional and erosional processes have resulted in land gain or loss through time.

Reconstruction of the geologic history of southeastern Texas illustrates how meteorologic or climate and sea level fluctuations influenced the structure of the area that is currently near sea level but which was far upstream when the sea level was much lower. Climatic influences on precipitation, sediment yield, sediment discharge, and load of the fluvial systems are all factors that interacted to produce the preserved strata. Tidal and climatic interactions with weather fronts and wind patterns generated currents, waves, and flood tides that affected surface water and constantly influenced coastal habitats.

### 1. Geomorphology

During the last Ice Age, the coastal shoreline moved seaward and then retreated inland depending on the erosional and depositional forces and shifting sea levels. During the onset of the Ice Age, the sea was dramatically lower, approximately 440 feet below its present level (Fisk and McFarlan 1955, Gould 1970). The shoreline was approximately 124 miles seaward of its present position which exposed Pleistocene surface sediments to erosion and weathering. Coastal streams cut valleys into the Pleistocene sediment. As glaciers retreated and sea levels rose, sand, silt, and clay sediments were deposited along the coast. The shoreline gradually migrated landward of its present location as evidenced by the inland locations of former beach ridges of the Recent age. The ridges represent paleo shorelines that evolved during the high stand in sea level. Because sediment supply was abundant as sea levels reached its present level 3,000 to 4,000 years ago, the shoreline advanced seaward of its present location. As sediment supply decreased, the shoreline began retreating and it is still eroding today.

The coastal water bodies such as Galveston Bay, Sabine Lake, and Calcasieu Lake resulted from the submergence of relic Pleistocene entrenched valleys (Fisk 1944). Marsh ponds enlarged when salinity changes or other stresses interrupted the marsh building process and gradually evolved into small lakes. Many irregularly shaped lakes represent old river or tidal stream courses that were abandoned.

The geologic formations are divided into three groups according to age: 1) Recent, 2) late Pleistocene or early Recent, and 3) Pleistocene. The geologic substrate of the Chenier Plain region is primarily composed of sediments deposited during the late Recent epoch with some subsurface Pleistocene outcropping. These deposits are overlain at the coast by a geologically recent series of inland ridges representing stranded beaches that align parallel with the coast. Accumulation of fine-grained sediment deposited between these multiple beach ridges formed marshes and mudflats. Tidal channels lie between successive ridges. The shore of the coast is formed by a narrow beach or washover terrace developed over time through the deposition of sand and shell. The coastline is breached by inlets that connect estuaries extending inland up river valleys.

### 2. Chenier Ridges

The Chenier Plain region is characterized by ridges composed of sand and shell fragments aligned parallel to the Gulf shoreline. These ridges originated from accumulations of sand sized particles deposited near river mouths that were reworked by waves and currents into multiple bars or ridges that formed concave seaward. The chenier ridges at the historic mouth of the Sabine River in both Texas and Louisiana are an example of this process. Away from the river mouths, cheniers represent ancient beach ridges that were formed through erosion processes along sections of the coast undergoing coastal retreat. Storm surges and wave action eroded existing beachfronts and nearshore deposits and deposited them inland over marsh and bay deposits forming the cheniers (Gosselink *et al*. 1979). Given the region's significant annual rainfall, wetlands isolated from the Gulf by the cheniers developed into highly productive freshwater coastal marsh habitats.

### 3. Soils

The Chenier Plain region is part of a recent geologic plain. Most soils within the Refuge Complex are remnants of ancient floodplains and Gulf of Mexico beaches and consist of old alluvium and marine sediment deposited by ancient streams and the Gulf of Mexico. These deposits are mostly clayey and sandy soils and exhibit a wide range in textural differences due to their origin within historic floodplain systems (Crout 1976). All Refuge Complex lands are located within the 100-year floodplain. The soil types, both acidic and alkaline, are poorly drained with slow permeability, moderate to high salinity, and a high shrink-swell potential (Crout 1976, USFWS 1994).

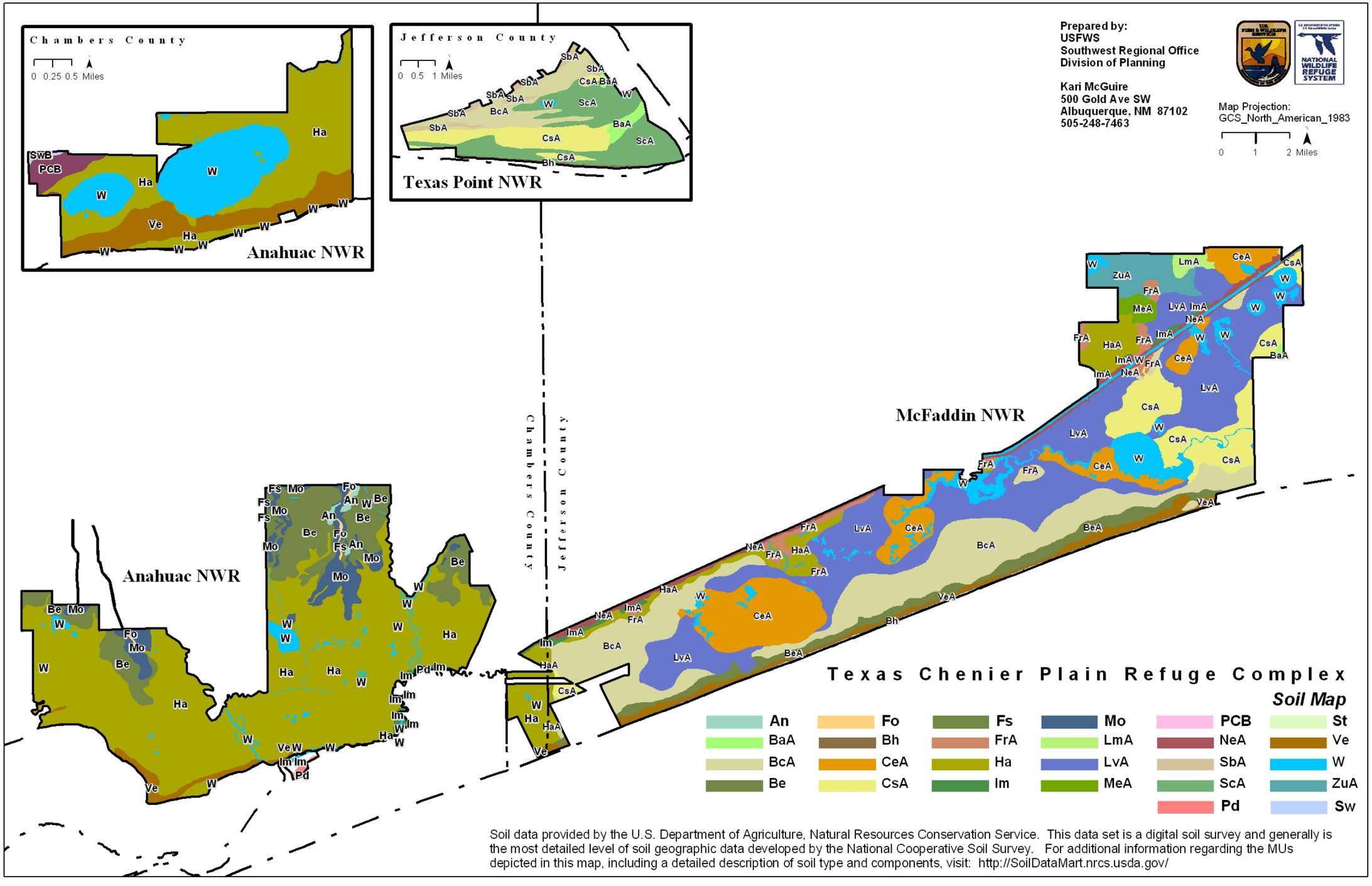
Three principal soil associations are found on the Refuge Complex and include: Morey-Crowley-Hockley Association consisting of silty soils of the coastal prairie; Harris-Made Land Association comprised of clay soils of the coastal marsh and spoil from dredging and similar operations; and the Sabine-Coastal Land Association consisting of mixed soils of the coastal prairies and coastal marshes (USFWS 1994).

The most prevalent soil association is the saline Harris-Made Land Association found within the Refuge Complex' intermediate, brackish, and saline marsh habitats. These areas consist of broad flats covered with coarse, salt tolerant vegetation. The flats are occupied mostly by Harris Soils. This is the predominant soil type found in the South Unit of McFaddin NWR. Other wetland soils located in pockets within the Refuge Complex consist of the Crowley-Waller complex. Both the Crowley and Waller soil series are level, deep, poorly drained, loamy soils which have mottled lower layers and moderately high available water capacity. Salty prairie habitats are underlain with both natural soils which are deep moderately saline clays, and the Made Land soils, which are stratified clay and loamy materials that have been excavated from canals, ditches, bayous and the GIWW. These soils are affected by salt spray, storm tides, and salty high water tables restricting the kind and density of plants present.

The upland habitats (prairies and coastal ridges) of the Refuge Complex are composed of the well-drained Sabine soils (predominantly acid Moray silt loam, Anahuac silt loam, and saline Veston loam). Coastal Land soils are found on the lower slopes of these sandy ridges and along the Gulf. These soil types form the Sabine-Coastal Land Association. The shoreline of Jefferson County is made up of this Association and the Saltwater Marsh Tidal Association. Coastal soils generally consist of deep, dark colored and slightly acidic sands. As remains of ancient Gulf of Mexico beaches, they are relatively low in nutrients. Specifically, the coastal soils differ dramatically in PH, color, texture, available water capacity, and drainage.

The project area's Gulf beaches are composed primarily of tidal marsh and Galveston fine sand which have virtually no organic matter, are excessively drained, and have a low available water capacity. The Gulf beach within the McFaddin NWR has a high percentage of shell material, reflecting a scarcity of sand. Clay outcroppings from the underlying strata are exposed in many areas following erosive events such as tropical storms and winter frontal passages.

The entire Texas Gulf Coast has been identifies by the U.S. Geological Survey as having geothermal potential.


Chambers County
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Texas Point NWR
Chambers County
Jefferson County
Anahuac NWR
McFaddin NWR
Prepared by:
USFWS
Southwest Regional Office
Division of Planning
Kari McGuire
500 Gold Ave SW
Albuquerque, NM 87102
505-248-7463
Map Projection:
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Texas Chenier Plain Refuge Complex
Soil Map
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Soil data provided by the U.S. Department of Agriculture, Natural Resources Conservation Service. This data set is a digital soil survey and generally is the most detailed level of soil geographic data developed by the National Cooperative Soil Survey. For additional information regarding the MUs depicted in this map, including a detailed description of soil type and components, visit: http://SoilDataMart.nrcs.usda.gov/

### 4. Relative Sea Level Rise

Relative sea level rise is the combination of land subsidence and eustatic sea level rise. Recently, the combination of rising sea levels and land subsidence and altered hydrological regimes have impacted many coastal processes, including geological processes such as erosion, sedimentation and soil formation. Coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem are being heavily impacted. Accelerated coastal land loss is occurring, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

Most of the present Gulf of Mexico shoreline and shorelines of major bays and inland lakes in the Chenier Plain region are retreating. The existing beaches are eroding and being deposited back over marshes or bay bottoms. Former bay bottoms and incised river valleys provide the nearshore sources of coarse grained sediment and broken shell that make up the beaches. The scarcity of coarse sediments in this littoral system contributes to the relative scarcity of well-developed offshore bars and onshore beaches and dunes.

Although shoreline retreat and along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as recent geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). Subsidence can also occur locally during periods of drought through surface dehydration, oxidation and shrinkage in the region's highly organic soils. Marsh fires during these conditions can also result in loss of surface elevation.

In addition to ongoing impacts, relative sea level rise poses a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration website, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise.

A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has also accelerated rates of shoreline retreat and coastal land loss along the Gulf shoreline. This reduced sand supply has contributed to the loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion and retreat by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges. Shoreline erosion and retreat along the Gulf of Mexico in the project area is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. The historic barrier beach/dune system has been almost entirely loss on both the Texas Point and McFaddin NWRs. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline is eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of beach and dune habitat, this loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease of the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water. (On McFaddin NWR, coastal erosion and damage from storm tidal surges have also destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Conversion of vegetated marshes to open water has occurred throughout the region in areas where rapid land subsidence resulted in submergence of wetlands. Relative sea level rise is resulting in increased saltwater intrusion further inland into both surface waters and underground freshwater aquifers. Increased saltwater intrusion due to relative sea level rise may decrease plant productivity and impact soil formation and marsh surface elevation gain, and future relative sea level rise threatens existing vegetated marshes with submergence and conversion to open water. Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation and drainage channels have caused plant mortality, peat collapse and erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. It is likely that these impacts have been and will be the most severe in areas subject to both saltwater intrusion and rapid subsidence.

## C. Hydrology

The historical pattern of hydrology in the Chenier Plain region was critical to the building processes that created and maintained the diversity of its coastal wetlands. Frequent flooding over low bayou banks and large volumes of rainwater flowing slowly across coastal prairies and marshes provided nutrients, sediments, and freshwater to marsh systems. Natural drainage allowed a cyclic pattern of drying and flooding under which wetland plants evolved and adapted. Over the past 5000 years, the Chenier Plain region was predominately a freshwater coastal marsh system, but contained a continuum of coastal marsh types associated with a natural salinity gradient. This continuum of freshwater, intermediate, brackish, and saline wetlands supported a diversity of floral and faunal communities.

Modifications of regional hydrology have affected ecological and geological processes critical to the long-term integrity of coastal ecosystems in the Chenier Plain region. In general, the primary human induced activities that have affected coastal wetlands include construction of the GIWW and smaller navigation canals, oil, gas and groundwater extraction, and channelization and deepening of natural waterways for navigation and inland drainage. The consequences of these activities have resulted in various ecological responses, some of which are directly responsible for the onset of others (Stutzenbaker 1990, White and Tremblay 1995):

- Saltwater now reaches farther inland into historically freshwater marshes altering the plant species composition and plant productivity. Overall, biological diversity decreased through the conversion of fresh and intermediate marshes to more brackish regimes and salt-tolerant plant and animal communities. Saltwater intrusion also introduced sulphates to these freshwater marshes, which under conditions of high water temperatures during summer are reduced to hydrogen sulphide. Sulphide toxicity can cause plant die-offs and has been implicated in a as a contributing factor in the conversion of vegetated emergent marsh to open water.

- New channels and modifications of natural waterways introduced tidal energies into historically non-tidal or micro-tidal marshes, resulting in decreased plant productivity, plant mortality, peat collapse and erosive loss of organic marsh soils. All have contributed to the conversion of the vegetated emergent marsh to open water. Introduction of tidal influence also altered marsh hydroperiods or wetting and drying cycles. Non-tidal and microtidal marshes whose soil surfaces were exposed only seasonally or during periods of drought became subject to daily tidal fluctuations.

- Increased saltwater intrusion reduces plant productivity in plant communities adapted to fresher hydrological regimes. Plant productivity, especially below-ground biomass in root systems, is an important component of soil formation in the Chenier Plain region's fresher coastal marshes. Reduced plant productivity may reduce soil formation and limit marsh surface elevation gain.

- Alterations to the natural drainage systems in the region have resulted in a rapid transport of freshwater and sediments from inland areas directly to the GIWW, bays and the Gulf, and have

generally eliminated the slower historic sheet flow of freshwater from the prairies into the marshes. Historic hydroperiods in the marshes have been altered as rapid drainage of inland flood waters has increased the frequency and depth of precipitation-driven flood events in downstream marshes. Conversely, drainage improvements in and adjacent to the marshes has promoted more rapid drainage and drying during normal or low precipitation cycles.

- Natural and human-caused subsidence has resulted in submergence or "drowning" of emergent wetlands and conversion to deeper, open water. Natural subsidence is the compaction of recent geologic sediments. Human-induced subsidence in the region occurs primarily from groundwater withdrawal and oil and gas extraction. Oil and gas extraction is believed to induce movement of near-surface geologic faults, causing a rapid drop in marsh elevation (White and Tremblay 1995). Subsidence also contributes to saltwater intrusion and is a causative factor in shoreline erosion/retreat and resultant coastal land loss along the Gulf, bays and larger waterbodies. The mean sea level trend for Sabine Pass, Texas is 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions.

**1. Drainage Basins**

Several systems of rivers and lakes cross the Chenier Plain from north to south and divide it into six fairly distinct drainage basins. The southeastern Gulf Coast of Texas is located within the East Bay Basin of Galveston Bay and the Sabine Basin (Gosselink *et al.* 1979). Anahuac NWR and the western portion of McFaddin NWR are located within the East Bay drainage basin of the larger Galveston Bay system, which is one of the most productive estuaries for fish and shellfish on the Texas Coast (Gosselink *et al*. 1979). East Bay is bound on the north by fresh and brackish marshes and on the south by Bolivar Peninsula which separates it from the Gulf. Anahuac NWR has a seven mile shoreline on East Bay. The primary freshwater source to this basin is rainwater, indirect freshwater input from the San Jacinto and Trinity Rivers, and freshwater inflows from the Sabine Basin which drain into and flow through the GIWW into this basin. The GIWW traverses the East Bay drainage basin.

This shallow and meandering watershed often has no distinct delineation between the drainage boundaries because of the relatively flat terrain and variability in natural and man-made factors influencing drainage patterns. Robinson Bayou, Oyster Bayou, Onion Bayou, East Bay Bayou, Elm Bayou and Mud Bayou constitute the natural drainage system of

East Bay. Anahuac NWR receives its freshwater inflows through Robinson Bayou, Oyster Bayou, Onion Bayou, East Bay Bayou and Elm Bayou, and though a series of irrigation canals and ditches. Many small meandering marsh streams also contribute to drainage patterns.

The western third of McFaddin NWR drains to the GIWW via Mud Bayou. Freshwater inflow to the western portion of the McFaddin NWR is restricted to local rainfall and that provided from the GIWW through Mud Bayou when the GIWW is fresh. The central and eastern portions of McFaddin NWR and all of Texas Point NWR are located within the Sabine basin. Salt Bayou drains the South Unit of McFaddin NWR from west to east through Star Lake and Clam Lake, and on to the GIWW or the Sabine-Neches Ship Channel via the Keith Lake Fish Pass. Prior to the construction of the GIWW, the Keith Lake Fish Pass and the Sabine-Neches Ship Channel, Salt Bayou was a tributary of Taylors Bayou, which flowed eastward from their confluence to its outlet into Sabine Lake. Texas Point NWR is drained from west to east by Texas Bayou and several man-made canals and ditches to the Sabine-Neches Ship Channel.

**2. Flooding**

The average annual precipitation in the project area is approximately 55 inches which includes many high and intense individual storm events. As a result, flooding is common. Alterations of the natural topography, primarily to promote drainage of the inland portions of watersheds have exacerbated flooding in the downstream portions of the watershed.

Lands within the project area and the Refuge Complex are susceptible to coastal flooding associated with tropical storms, hurricanes, and during periods of heavy precipitation. Inland flooding can damage existing infrastructure (buildings, roads, levees, power poles, mining operations, oil/gas wells, and storage tanks) depending on the level and extent of flood stage. However, freshwater from these events can be ecologically beneficial by recharging the freshwater wetlands and providing nutrient and sediment to these areas. The lands directly along the Gulf Coast are most susceptible to flooding from tidal surges. Erosional scouring and saltwater intrusion associated with storms can result in the loss of freshwater emergent and aquatic vegetation and an increase in open water habitat, particularly in areas subjected to long-term inundation with saltwater.

**3. Water Quality**

Surface water quality in the region, project area and the Refuge Complex is influenced by industrial and agricultural practices and saltwater intrusion. The movement of saltwater from the Gulf and bays inland through the bayou and marsh systems varies depending upon tidal action, storms, and storm runoff. Within the project area, channel construction including the GIWW and channelization of natural waterways have facilitated the movement of saltwater further inland than what occurred historically or what would occur under natural conditions. The level and impacts of saltwater intrusion vary by area.

Agricultural lands supporting rice cultivation within the surrounding lands contribute nutrients and toxins to surface waters within coastal watersheds. The application of herbicides is used in the farming of rice, soybeans, sorghum, and hay. Rice farming dominates in this area of the Texas Chenier Plain. Concentrations of herbicides are generally greatest during May, June, and July with the lowest concentrations occurring in the fall and winter. The herbicide, Molinate, is the most commonly used chemical on rice and was found in the highest concentrations of the herbicides (USGS, Open-File Report, 96-124). Both Atrazine and Metolachlor were detected in about 70% of the water samples taken in the National Water Quality Assessment Program (ibid) for the coastal prairie agricultural area of the Trinity River Basin. The insecticides, Carbofuran and Diazinon, were the most commonly detected chemicals, but they were only found in less than 25% of the samples taken (*ibid)*. The values for Atrazine and Carbofuran were less than the Maximum Contamination Level (MCL) set by EPA for drinking water (NAWQA Fact Sheet 1994). There are no MCL values set by the EPA for Metolachor, Molinate, or Diazinon for drinking water or aquatic organisms in fresh or saltwater.

Nitrates from nutrient loading were common in agricultural areas in the Trinity River Basin study area, where fertilizer application resulted in nonpoint source discharge into streams, creeks, and bayous during

storm events herbicides (USGS, Open-File Report, 96-124). Nitrate concentrations were not detected at levels that would cause adverse impacts, but increased nitrogen and phosphorous levels can result in biochemical depletion of oxygen in surface water

Sediment, aquatic invertebrates, and fish tissue samples were collected from four locations (wetlands, bayous, and other waterways) on the Anahuac NWR for a contaminant survey conducted by the USFWS Division of Ecological Services in 1992. Contaminants examined in the analysis included organochlorine and organophosphate pesticides, heavy metals, and petroleum hydrocarbons. Analysis indicated that only two areas had minor contaminant problems. Petroleum hydrocarbons contaminate the irrigation canal sediment near a diesel powered lift pump and the bottom sediments of Jackson Ditch near a petroleum production area. Four heavy metals, chromium, copper, nickel, and silver were also present at elevated levels in the sediment of Jackson Ditch, relative to other locations on the Refuge.

Other potential sources of contaminants affecting Refuge lands and waters include oil spills, leaks, and contamination from oil production and transport (active wells, pipelines, petrochemical shipping in the GIWW), aerial deposits of airborne contaminants from area refineries, point source pollution from upstream facilities such as landfills, and non-point source pollution from storm water run-off from municipal and industrial developments.

Although not directly related to water quality, avian disease such as cholera and botulism, which can affect and kill large concentrations of migratory birds, is influenced by the availability of freshwater. Disease outbreaks usually occur during periods when high concentrations of waterfowl are in the area, temperatures are mild, and less than normal wetlands or open water habitats are available to maintain large concentrations of birds. Large concentrations of birds in wetland areas can quickly deteriorate the water quality of those areas, factors which propagate the spread of disease. During periods of avian disease outbreaks, immediate clean up is essential as well as draining areas where disease outbreaks have occurred and pumping freshwater to provide additional freshwater habitat to disperse bird concentrations and alleviate the transmission of cholera. To date, major disease outbreaks of botulism, avian cholera, or duck virus enteritis have not occurred on the Refuge Complex. Field monitoring of waterfowl concentrations on the Refuge Complex is conducted weekly during the wintering season, in combination with monthly aerial surveys, to provide early detection of disease outbreaks.

Groundwater is shallow in the area and in many cases groundwater levels are at the surface. The availability and quality of groundwater for domestic supply or recreational use throughout a majority of the study area is generally unknown. The deeper Gulf Coast aquifer may yield large quantities of water, but there is little indication that large volume groundwater pumping is common or economically sound. The larger water wells generally are associated with domestic supply for the small communities in or adjacent to the Complex (USFWS, Engineering Assessment, 1998).

The limited data available on groundwater quality indicates that nitrates were the only nutrients measured in groundwater within the study area (USGS, WRIR94-4086, 1995). The concentration in shallow wells was greater than the concentrations in the deeper wells (*ibid*).

**4. Water Rights**

Open water habitats that are classified as navigable waters include rivers, bayous, streams, and all bay habitats that are under the jurisdiction of the State of Texas. Texas surface waters are owned by the state and appropriated by the state to specific lands for beneficial use. Texas is characterized as an appropriative water right state like most of the western states, but does have cases where riparian rights have been recognized. Surface water may be diverted or stored for beneficial use if water rights are appurtenant to the land (USFWS, Engineering Assessment, 1998). One exception is related to groundwater that discharges from a spring or seep to the surface. The volume of the spring or seep outflow is owned by the landowner and may be utilized by the landowner on the appurtenant lands. Once the outflow from the spring reaches a natural water course and leaves the landowners property, it falls under the ownership and jurisdiction of the state.

Anahuac NWR and McFaddin NWR have water rights associated with the Trinity River Basin and the western portion of the Neches-Trinity Coastal Basin (final determination October 30, 1985). The Anahuac NWR is entitled to diversion and use of 21,000 acre feet of water per year from Oyster Bayou, tributary of East Bay, for wildlife purposes and irrigation of 825 acres of land. This water right identified three diversion points on the Oyster Bayou for a maximum combined rate of 88.89 cfs. With this water right (priority date of December 31, 1943), the USFWS can maintain reservoirs and impound 1,025 acre feet of water. Impounded water is used to maintain the following marsh units: Shoveler Pond, approximately 800 acre feet; Teal Slough, approximately 150 acre feet; and Marsh Pond, approximately 75 acre feet (Claim #2084, Certificate of Adjudication 07-4296, 1985).

Water rights associated with the East Unit of Anahuac NWR authorize diversion from two points on Onion Bayou, tributary of Oyster Bayou (priority date of September 21, 1970). This water right allows for the diversion and use of 5,932 acre feet of water annually from Onion Bayou to irrigate a maximum of 1,853.75 acres of land out of a 12,779.50 acre tract with a maximum rate of 26.67 cfs. The water rights also allow for the impoundment and storage for subsequent use 952 acre feet to maintain two off channel reservoirs at 604 acre- foot and 348 acre-foot capacities (Permit #2623, Certificate of Adjudication 07-4302, 1985). This water right was amended in May 2005 (Certificate No. 07-4302A) to allow the diversion of water anywhere along two segments of a tributary to Onion Bayou and at two additional diversion points on Onion Bayou. To maintain these water rights, an annual water report must be filed with the Texas Commission on Environmental Quality by the first of March of each year.

Most drainage ditches and agricultural water delivery systems are owned and maintained by county navigation and drainage districts, or similar agencies. Acquiring and receiving irrigation water on Refuge Complex lands is currently possible from one of two water-related authorities in the area, the Chambers-Liberty Counties Navigation District and the Lower Neches Valley Water Authority.

Lands within the study area that receive irrigation water either have water rights and pump from the creeks and bayous or purchase water from the above mentioned water purveyors. These irrigation and drainage districts provide water on a per acre or acre-foot basis which costs from approximately $45 per acre in the Lower Neches River Authority to $85 per acre in the Chambers-Liberty Counties Navigation District (USFWS, Engineering Assessment, 1998). These costs are based on irrigation delivery for rice farming which use between 3.5 and 4.0 acre-feet/acre/year. Wetland management generally requires less water per acre (approximately one-third the water) than what is required for rice farming. Therefore, water costs for wetland management could be less on a per acre basis than for rice farming.

## D. Mineral Resources

Oil and gas exploration and development has occurred within the project area for over 100 years. The famous “Spindletop Dome” discovery well which came in as a “gusher” on January 10, 1901, is located just to the north of McFaddin NWR in Jefferson County. This discovery well and the subsequent oil boom ushered in the modern age of petroleum. The gusher at Spindletop was responsible for creating several companies that were to become giants in the oil industry, including Gulf Oil, Amoco, and Humble Oil Company (later to become part of Exxon).

The following discussion is limited to mineral resources and related easements within the Refuge Complex. The USFWS does not own mineral interest underlying the lands within the Refuge Complex and must provide reasonable access to mineral owners to explore and develop their mineral interests under the Texas laws governing interests in real property.

Oil was discovered along the northwest shoreline of Clam Lake, now part of the McFaddin NWR, in 1947. Subsequently, several wells were drilled in what became the Clam Lake field. Only a small number of wells are currently producing. The oil field encompasses approximately 100 acres, and includes separator facilities and tank batteries. PAPCO, Inc. is the current leaseholder/operator of the Clam Lake field. Oil and gas produced is transported by pipelines to temporary storage facilities located on the GIWW and then to distant refining facilities by barge. Oil and gas exploration and development has occurred throughout the Refuge, and infrastructure (well pads, levees, roads, gathering lines, etc.) from these

activities remains. There are currently no producing wells outside of the Clam Lake field on the Refuge. Although not within the Refuge Complex, the Coalinga field north of Sabine Pass is located in the eastern portion of the Salt Bayou watershed. Extraction of subsurface fluids in both these oil fields are believed to have caused localized land subsidence through activation near-surface geologic faults, which likely contributed to conversion of emergent marshes to open water in the Salt Bayou marshes south of the GIWW (White and Tremblay 1995).

Until recently, British Petroleum-Vastar Inc. operated an onshore oil and gas processing facility located on a 17-acre privately-owned tract on the Gulf shoreline within McFaddin NWR. This facility received crude oil and natural gas from offshore wells in the Gulf of Mexico and conducted the first stage processing of these products. The facility ceased operations in 2004, and most equipment and buildings have been removed from the site.

Easements for buried pipelines within McFaddin NWR are held by several companies. A 50-foot pipeline easement is held by United Gas Company for a 16-inch natural gas pipeline from the British Petroleum-Vastar facility north across the Refuge to private property located along the GIWW. A 50-foot easement is held by Scurlock Oil Company for a six-inch crude oil pipeline paralleling the aboveground 16-inch line. Scurlock also holds a 50-foot easement for a four-inch crude oil line located along the Gulf of Mexico shoreline. Shell Company/Exxon USA holds a 50-foot easement for a three-inch natural gas pipeline from private property (Phelan property) along the GIWW to the Clam Lake oil field. The U.S. Department of Energy holds an easement for a buried 48" pipeline that carries brine from the Big Hill Strategic Petroleum Reserve to the Gulf of Mexico.

No active oil and gas wells are present on Texas Point NWR at this time. Several inactive gas wells exist on the southeast end of the Refuge. Two natural gas/crude oil pipelines cross Texas Point NWR. A waterline also exists along the western boundary of the Refuge.

Oil and gas exploration and development has also occurred throughout the Anahuac NWR, and infrastructure associated with formerly producing wells remains. The Roberts-Mueller oil and gas field was developed in the 1950's and 1960's, and is the site of the most-concentrated oil and gas exploration and development on the Refuge. A large number of wells were drilled in this field, although only a few are currently producing. Houston Oil Producing Enterprises, Inc. and Magnum Producing, LP are the current leaseholders/operators of the Roberts-Mueller field, which includes two tank batteries. Kerr-McGee Oil and Gas Onshore, LLC currently holds exploration and development leases and recently drilled three producing wells on the northern portion of the East Unit on the Refuge. These wells and associated production facilities are now owned by Denbury Onshore, LLC. Product from the wells is transported via gathering lines to an off-refuge separator/tank battery facility located north of F.M. Road 1985. In 2006, Denali Oil and Gas drilled a successful well along East Bay in the Mitigation Tract of the Refuge. Natural gas from this well is separated on site and piped to a nearby natural gas pipeline. Produced liquids are transported via gathering lines to off-refuge production facility.

There are several pipeline easements within Anahuac NWR. The Centana Pipeline Co. holds an easement for a 12"natural gas pipeline which comes onshore from Galveston Bay near Robinson Bayou and traverses the western portion of the Refuge. A Rutherford Oil Company 6" natural gas pipeline crosses the Mitigation Tract Unit of the Refuge and connects to the Centana pipeline. A small above-ground metering station is located near the intersection of these pipelines. Both the Rutherford pipeline and metering station are permitted under a Refuge Special Use Permit. The Winnie Pipeline Co. holds an easement for a natural gas pipeline which traverses the Roberts-Mueller and East units in the central portion of the Refuge. Kerr-McGee transports natural gas produced from two wells on the Refuge via a connecting pipeline from their separator facility north of F.M. Road 1985 back south and west through the Refuge and connects to this pipeline.

Extensive seismic surveys have been conducted throughout the Refuge Complex, including several recent 3-D surveys conducted from 1995-2005. These recent seismic surveys have covered almost all of Anahuac, Moody, McFaddin and Texas Point NWRs.

Effective management of the mineral program of the Refuge Complex requires a considerable amount of coordination with lessee/operators, development and issuance of Special Use Permits, site inspections, and mitigation for impacts to wildlife and habitat. Management of oil and gas activities requires coordination with state agencies including the Texas Railroad Commission and the Texas General Land Office regarding compliance with State statutes governing oil and gas activities. Coordination with these and other agencies including the Environmental Protection Agency, U.S. Coast Guard, U.S. Army Corps of Engineers, National Marine Fisheries Service and the Texas Parks and Wildlife Department is also required in response to accidental releases and spills.

# II. BIOLOGICAL RESOURCES

## A. Vegetation and Habitats

Wetland habitats within the project area include coastal marshes, forested wetlands along major river and bayou systems, natural and man-made wetlands (reservoirs, livestock ponds, rice fields) associated with upland prairies inland of the marshes, and open water of bays, rivers, bayous and other waterways. Wetland habitats include estuarine, palustrine, riverine and lacustrine wetlands (Moulton *et al*. 1997).

The intermediate, brackish and saline emergent coastal marshes found in the project area and the Refuge Complex are classified as estuarine intertidal emergent wetlands (USFWS, National Wetlands Inventory). Freshwater wetland habitats within the project area include palustrine emergent marsh (fresh marsh and wet prairie), palustrine farmed wetlands (rice fields) and some natural “prairie wetlands”, and these are also important habitats on the Refuge Complex. Palustrine forested wetlands occur near the mouth of the Trinity River and along Taylors Bayou within the project area, but this habitat type is not represented on the Refuge Complex. Estuarine intertidal emergent, palustrine emergent, and palustrine forested wetlands are all recognized as nationally-declining wetland types (USFWS, National Wetlands Inventory).

The primary upland land use within the project area is agriculture, and most upland habitats are now agricultural lands (croplands, improved and unimproved pasture or rangeland). Rice is the primary crop produced in the project area, and livestock production (cattle) is the other primary agricultural activity.

Over 9 million acres of native tallgrass prairie once occurred along the Gulf Coast in Texas and Louisiana. It is now estimated that 99.8% and 99.6 % of little bluestem and eastern gamma grass/switch grass prairies, respectfully, have been lost in Texas (McFarland 1995). Fragmented remnants of the historic native tallgrass coastal prairie occur in the project area, with some very small (less than 25 acres) remnants occurring on the Refuge Complex. Concurrent with the conversion of the native prairie to agricultural and other land uses was the loss of most natural “prairie pothole” wetlands. Native prairie remnants in the project area contain some of these natural freshwater wetlands. Moist soil management is an intensive habitat management practice on the Anahuac NWR which is aimed at restoring some of the functions of natural prairie wetlands.

Other upland habitats found in the project area and on the Refuge Complex include beach ridges/dunes and small coastal woodlots located on the chenier ridges or on elevated features (both natural and man-made) including bayou banks and levees. A few larger tracts of upland forest are found in the project area.

### 1. Wetland and Aquatic Habitats

#### a. Estuarine and Palustrine Emergent Wetlands

Estuarine and palustrine emergent wetlands in the project area and the Refuge Complex include the continuum of coastal marsh types found in the Chenier Plain region, from fresh to saline along a salinity gradient. This continuum includes the palustrine freshwater marshes, whose average water salinity is less than 0.5 parts per thousand. Estuarine marshes include intermediate marsh (salinity range for 0.5 to

<5.0 ppt with an average salinity of 3.3 ppt), brackish marsh (salinity range of 5.0 to 18.0 ppt with an average salinity of 8.0 ppt), and saline marsh with salinities over 18.0 ppt. Emergent and aquatic plant species have different tolerances to salinity, and water and soil salinities are therefore important factors influencing plant species composition (and fish and wildlife species composition) in the various marsh types. Table 3-2 lists the common indicator plant species for the emergent marsh types and aquatic habitats occurring in the project area.

Both local precipitation and drainage of inland waters along natural and man-made waterways provide freshwater inflows to the project area's coastal marshes. The freshwater marsh and wet prairies generally occur adjacent to the upland prairies, where freshwater from precipitation and/or inland drainage accumulates in level and low-lying areas. These palustrine emergent wetlands are non-tidal, and receive influx of saltwater only under high storm surge conditions generated by the more severe hurricanes and tropical storms. Plant species found exclusively in the freshwater marsh are intolerant of salt except at very low levels. Emergent plants restricted to fresh marsh include rice cutgrass and giant cutgrass. The intermediate marsh generally lies seaward of the fresh marsh. These estuarine marshes are primarily micro-tidal, i.e., they are not subject to daily tidal action, but receive influxes of saltwater during higher tides associated with storms and the vernal and autumnal equinoxes.

Table 3-2.
Common Plants of Wetland and Aquatic Habitats

| Marsh Type | Associated Plant Species (Common and *Scientific* Name) |
|---|---|
| Saline | smooth cordgrass *Spartina alterniflora*<br>glassworts *Salicornia spp.*<br>marshhay cordgrass *Spartina patens*<br>maritime saltwort *Batis maritima*<br>seashore saltgrass *Distichlis spicata*<br>blackrush *Juncus roemerianus*<br>saline marsh aster *Aster tenuifolius*<br>Carolina wolfberry *Lycium carolinianum*<br>bushy sea-oxeye *Borrichia frutescens* |
| Brackish | saltmarsh bulrush *Bulbuschoesus robustus*<br>widgeon grass *Ruppia maritima*<br>dwarf spikerush *Eleocharis parvula*<br>marsh pea *Vigna luteola*<br>water hemp *Amaranthus australis*<br>marshhay cordgrass *Spartina patens*<br>seashore saltgrass *Distichilis spicata* |
| Intermediate | Olney bulrush Bulbuschoesus olneyi<br>coastal water-hyssop Bacopa monnieri<br>California bulrush Scirpus californicus<br>banana waterlily Nymphaea mexicana<br>Colorado river hemp Sesbania macrocarpa<br>marshhay cordgrass Spartina patens<br>seahore paspalum Paspalum vaginatum<br>baby pondweed Potamogeton pusillus<br>sand spikesedge Eleocharis montividensis<br>narrow leaf cattail Typha angustifolia<br>common reedgrass Phragmites australis<br>spikerushes Eleocharis spp.<br>sago pondweed Potamogeton pectinatus<br>coast cockspur Echinochloa walteri<br>sprangletop Leptochloa spp. |

| | |
|---|---|
| Fresh | maiden cane *Panicum hemitomon*<br>duckweed *Lemna spp.*<br>giant cutgrass *Zizaniopsis miliacea*<br>fanwort *Cabomba caroliniana*<br>rice cutgrasses *Leersia oryzoides*<br>watershield *Brasenia schreberi*<br>marsh millet *Echinochloa spp.*<br>American lotus *Nelumbo lutea*<br>arrowheads *Sagittaria spp.*<br>blatterworts *Utricularia spp*<br>white waterlily *Nymphaea elegans*<br>marshhay cordgrass *Spartina patens*<br>alligatorweed *Alternathera philoxeroides*<br>Jamica sawgrass *Cladium jamaicense*<br>Southern naiad *Najas quadalupensis*<br>smartweed *Polygonum spp.*<br>flat sedges *Cyperus spp.*<br>sand rush *Eleocharis montevidensis*<br>sprangletop *Leptochloa spp.*<br>longtom *Paspalum lividum*<br>burheads *Echinodorus spp.*<br>squarestem spikerush *Eleocharis quadrangulata*<br>Sesbania *Sesbania spp.* |
| Inland<br>Open water* | sago pondweed *Potamogeton pectinatus*<br>duckweed *Lemna spp.*<br>Southern naiad *Najas guadalupensis*<br>waterlettuce *Pistia stratiotes*<br>wigeon grass *Ruppia maritima*<br>alligatorweed *Althenathera philoxeroides*<br>water hyacinth *Eichlornia crassipes* |
| Forested Wetlands<br>(true swamps) | bald cypress *Taxodium distichum*<br>water tupelo *Nyssa aquatica*<br>buttonbush *Cephalanthus occidentalis*<br>swamp privet *Ligustrum sinense* |
| *Inland Open Water (rivers, estuaries, drainage ditches, tidal creeks, bayous, reservoirs, lakes, ponds, navigation canals) | |

Intermediate marsh is the predominant marsh type on the Refuge Complex, and contains the greatest overlap of plant species whose salinity tolerances range from fresh to brackish. Common emergent plants include marshhay cordgrass, Olney bulrush, and seashore paspalum. Brackish marshes receive greater tidal influence than the intermediate marshes. Common emergent plants include marshhay cordgrass, seashore saltgrass, and saltmarsh bulrush. Saline marshes are subject to daily tidal influence. Smooth cordgrass and black rush are the two dominant emergent plant species found in the saline marshes.

The full continuum of marsh types supports highly diverse and productive biological communities, and conservation of biological diversity in the project area is dependent on maintaining this continuum of wetland habitats. Plant and animal diversity is greater in the fresh and intermediate marshes than in the brackish and saline marsh types. Intermediate marsh receives the highest use of any of the marsh types by wintering and migrating waterfowl and by many wading bird species. Fresh, intermediate and brackish marshes are extremely important to migratory waterfowl. Brackish and saline marshes provide important habitat for many shorebird and colonial-nesting waterbird species, and are the primary nursery habitat for

larval and post-larval stages of many commercially and recreationally-important marine fish and shellfish species.

Palustrine emergent wetlands within the project area include natural “prairie wetlands”. Prior to the conversion of native prairie to agricultural and other land uses, these isolated, shallow freshwater wetlands were interspersed throughout the region’s native coastal prairie grasslands. From mid-1950s to the early 1990s, losses of palustrine emergent wetlands were the greatest among all wetland types on the Texas Gulf Coast (Moulton *et a*l. 1997). Over 235,000 acres were lost during this period, and the average annual net loss for these wetlands was 6,355 acres. Rural and urban development and conversion of the native prairie to agricultural land uses were the primary causative factors. Within the project area, these natural prairie wetlands can currently be found only within the few remnant stands of uncultivated native prairie.

Palustrine farmed wetlands within the project area are primarily in some form of rice production (Moulton *et al*. 1997). Flooded rice fields and rice fallow provides valuable wetland habitat for migratory birds and other wildlife. Approximately 500-700 acres of rice are farmed annually on the Anahuac NWR through a cooperative farming program, and cropland habitat on the Refuge is intensively managed for wintering and migrating waterfowl, shorebirds and other wetland-dependent migratory birds.

**b. Palustrine Forested Wetlands**

Palustrine forested wetland habitats contain woody communities where the soil is saturated or covered with water for one or more months during the growing season. Two types of forested wetland habitats occur in the project area: 1) the alluvial forest that grades from cypress-tupelo swamp to bottomland hardwood forest and is generally flooded on a seasonal basis when river discharge is high, and 2) true swamps that are dominated by cypress-tupelo forest and are flooded most of the year (Gosselink *et al.* 1979, 1982). Forested wetlands have similar functions and values as emergent wetlands with the added dimension of the tree canopies providing valuable habitat for songbirds. Within the project area, forested wetlands occur along Taylors and Mayhaw bayous and near the mouth of the Trinity River. This habitat type does not occur within the current boundaries of the Refuge Complex.

Alluvial forests are dominated by a wide variety of trees, shrubs, vines, and herbs (Gosselink *et al.* 1979, USFWS 1982, 1985a, 1994, 1998). Seasonal overbank flooding from adjacent rivers, streams, and bayous provides optimum conditions for growth and development of plant species found in these habitats. The more common tree species in alluvial forests include water oak, red maple, cottonwood, boxelder, Carolina ash, overcup oak, maple, bald cypress, water tupelo, nuttall oak, and swamp privet (Table 3-2). Vines common in these habitats include poison ivy, trumpet creeper, greenbriar, and peppervine. Numerous herbaceous species are abundant in alluvial forests.

True swamps generally are less diverse than the alluvial forests, as a result of extensive periods of inundation (Gosselink *et al.* 1979, USFWS 1982, 1994, 1998). Common trees and shrubs in this habitat include bald cypress, water tupelo, button bush, and swamp privet. Vines and herbs are typically absent except during periods of excessive drought.

As a result of elevation differences and diverse nature of this habitat, forested wetlands typically support a diversity of terrestrial, arboreal, and aquatic species (Gosselink *et al.* 1979, USFWS 1982, 1985a, 1994, 1998). Use of this habitat is typically seasonal depending on factors such as the availability of food and cover. The variety and number of species present during the spring, summer, and fall are indicators of use during these periods with low numbers and variety during the winter period. The habitat is particularly important to insectivorous birds during the warmer months because of the large numbers of herbivorous insects present during this period. Forested wetlands provide optimum habitats throughout the year for resident mammals, birds, reptiles, amphibians, insects, aquatic invertebrates, and finfish.

### c. Aquatic Habitats

Aquatic habitats within the project area include open water and nearshore Gulf habitats (USFWS 1979, 1998). Inland open water includes all water bodies inland of beaches and passes including estuaries, rivers, drainage ditches, navigational canals, tidal creeks, bayous, reservoirs, lakes, and ponds collectively (Gosselink *et al*. 1979, USFWS 1998).

Inland open water habitats occur along a salinity gradient that ranges from below 0.5 ppt (fresh) to over 25.0 ppt (saline) (USFWS 1979, 1994, 1998). Plant communities vary greatly as the salinity changes along this gradient. Saline open water habitat is generally shallow and turbid and is not likely to support any rooted vascular plants. Phytoplankton are the most likely plant or plant like species to occur in this habitat. As salinity decreases, the potential for and diversity of vascular plants increases. Common vascular species include a number of rooted and floating aquatics such as wigeon grass, several pondweeds, banana waterlily and American lotus (Table 3-2). Salinity ranges in inland open water habitats have a significant influence on the plant and animal community composition that occur in these habitats (USFWS 1970, 1994, 1998). The salinity gradient supports high floral and faunal species richness.

## 2. Upland Habitats

Upland habitats within the project area include native prairie (non-saline and salty prairie) and other grasslands, upland forest and woodlots, and beach ridges and dunes.

### a. Native Coastal Prairie and Prairie Grasslands

Native salty prairie habitats are found on low-lying coastal ridges and flats which are slightly higher in elevation than the adjacent marshes. Plant communities typical of native salty prairie can also be found on elevated man-made features including dredge material deposits and levees. Underlying soils are of the Harris-Made Land Association, and are saline. Salty prairies are characterized by the presence of Gulf cordgrass as the dominant plant species. Other common native plants include knotroot bristlegrass, bushy bluestem, seaside goldenrod, western ragweed, wooly rosemallow, saltmarsh aster, seepweed, annual sumpweed and bigleaf sumpweed (Table 3-3). Highly disturbed salty prairie sites are likely to also include species such as rabbitfoot grass, shoregrass, bushy sea oxeye, and salt heliotrope. Salty prairie is an important nesting habitat for Mottled Ducks, a resident waterfowl species (Stutzenbaker 1988).

The salty land complex is found on nearly level areas along the coast, no more than one foot above mean high tide. This vegetation complex appears to be a result of erosion of salty prairies that now are influenced by storm and wind tides, a saline water table, and heavy salt spray. Included within the salty land complex are the transitional, salty prairie salt flats, beach overwash, salt barrens, and transitional mudflats. The plant community is composed of bushy sea oxeye, maritime saltwort, glasswort, sea lavender, shoregrass, seashore saltgrass, and small clumps of Gulf cordgrass.

Over 9 million acres of native tallgrass coastal prairie once occurred along the western Gulf Coast in Texas and Louisiana (Smeins *et al*. 1991). Based on remnant stands of native grasslands, prairies on the upper Texas coast were characterized by little bluestem, brownseed paspalum, and Indiangrass or eastern gammagrass and switchgrass associations, depending on hydrology (Diamond and Smeins 1984). It is now estimated that 99.8% and 99.6% of little bluestem and eastern gamma grass/switchgrass prairies, respectfully, have been lost in Texas (McFarland 1995). The little bluestem-brownseed paspalum community has been identified as a threatened natural community and the eastern gammagrass-switchgrass community has been identified as an endangered natural community by the Texas Organization for Endangered Species (Diamond *et al*. 1992). Both communities are assigned a Global conservation status rank of “Critically Imperiled” (G1) by The Nature Conservancy (2002).

| Table 3-3.<br>Common Plants of Terrestrial Upland Habitats within the project area. | |
|---|---|
| Upland Type | Associated Plant Species (Common and *Scientific* Name) |
| Salty Prairie | Gulf cordgrass *Spartina spartinae*<br>knotroot bristlegrass *Setaria geniculata*<br>seaside goldenrod *Solidago sempevirens*<br>eastern baccharis *Baccharis halimifolia* |
| Native Prairie<br>(non-saline) | little bluestem *Schizachyrium scoparium*<br>Indiangrass *Sorghastrum nutans*<br>switchgrass *Panicum virgatum*<br>brownseed paspalum *Paspalum plicatulum*<br>southwestern waxmyrtle *Myrica cerifera*<br>bushy bluestem *Andropogon glomeratus*<br>Panicum grasses *Panicum spp.* |
| Prairie Grasslands<br>(non-saline) | broomsedge bluestem *Andropogon virginicus*<br>bushy bluestem *Andropogon glomeratus*<br>brownseed paspalum *Paspalum plicatulum*<br>vaseygrass *Paspalum urvillei*<br>common Bermudagrass *Cynodon dactylon*<br>Brazilian verbena *Verbena brasiliensis*<br>seacoast sumpweed *Iva annua*<br>giant ragweed *Ambrosia trifida*<br>Southern dewbwerry *Rubus trivialis*<br>Eastern baccharis *Baccharis halimifolia*<br>Chinese tallow *Sapium sebiferum* |
| Upland Forests and Woodlots | hackberry *Celtis occidentalis*<br>mulberry *Morus rubra*<br>black willow *Salix nigra*<br>live oak *Quercus virginiana*<br>common persimmon *Diospyros virginiana*<br>sugarberry *Celtis laevigata*<br>prickly ash *Zanthoxylum clava-herculis*<br>slash pine *Pinus elliotii*<br>salt cedar *Tamarix gallica*<br>Chinese tallow *Sapium sebiferum* |
| Alluvial Forests | water oak *Quercus nigra*<br>red maple *Acer rubrum*<br>box elder *Acer negundo*<br>carolina ash *Fraxinus caroliniana*<br>overcup oak *Quercus lyrata*<br>bald cypress *Taxodium distichum*<br>water tupelo *Nyssa aquatica*<br>swamp privet *Ligustrum sinense*<br>poison ivy *Toxicodendron radicans*<br>trumpet creeper *Campsis radicans*<br>greenbriar *Smilax spp.*<br>peppervine *Amelopsis arborea* |

| Table 3-3.<br>Common Plants of Terrestrial Upland Habitats within the project area. | |
|---|---|
| Upland Type | Associated Plant Species (Common and *Scientific* Name) |
| Beach Ridges and Dunes | sea purslane *Sesuvium maritimum*<br>whorled dropseed *(sporobolus pyramidatus*)<br>saltmeadow cordgrass *(Spartina patens)*<br>bitter panicum *Panicum amarum*<br>white morninglory *Ipomoea stolonifera*<br>camphor daisy *Haglopappus phyllocephalus*<br>silver croton *Croton punctatus*<br>Virginia dropseed *Sporobolus virginicus*<br>Goat-foot morninglory *Ipomoea pes-caprae*<br>beach evening primrose *Oenothera drummondii*<br>glassworts *Salicornia spp.*<br>salt heliotrope *Heliotropium curassavicum*<br>sea-lavender *Limonium carolinianum*<br>bushy sea-ox-eye *Borrichia frutescens* |

Statewide in Texas, the coastal prairie has seen the greatest industrial development since World War II (Schmidly 2002). Most of the original coastal prairie has been lost because of direct conversion to other cover types, i.e. improved pasture, cultivated rice and other crops, and industrial, urban or suburban development. Additionally, remaining areas have been altered through a number of factors, primarily changes in fire, herbivory, and hydrology. Native prairies managed as pastures face such threats as homogenized burn regimes, overgrazing, and application of broadleaf herbicides. All these management practices are thought to reduce the floristic diversity that exemplifies coastal prairies (Allain and Johnson 1997). The introduction of non-native plant species has also impacted native coastal prairies on the Gulf Coast, and invasive exotic species such as Chinese tallow pose a significant threat to remnant prairies. Many of these remnant prairies are distributed in small patches along railroad tracks, wide fencerows, and well managed hay meadows. A recent survey in Louisiana, for example, found only 37 existing coastal prairie remnants (USGS, NWRC 2004). These remnants totaled 546.142 acres, ranging in size from 0.016 – 169.905 acres.

Remnant native prairie habitats generally lie inland of the coastal marshes on slightly drier upland sites. They occur on non-saline soils of the Sabine-Coastal Lands Association. Non-saline grassland and prairie wetlands are dominated by Beaumont, Morey and Frost soil types. It is recognized that the transition between marsh and prairie habitats is usually not distinct and certain species and vegetative communities are found in both habitats (Smeins *et al*. 1991). Typical of native prairie remnants in the project area are mid and tallgrass species such as little bluestem, big bluestem, Indiangrass, switchgrass, brownseed paspalum, Eastern gammagrass, and Gulf Coast muhly (Smeins *et al*. 1991, McFarlane 1995) (Table 3-3). Numerous forbs, legumes, and one native shrub, southern wax myrtle, are also present. Historically many of the prairie habitats had microknolls and microdepressions, called gilgai, caused by contraction and expansion of clays (Gustavson 1975). Other areas which have loamy soils and clays contain small sandy mounds called mima or pimple mounds (Deitz 1945). Mima mounds support remnant prairie plant communities. These mounds provide the topographic and hydrological variability believed responsible for much of the floristic diversity found in high quality coastal prairies (Grace *et a*l. 2000). Almost the entire historic native prairie habitat within the project areas has been leveled removing all gilgai, mima or pimple mound topography.

Seed viability in prairie plants is believed to be reduced in highly fragmented prairie landscapes due to loss of genetic variability as remnant stands become smaller and more isolated. Conservation of existing coastal prairie remnants in the project area is critical because they represent reservoirs of genetic material, and are extremely valuable sources of viable local seed and plant materials. Prairie plants on the upper Texas Coast evolved under relatively unique climatic conditions of high annual rainfall and

hydric soils, and future restoration of native prairie in the region depends on the protection of existing viable local seed and plant material sources.

Approximately 4,420 acres of mixed grassland non-saline uplands occur on the Anahuac NWR. Of this total, approximately 2,914 acres are permanently fallowed agricultural fields which have re-vegetated over time by native and non-native grasses, forbs and woody vegetation. Cover estimates within these habitats based on field transect surveys are as follows: native and non-native grasses represent 55% cover, forbs 19% cover, woody shrubs 4% cover, litter 4% cover and bare ground 18% cover (USFWS, unpublished data). Broomsedge bluestem, bushybeard bluestem, brownseed paspalum, Brazilian verbena, seaside goldenrod, western ragweed, annual seepweed are common native plant species on these sites (Table 3-3) Restoration activities including transplanting or sprigging of native grasses and forbs and seeding have occurred on some of these mixed grassland units in an effort to increase abundance and diversity of native plants in these habitats. The highest quality native prairie on Anahuac NWR occurs in relatively small, fragmented areas which were never cultivated or were cultivated for a relatively short time. These remnant prairie areas total approximately 1,065 acres. Some permanently fallowed croplands on the Anahuac NWR have been restored to native prairie grassland communities through a proactive process of removing exotic and native woody vegetation, restoring natural contours and hydrology by removing rice field levees and ditches, working the soil and planting with native prairie seed. On the East Unit, approximately 441 acres of permanently fallowed cropland has been restored to native prairie in this manner.

Approximately 1,152 acres of non-saline prairie grasslands occur on McFaddin NWR, almost all of which are found on the North Unit. A total of 172 acres of non-saline prairie grasslands occur on the northern portion of Texas Point NWR. These grasslands have not been cultivated, but have been reduced in quality by a variety of factors including invasion by exotic Chinese tallow and McCartney rose.

The rarity of existing high-quality native coastal prairies in the project area makes protection of these areas a priority. The USFWS' proposed boundary expansions of the Moody and Anahuac NWRs contain important remnant native coastal prairie habitats. The Nature Conservancy's Gulf Coast Marshes and Prairies Ecoregional Conservation Plan identified the "Middleton Prairie" and "Robinson-Oyster Bayou" areas in Chambers County as important conservation areas because they contain remnants of both "Critically Imperiled" prairie plant communities (The Nature Conservancy 2002). Threats to remaining coastal prairies have not declined. Perhaps the most immediate threat to remnant coastal prairies occurring within the proposed boundary expansion areas for the Anahuac and Moody NWRs is conversion to improved pasture or agriculture. Both involve land leveling which removes the historic topographic mima mound features which support these diverse and rare plant communities. Development pressures will increase due to ongoing urban sprawl in the greater Houston area.

Many animal species typical of northern prairies, such as Henslow's Sparrows, Smooth Green Snakes, and Prairie Voles, were all found year-round in the Gulf coastal prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf coastal prairies as wintering and/or migratory habitat. Many of the birds that would benefit from protection and management of native coastal prairie habitats are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as "Avian Species of Conservation Concern" in the Gulf Prairies Bird Conservation Region (USFWS 2005). For example, Mottled Duck, White-tailed Hawk, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats.

The Mottled Duck is a southern species that spent its whole life cycle in coastal prairies and adjacent marshes. The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as

"sennabean ponds," as valuable brood rearing habitat. These natural prairie wetlands have also been lost with the conversion to agricultural uses.

**b. Upland Forests and Coastal Woodlots**

Upland forests and coastal woodlots generally occur on higher elevation uplands that contain acidic soil conditions and are composed of mixed hardwood species and primarily loblolly and slash pine. With a dense overstory and understory, the upland forest community is characterized by structural diversity and high biomass of standing vegetation and surface litter material which provides refuge for many animals (Gosselink *et al.* 1979). Common overstory species include liveoak, water oak, overcup oak, willow, sweetgum, southern magnolia, prickly ash, American elm, cedar elm, huisache, green ash, hawthorne, red mulberry, and common persimmon. Typical understory species include eastern red cedar, black cherry, rough-leaf dogwood, sugarberry, American beauty berry, poison ivy, palmetto, blackberry, grape, Appian cactus, wax myrtle, common elderberry, arrowwood, peppervine, honeysuckle, and greenbrier (Table 3-3).

In pre-settlement times, upland habitats in the Chenier Plain region were dominated by bluestem prairies and trees were restricted to riparian areas (Diamond and Smeins 1984, Smeins *et al*. 1991) and the more elevated chenier ridges. The amount of native coastal woodlot habitat in the region has been reduced mainly through development, conversion to pasture and logging of bottomland hardwoods. Mueller (1981) estimated that only 22 woodlots of an acre or larger remain on the upper Texas Gulf Coast. Woody habitat has significantly increased in the project area with the rapid expansion exotic Chinese tallow trees. However, these new woodlands provide poor habitat for migrant songbirds (Barrow and Renne 2001).

There are approximately 57 acres of coastal woodlots and riparian woodlands on Anahuac NWR, 60 acres of woodlots on the chenier ridges on Texas Point NWR, and 10 acres of woodlots on McFaddin NWR's North Unit.

Coastal woodlots in the Chenier Plain region are extremely important to migrating songbirds. Coastal woodlots mark the first landfall for hundreds of thousands of neotropical migratory birds making the trans-Gulf flights from Mexico, Central and South America during spring. These birds spend one to several days in these woodlands, resting and foraging to help replenish fat reserves before continuing their migration to breeding habitats (Rappole 1974, Sprunt 1975, Mueller 1981). Migrant landbirds make greater use of woodlots with larger trees and dense understories (Mueller and Sears 1987). Coastal woodlots provide the last opportunity for neotropical migratory birds to increase fat reserves prior to another trans-Gulf migration to wintering areas (Caldwell *et al*. 1963). Although comprising less than 1% of Refuge Complex acreage, woodland habitats help support its diverse avian community, which includes several sensitive songbird species. Six of the 7 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in Refuge Complex woodlands. In 2001, the USFWS listed 4 species that occur in Refuge Complex woodlands as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (under the North American Bird Conservation Initiative).

**c. Agricultural Lands**

Rice and livestock production are the predominant agricultural activities in the project area, and rice fields and pastureland are the predominant upland habitats. Conversion of native habitats to agricultural uses has occurred on most lands which would support these uses. The proportion of lands utilized for rice production and pastureland in the project area varies from year to year. Rice production in the project area has trended significantly downward in recent years.

Rice production requires seasonal flooding, which creates emergent wetland habitat utilized by many avian and other wildlife species throughout the spring and summer. During fall and winter, flooded rice stubble and rice fallow, plowed fields, water leveled fields, weedy fields, ryegrass fields, and pastureland

in the project area provide habitats which historically have supported large concentrations of wintering and migrating waterfowl, shorebirds and wading birds.

Abandoned rice fields and pasturelands in the project area are extremely susceptible to invasion by exotic plants, including Chinese tallow and deep-rooted sedge, which outcompete native plants and decrease habitat values for most native wildlife species.

### 3. Refuge Complex Habitat Characterization

#### a. Moody NWR

The 3,516-acre Moody NWR is a privately-owned property upon which the USFWS owns and administers a perpetual non-development conservation easement. Approximately one-third of this tract is comprised of two natural brackish lakes, Lake Surprise and Lake Wallis. Emergent marsh habitats and interspersed ponds and sloughs are primarily intermediate (Table 3-4). Salty prairies are interspersed throughout the marshes.

#### b. Anahuac NWR

The 34,339-acre Anahuac NWR is comprised primarily of low-lying coastal marsh and transitional wet prairie habitats, and is dissected by four estuarine bayous which drain into East Galveston Bay or the GIWW. Most of the Refuge is below the 5 feet above mean sea level contour elevation, and is subject to frequent tidal and freshwater flooding. Marsh habitats on Anahuac NWR include fresh, intermediate, brackish and saline marshes, with intermediate marsh being the predominant marsh type.

Upland areas on the Anahuac NWR are classified as non-saline prairie/agricultural. Approximately 2,290 acres within this classification are croplands currently farmed in rice. There are several small remnants of native prairie scattered throughout the uplands, and remaining upland acres consist mostly of fallowed croplands which are managed as or are being restored to native prairie grasslands, or managed as moist soil units. Several small coastal woodlots occur on natural and man-made elevated sites including the banks of bayous, canal levees, and shell middens. Two dredged material disposal compartments and some uncontained dredge material occur on the Refuge along the GIWW. Table 3-5 lists habitat types found on Anahuac NWR (USFWS, unpublished data).

Table 3-4.
Habitat Types of the Moody NWR, Texas.

| Habitat Type | Approximate Acreage | Percent of Refuge |
|---|---|---|
| Intermediate marsh | 1,214 | 35.4 |
| Natural lake - brackish | 1,029 | 30.0 |
| Salty prairie | 658 | 19.2 |
| Brackish marsh | 270 | 7.9 |
| Non-saline prairie | 211 | 6.1 |
| Saline marsh | 49 | 1.4 |
| TOTAL ACRES* | 3,431 | --- |

*Note: Differences between official Refuge tract acreages and acreages generated by habitat classification are due to errors in georectification.

Table 3-5.
Habitat Types of the Anahuac NWR, Texas.

| Habitat Type | Approximate Acreage | Percent of Refuge |
|---|---|---|
| Fresh Marsh | 1,167 | 3.4 |
| Intermediate Marsh | 14,560 | 42.5 |
| Brackish Marsh | 4,800 | 14.0 |
| Saline Marsh | 687 | 2.0 |
| Salty Prairie | 2,622 | 7.6 |
| Open Water – bayous, GIWW | 462 | 1.3 |
| Non-Saline Prairie/Agricultural | 8,806 | 25.7 |
| Leveed Impoundment | 979 | 2.9 |
| Dredged Material Containment Compartments | 122 | 0.4 |
| Uncontained Dredged Material | 56 | 0.2 |
| TOTAL ACRES* | 34,261 | --- |

Table 3-6.
Habitat Types of the McFaddin NWR, Texas.

| Habitat Type | Approximate Acreage | Percent of Refuge |
|---|---|---|
| Fresh Marsh | 5,356 | 9.6 |
| Intermediate Marsh | 37,468 | 67.0 |
| Brackish Marsh | 3,294 | 5.9 |
| Salty Prairie | 3,817 | 6.8 |
| Non-Saline Prairie | 1,320 | 2.4 |
| Inland Open Water – Bayous, GIWW | 646 | 1.2 |
| Leveed Impoundment | 95 | 0.2 |
| Dredge Material Containment Compartment | 988 | 1.8 |
| Natural Lake - Intermediate | 712 | 1.3 |
| Natural Lake - Brackish | 1,479 | 2.6 |
| TOTAL ACRES* | 55,918 | --- |

*Note: Differences between official Refuge tract acreages and acreages generated by habitat classification are due to errors in georectification.

**c. McFaddin NWR**

McFaddin NWR consists of 58,861 acres of primarily coastal marsh habitat (Table 3-6). Of this total, the USFWS holds conservation easements on 7,749 acres with the remaining held in fee title ownership.

The GIWW bisects the Refuge and divides historically contiguous watersheds. The South Unit of the Refuge lies south of the GIWW and is predominately an intermediate marsh consisting of emergent marsh and several interconnected ponds and shallow lakes. The GIWW effectively cut off freshwater inflows via natural waterways and surface sheet flows from the marshes and prairies north of the GIWW to the marshes of the South Unit. Freshwater supply to the South Unit is now limited to local precipitation. Salt Bayou drains the eastern two-thirds of the South Unit eastward to the GIWW and the Sabine River (Sabine-Neches Ship Channel,) and Mud Bayou drains the western third of the South Unit to the GIWW and East Galveston Bay. Star Lake, Clam Lake, Willow Lake and Barnett Lake are natural lakes occurring within the Salt Bayou watershed on the South Unit. Brackish marshes occur primarily in the western and eastern portions of the South Unit, where tidal influence through Mud and Salt bayous is greatest. Intermediate and brackish marshes comprise approximately 37,468 acres and 3,294 acres of the Refuge, respectively.

The 7,188-acre North Unit lies north of the GIWW and is predominately fresh marsh. It contains a portion of Willow Slough Marsh, the largest remaining coastal freshwater marsh in Texas. Approximately 5,356 acres of the Refuge are classified as fresh marsh. The Willow Slough Marsh has historically wintered large numbers of waterfowl, including one of the larger concentrations of Ring-necked Ducks in Texas. This highly productive freshwater marsh supports high densities of water shield, a floating aquatic plant which is a preferred food source for this diving duck species. The Refuge's North Unit also includes approximately 1,324 acres of non-saline prairie, within which occur several small coastal woodlots.

Salty prairie comprises approximately 3,817 acres of the Refuge, and much of this habitat type occurs immediately landward of the Gulf of Mexico beach/beach ridge and dune complex. The beach/beach ridge and dune complex along the Gulf shoreline is included within the salty prairie habitat designation in Table 3-6.

Most of the Gulf shoreline on the Refuge is retreating. Beaches are generally narrow and fairly steep, with a thin layer of sand and shell hash overlying mud deposits. Erosive events which generate high tides or tidal surges (tropical cyclones and winter frontal passages) move these beach sediments seaward and inland, leaving highly erodible Pleistocene clays exposed on the beaches. A remnant system of low dunes occurs on the easternmost 2-mile section of the Gulf shoreline on the Refuge adjacent to Sea Rim State Park. A low terrace or beach ridge, comprised of recent beach overwash deposits, lies immediately landward of the beach along the remaining 15 miles of Gulf shoreline on the Refuge. This washover terrace varies in elevation from approximately 1.5 to 3.5 feet above mean sea level, and varies in width from approximately 50 to 250 feet.

There are several dredged material disposal compartments along the GIWW on both the South and North units, and several deposits of unconfined dredge material along the south bank of the GIWW on the South Unit. Table 3-6 lists habitat types found on McFaddin NWR (USFWS, unpublished data).

### d. Texas Point NWR

The 8,972-acre Texas Point NWR is predominately a saline-brackish marsh complex, consisting of emergent marshes, tidal flats, shallow lakes and ponds. Table 3-7 lists the habitat types found on Texas Point NWR (USFWS, unpublished data). Three branches of Texas Bayou enter the marshes directly from the Sabine-Neches Ship Channel proximal to its outlet into the Gulf of Mexico. The eastern and southern portions of the Refuge are comprised of saline and brackish marshes which are strongly influenced by daily tidal action. Saline and brackish marshes comprise approximately 4865 acres and 2300 acres of the Refuge, respectively. Small amounts of intermediate marsh occur in western and northern portions of the Refuge. Interspersed within the marshes are slightly elevated fan-shaped salty prairie chenier ridges aligned east to west. The two northernmost cheniers (classified as non-saline prairie in Table 3-7) on the Refuge are high enough in elevation to support grasses and forbs and some woody vegetation which forms several small coastal woodlots.

Table 3-7.
Habitat Types of the Texas Point NWR, Texas.

| Habitat Type | Approximate Acreage | Percent of Refuge |
|---|---|---|
| Intermediate Marsh | 1,362 | 15.2 |
| Brackish Marsh | 2,300 | 25.6 |
| Saline Marsh | 4,865 | 54.2 |
| Salty Prairie | 209 | 2.3 |
| Non-saline prairie | 232 | 2.6 |
| TOTAL ACRES* | 8,968 | --- |

*Note: Differences between official Refuge tract acreages and acreages generated by habitat classification are due to errors in georectification.

### 4. Habitat Characterization for Refuge Boundary Expansion Areas

Specific areas within the project area that were identified as having substantial acreages of habitats with high biological values and were considered in the development of the Refuge Boundary Expansion Alternatives. These include:

- **East of High Island** – Intermediate and brackish marsh. Contains two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent. High quality wintering and migrational habitat for waterfowl and other wetland-dependent migratory bird species. Intertidal areas are utilized by a variety of commercial and recreational activities important to marine organisms. There are no known unique community types in this area.

- **Middleton Prairie** – Non-saline prairies of which a significant component is prairie/grassland. Contains one of the largest remnant native coastal tallgrass prairie tracts on the Texas Upper Coast. This area also has one nationally recognized declining wetland type - the palustrine emergent. High habitat value for waterfowl, particularly for the resident Mottled Duck and for many species of grassland-dependent migratory birds. Unique community type within the Texas Chenier Plain region is the prairie/grassland habitat type.

- **Willow Slough Marsh** – Fresh marsh and non-saline prairie (prairie/agriculture). Contains the last large and relatively intact marsh in the Texas Chenier Plain which provides high quality habitat for waterfowl, other migratory birds, and for a great variety of plant and wildlife species dependent on this wetland type. Two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent. Contains two large coastal woodlots, a unique community type in the Texas Chenier Plain region.

- **Oyster Bayou Marsh** – Non-saline prairie (prairie/agriculture) with intermediate marsh. Contains two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent. High quality wintering and migrational habitats for waterfowl and other wetland-

dependent migratory bird species. An important riparian woodlot bisects this area along Oyster Bayou. No known unique community types in this area.

- **Robinson Bayou** – Non-saline prairie (prairie/agriculture) and intermediate marsh (over 80% of the area). Contains two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent wetland types. High quality wintering and migrational habitats for waterfowl and other wetland-dependent migratory bird species. This area has several coastal woodlots, a unique community type in the Texas Chenier Plain. Contains prairie/grasslands, a unique community type within the Texas Chenier Plain region.

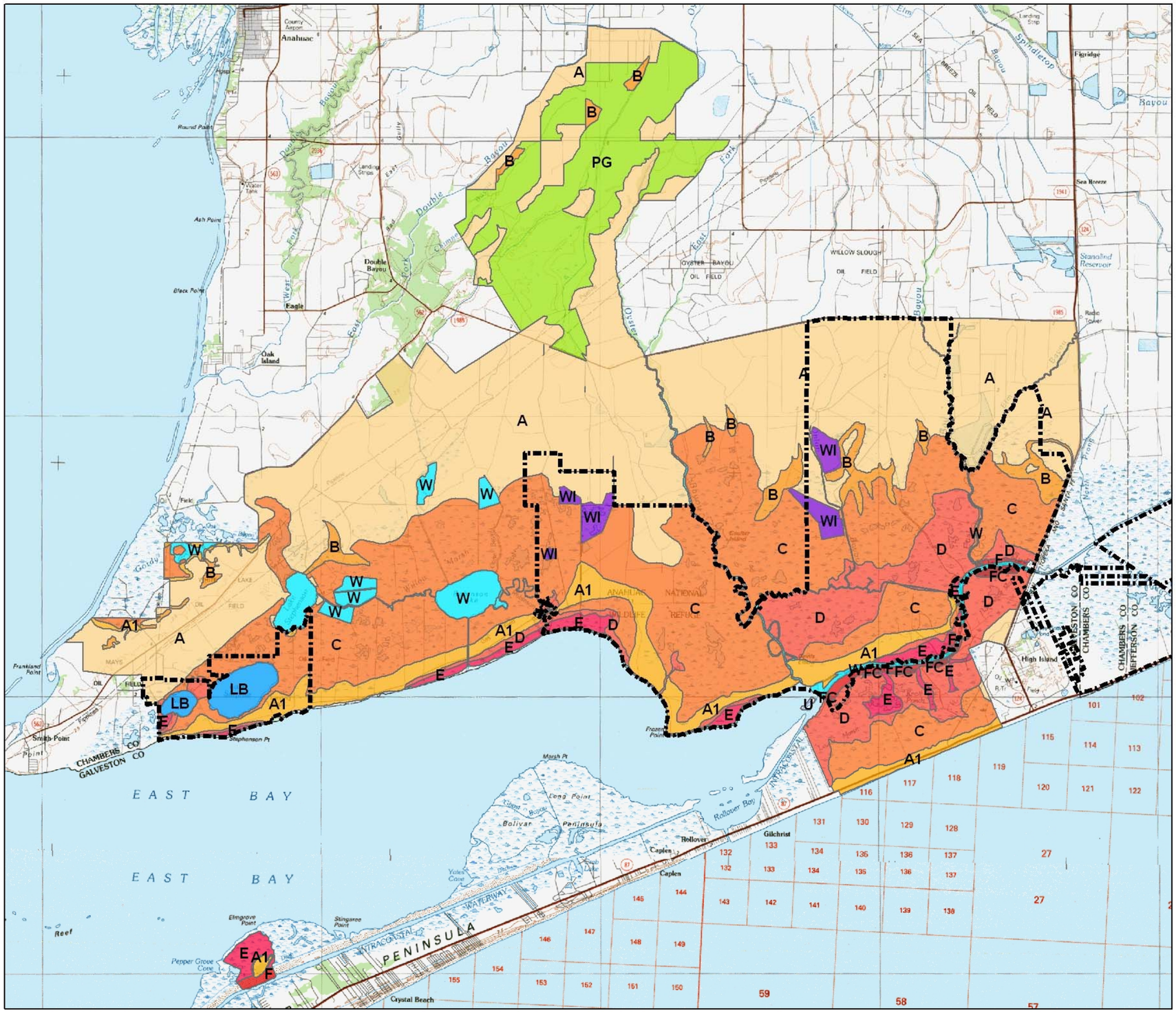
- **Taylors Bayou** – Over 60% of this area contains forested wetlands which provide a high quality habitat for migrating neotropical migratory birds and wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species. Forested wetland is one of the nationally recognized declining wetland types. It is also considered a unique community type within the Texas Chenier Plain region.

- **Elm Bayou** – Non-saline prairie (prairie/agriculture). Contains one nationally recognized declining wetland type - Palustrine emergent wetland type. Rice croplands are currently managed such that they provide high quality wintering and migrational habitats for waterfowl and other wetland-dependent migratory bird species. A small but important riparian area is located along Elm Bayou. No unique community types.

- **Lower Marsh** – Brackish marsh with one nationally recognized declining wetland type - estuarine intertidal emergent wetlands. Moderate habitat value to waterfowl and other migratory birds. Intertidal areas are utilized by a variety of commercial and recreational activities. These areas are important to marine organisms. Has an established beach dune system which may reduce coastal erosion rates. No known unique community types.

The following two pages contain maps which delineate the various habitat types found on the Texas Chenier Plain Refuge Complex lands and the proposed boundary expansion lands.

A continuum of coastal marsh types, based on a salinity gradient, is depicted on the Vegetation Type maps. This continuum includes fresh marsh (salinities less than 0.5 parts per thousand (ppt)), intermediate marsh (salinities between 0.5 and 5.0 ppt; mean 3.3 ppt), brackish marsh (salinities between 5.0 and 18.0 ppt; mean 8.0 ppt), and saline marsh (salinities 18.0 ppt) (Gosselink *et al.* 1979). Please refer to Table 3-2, in this chapter, for a detailed list of indicator plant species commonly associated with each depicted marsh type.




## Vegetation Types on the Moody and Anahuac NWRs

Marsh delineations as defined by Refuge Biologists based on high altitude aerial photography. Linework drawn on an unregistered, unrectified photo mosaic. Due to known errors in lines drawn on mosaic and process of rubbersheeting delineations to best fit USGS 7.5 quadrangles some alignment errors may be apparent when overlaid on geo-referenced data.

This map is meant for use in viewing relative positions and sizes of the habitats at small scales.

### Legend

- Refuge Boundary
- A — Non-saline Prairie/Agriculture
- A1 — Salty Prairie
- B — Fresh Marsh
- C — Intermediate Marsh
- D — Brackish Marsh
- E — Saline Marsh
- F — GIWWW Spoil Areas
- FC — Contained Spoil
- PG — Prairie Grassland
- W — Inland Open Water
- LB — Natural Lake - Brackish
- WI — Waterfowl Impoundment
- U — Unclasified

Refer to Table 3-2 *Common Plants of Wetland and Aquatic Habitats*, in Chapter 3, for a list of indicator species commonly associated with the marsh types.

**Scale = 1:135,996**

0 1.5 3 6 Kilometers

0 1 2 4 Miles

N W E S

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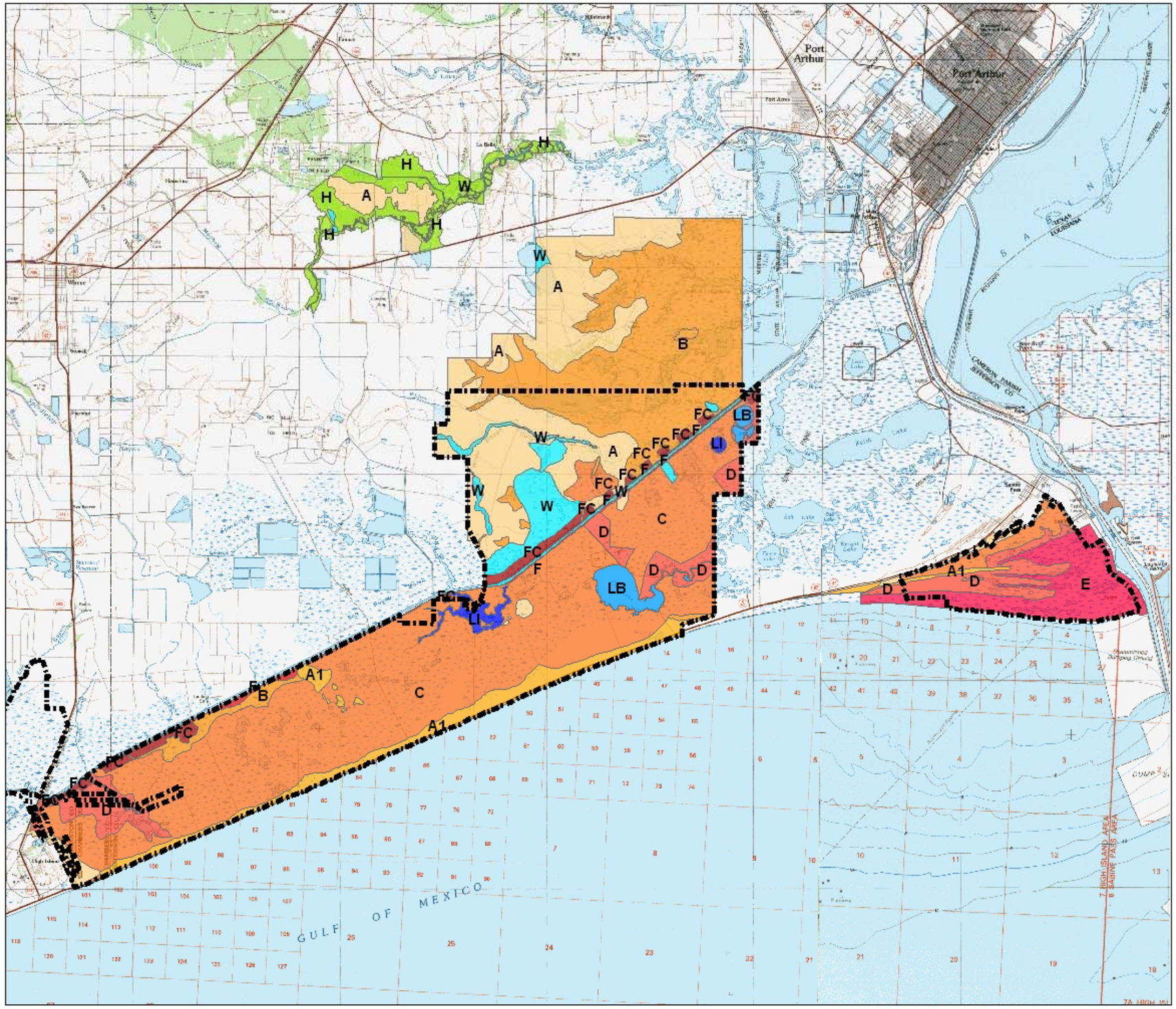
500 Gold Ave. SW Albuquerque, NM 87102
505-248-7463




## Vegetation Types on the McFaddin and Texas Point NWRs

Marsh delineations as defined by Refuge Biologists based on high altitude aerial photography. Linework drawn on an unregistered, unrectified photo mosaic. Due to known errors in lines drawn on mosaic and process of rubbersheeting delineations to best fit USGS 7.5 quadrangles some alignment errors may be apparent when overlaid on geo-referenced data.

This map is meant for use in viewing relative positions and sizes of the habitats at small scales.

### Legend

- Refuge Boundary
- A — Non-saline Prairie/Agriculture
- A1 — Salty Prairie
- B — Fresh Marsh
- C — Intermediate Marsh
- D — Brackish Marsh
- E — Saline Marsh
- F — GIWWW Spoil Areas
- FC — Contained Spoil
- H — Bottomland Hardwood
- W — Inland Open Water
- LB — Natural Lake - Brackish
- LI — Natural Lake - Intermediate
- WI — Waterfowl Impoundment

Refer to Table 3-2 *Common Plants of Wetland and Aquatic Habitats*, in Chapter 3, for a list of marsh types and associated plant species.

**Scale = 1:183,182**

0 2 4 8 Kilometers

0 1.5 3 6 Miles

N W E S

**U.S. Fish and Wildlife Service**
Southwest Regional Office - Division of Planning
500 Gold Ave. SW Albquerque, NM 87102
505-248-7463

## B. Fish and Wildlife Resources

The project area provides important habitats for numerous fish and wildlife species including over 300 documented avian species. According to the Texas Parks and Wildlife Department, over 75 species of freshwater fish and over 400 species of salt and brackish water species occur in the bays, bayous, and Gulf of Mexico waters bordering the Refuge Complex.

### 1. Avian Species

A total of 285 avian species, of which at least 52 are documented nesting species, have been recorded on the Refuge Complex. Wetland habitats on the Refuge Complex support major concentrations of wintering and migrating waterfowl, shorebirds, and wading birds and provide important habitat for many species of marsh birds and waterbirds. Many species of landbirds, including many neotropical migrants, use coastal woodlots, forested wetlands and other forested habitats within the project area in large numbers during fall and spring migration. Remnant stands of native prairie and other upland grassland habitats provide habitat for many grassland songbirds, including several species whose continental populations are in decline.

#### a. Waterfowl

A priority objective of the Refuge Complex is to provide quality habitat for wintering waterfowl. The project area and Refuge Complex are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway, and some waterfowl from the Mississippi, Atlantic, and Pacific Flyways also winter here. The 2004 mid-winter waterfowl survey for the Central Flyway indicates that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. The coastal marshes, wet prairies, rice fields and moist soil units of the Refuge Complex are used by 27 species of ducks and five species of geese. Waterfowl hunting is a traditional and important outdoor recreational activity throughout the project area. The Refuge Complex and State Wildlife Management Areas provide a wide range of waterfowl hunting opportunities for the public.

The USFWS conducts aerial waterfowl surveys monthly from September through March on national wildlife refuges on the Texas Gulf Coast. On Anahuac NWR between 1997 and 2004, numbers of ducks peaked at 188,182 in November of 2002 (Table 3-8). The most common duck species observed were, in order of abundance, American Green-winged Teal (*Anas crecca*), Gadwall (*Anas strepera*), Northern Shoveler (*Anas clypeata*), Blue-winged Teal (*Anas discors*) and Northern Pintail (Anas acuta). Following the top five species were American Wigeon (*Anas americana*), Mallard (Anas platyrhynchos) and Mottled Duck (*Anas fulvigula*), respectively. Goose numbers on Anahuac NWR peaked at 118,634 in February of 2004 for this survey period (Table 3-9). On McFaddin NWR during the same time period, numbers of ducks peaked at 153,206 in March 2001 (Table 3-10). Goose numbers peaked at 97,786 in January 2001 (Table 3-11). Snow geese (*Chen caerulescens*) are the principal goose species found on the refuges. Other geese include Greater White-fronted (*Anser albifrons*), Cackling geese (*Branta hutchinsii*), and Ross's geese (*Chen rossii*). On Texas Point NWR, numbers of ducks peaked at 12,586 in 1999 (Table 3-12).

Table 3-8. Number of Ducks Observed During Aerial Waterfowl Surveys on Anahuac NWR, 1997-2004.

| Year | Sept | Oct | Nov | Dec | Jan | Feb | Mar | High Count |
|---|---|---|---|---|---|---|---|---|
| 1997/1998 | 13709 | 18836 | 48583 | 75821 | 50139 | 78477 | 74937 | 78477 |
| 1998/1999 | 27454 | 6906 | 28589 | 90982 | 128086 | 73775 | 57427 | 128086 |
| 1999/2000 | 33735 | 88028 | 79863 | 77386 | 90091 | 81845 | 64410 | 90091 |
| 2000/2001 | 28954 | 16142 | 96779 | 90091 | 70856 | 69987 | 57156 | 96779 |
| 2001/2002 | 556 | 13374 | 40801 | 94271 | 71658 | * | 59731 | 94271 |
| 2002/2003 | 49 | 7216 | 188182 | 94710 | 43820 | * | 26314 | 188182 |
| 2003/2004 | 2429 | 14586 | 66010 | 74636 | 35073 | 53573 | 22110 | 74636 |
| **Average** | **15269** | **23584** | **78401** | **85413** | **69960** | **71531** | **51726** | **107217** |

Table 3-9. Number of Geese Observed During Aerial Waterfowl Surveys on Anahuac NWR, 1997 – 2004.

| Year | Sept | Oct | Nov | Dec | Jan | Feb | Mar | High Count |
|---|---|---|---|---|---|---|---|---|
| 1997/1998 | 0 | 106 | 36702 | 6902 | 13607 | 14091 | 0 | 36702 |
| 1998/1999 | 0 | 168 | 113155 | 33559 | 7128 | 9702 | 274 | 113155 |
| 1999/2000 | 0 | 717 | 20441 | 8085 | 18669 | 18077 | 56 | 20441 |
| 2000/2001 | 0 | 0 | 1529 | 5915 | 9336 | 5319 | 0 | 9336 |
| 2001/2002 | 0 | 7300 | 7401 | 38329 | 25813 | * | 6031 | 38329 |
| 2002/2003 | 0 | 0 | 4534 | 21376 | 7736 | * | 0 | 21376 |
| 2003/2004 | 0 | 120 | 366 | 24238 | 64620 | 118634 | 49 | 118634 |
| **Average** | **0** | **1201** | **26304** | **19772** | **20987** | **33164** | **915** | **51139** |

Table 3-10. Number of Ducks Observed During Aerial Waterfowl Surveys on McFaddin NWR, 1997-2004.

| Year | Sept | Oct | Nov | Dec | Jan | Feb | Mar | High Count |
|---|---|---|---|---|---|---|---|---|
| 1997/1998 | 3356 | 17561 | 23533 | 39308 | 80756 | 51387 | 107821 | 107821 |
| 1998/1999 | 63306 | 38138 | 62032 | 173152 | 70570 | 117599 | 104864 | 173152 |
| 1999/2000 | 16788 | 35323 | 44490 | 66127 | 46912 | 51665 | 25626 | 66127 |
| 2000/2001 | 26010 | 10485 | 30489 | 30743 | 75781 | 49704 | 153206 | 153206 |
| 2001/2002 | 16631 | 78 | 16231 | 1517 | 28635 | * | 43621 | 43621 |
| 2002/2003 | 28 | 387 | 644 | 14930 | 6847 | * | 6591 | 14930 |
| 2003/2004 | 420 | 3779 | 7049 | 7461 | 20421 | 30722 | 26793 | 30722 |
| **Average** | **18077** | **15107** | **26353** | **47605** | **47132** | **60215** | **66932** | **84226** |

Table 3-11.
Number of Geese Observed During Aerial Waterfowl Surveys on McFaddin NWR, 1997 – 2004.

| Year | Sept | Oct | Nov | Dec | Jan | Feb | Mar | High Count |
|---|---|---|---|---|---|---|---|---|
| 1997/1998 | 0 | 187 | 9674 | 13350 | 55081 | 56477 | 0 | 56477 |
| 1998/1999 | 0 | 952 | 3908 | 12865 | 11985 | 10338 | 1254 | 12865 |
| 1999/2000 | 0 | 353 | 621 | 4796 | 21143 | 11407 | 0 | 21143 |
| 2000/2001 | 0 | 0 | 2330 | 79993 | 97786 | 78186 | 101 | 97786 |
| 2001/2002 | 0 | 0 | 0 | 203 | 47046 | * | 3759 | 47046 |
| 2002/2003 | 0 | 0 | 536 | 288 | 18258 | * | 0 | 18258 |
| 2003/2004 | 0 | 0 | 224 | 1238 | 1804 | 1707 | 0 | 4973 |
| **Average** | **0** | **213** | **2470** | **16105** | **36158** | **31623** | **78995** | **36935** |

* Survey not conducted in February 2002 and 2003.

Table 3-12.
Number of Ducks Observed During Aerial Waterfowl Surveys on Texas Point NWR, 1997-2004.

| Year | Sept | Oct | Nov | Dec | Jan | Feb | Mar | High Count |
|---|---|---|---|---|---|---|---|---|
| 1997/1998 | 911 | 868 | 2048 | 3413 | 1013 | 6139 | 3659 | 6139 |
| 1998/1999 | 261 | 658 | 577 | 11691 | 4141 | 2143 | 3970 | 11691 |
| 1999/2000 | 380 | 1803 | 12586 | 6096 | 12457 | 9782 | 7508 | 12586 |
| 2000/2001 | 66 | 333 | 2986 | 4516 | 2855 | 1950 | 6471 | 6471 |
| 2001/2002 | 275 | 1362 | 3888 | 1866 | 2527 | * | 2852 | 3888 |
| 2002/2003 | 15 | 1270 | 1174 | 911 | 2371 | * | 770 | 2371 |
| 2003/2004 | 152 | 3860 | 659 | 452 | 1414 | 1342 | 2708 | 3860 |
| **Average** | **294** | **1451** | **3417** | **4135** | **3825** | **4271** | **3991** | **6715** |

* Survey not conducted in February 2002 and 2003.

Table 3-13. Percentage of Total Harvest of the Top Five Harvested Duck Species from the East Unit of Anahuac NWR, 1999 – 2004.

| Rank | 2003/2004 | 2002/2003 | 2001/2002 | 2000/2001 | 1999/2000 |
|---|---|---|---|---|---|
| 1 | Gadwall (27%) | Green-winged teal (27%) | Gadwall (32%) | Green-winged teal (28%) | Green-winged teal (35%) |
| 2 | Green-winged teal (25%) | Blue-winged teal (23%) | Green-winged teal (19%) | Northern Shoveler (21%) | Gadwall (27%) |
| 3 | Blue-winged teal (12%) | Gadwall (15%) | Blue-winged teal (11%) | Gadwall (14%) | Northern Shoveler (10%) |
| 4 | Northern Shoveler (10%) | Scaup (9%) | Northern Shoveler (10%) | Blue-winged teal (10%) | Mallard (7%) |
| 5 | Mottled Duck (9%) | Mottled Duck (8%) | Ring-necked Duck (5%) | Lesser Scaup (6%) | Mottled Duck (6%) |

In order to monitor trends in wintering waterfowl populations, harvested birds are examined and age, sex, species and body condition data are collected at hunter check stations on the Anahuac and McFaddin NWRs. Tables 3-13 and 3-14 present the top five species harvested on the East Unit of Anahuac NWR, and on the Star Lake and Permit Area units of McFaddin NWR, respectively, from 1999 – 2004.

Measurements taken at check stations provide critical data on the body condition of waterfowl on the refuge. Body condition is an index used by biologists and managers to assess the health of waterfowl populations with the assumption that improved condition increases survival and reproductive success.

Nine of the 27 species of waterfowl found on the Refuge Complex are listed by the USFWS' Migratory Bird Office as a "Game Bird Below Desired Condition" (USFWS 2004). They include: Canvasback, Mallard, Mottled Duck, Northern Pintail, Redhead, Ring-necked Duck, Greater Scaup, Lesser Scaup, and Wood Duck. Snow Goose and Ross's Goose are listed as Over Abundant.

Table 3-14.
Percentage of Total Harvest of the Top Five Harvested Duck Species from the Star Lake/Clam Lake and Spaced Hunt units of McFaddin NWR, 1999 – 2004.

| Rank | 2003/2004 | 2002/2003 | 2001/2002 | 2000/2001 | 1999/2000 |
|---|---|---|---|---|---|
| 1 | Green-winged teal (25%) | Lesser Scaup (28%) | Gadwall (29%) | Green-winged teal (32%) | Green-winged teal (42%) |
| 2 | Gadwall (22%) | Green-winged teal (17%) | Green-winged teal (24%) | Gadwall (15%) | Gadwall (17%) |
| 3 | Blue-winged teal (16%) | Blue-winged teal (16%) | Lesser Scaup (9%) | Lesser Scaup (15%) | Blue-winged teal (9%) |
| 4 | Northern Shoveler (12%) | Gadwall (13%) | Northern Shoveler (8%) | Northern Shoveler (12%) | Northern Shoveler (6%) |
| 5 | Lesser Scaup (8%) | Mallard (6%) | Blue-winged Teal (7%) | Blue-winged teal (5%) | Wigeon (5%) |

**b. Resident Waterfowl - Mottled Ducks**

The Mottled Duck is a resident waterfowl species that is entirely dependent upon coastal habitats along the Gulf of Mexico. Two populations of Mottled Ducks are recognized – one in Florida, and the Western Gulf Coast population which utilizes coastal habitats in Alabama, Mississippi, Louisiana, Texas and Mexico. No interchange between these two populations is believed to occur.

Essentially non-migratory, the Mottled Duck is tied to coastal habitats for its entire life cycle. Mottled Ducks are year-round residents in fresh, intermediate and brackish marshes as well as suitable agricultural areas on the Refuge. They typically nest in gulf and marshhay cordgrass on dryer areas and utilize adjacent wetlands for raising broods. The Upper Texas Gulf Coast, including the project area and Refuge Complex, has historically been considered the core of Mottled Duck habitat in Texas. Wetland and grassland habitats and rice agricultural lands here continue to be extremely important to the Western Gulf Coast Mottled Duck population. An average of 26.2% of the total Mottled Ducks counted during monthly (September – March) surveys on the nine coastal Texas refuges were located on Anahuac NWR (1985-2003) (USFWS unpublished data).

Aerial wintering waterfowl and Mottled Duck breeding pair surveys on national wildlife refuges and the Texas Mid-Winter Waterfowl Survey have documented a decline in Mottled Duck numbers in Texas in recent years. Breeding pair surveys conducted on coastal National Wildlife Refuges in Texas have documented a decrease from 22.99 pairs/square mile in 1986 to 1.75 pairs/square mile in 2003. This trend line indicates a continuous long-term decline (r= -0.75). In addition to being listed as a “Game Bird Below Desired Condition” by the USFWS Migratory Bird Office, the Mottled Duck is also regarded as a priority wetland associated species by the Texas Parks and Wildlife Department (Texas Parks and Wildlife Department 2000).

**c. Shorebirds, Wading Birds, Marsh, and Waterbirds**

The tidal flats, beaches, marshes, and intensively managed habitats such as rice fields and moist soil impoundments on the Refuge Complex and within the project area provide shallow water feeding, breeding, and resting habitat for numerous shorebirds, wading birds, and other marsh and waterbirds. The Anahuac NWR was designated a “Shorebird Site of International Importance” by the Western Hemisphere Shorebird Reserve Network in 2005. Thirty-two species of shorebirds regularly occur on the Refuge Complex, ten of which are considered ‘highly imperiled’ or of ‘high concern’ under the U.S. Shorebird Conservation Plan. In addition, the Anahuac NWR regularly supports over 2200 whimbrel in the spring migration, greater than 10% of the Flyway population of this species.

Shorebird counts were conducted along the Texas Coast between March 22 through May 17 during two-week intervals in the spring of 1993 (Lee Elliot, USFWS biologist personal communication, February 2000). Peak numbers of shorebirds were recorded between March 22 and April12 at three sites in or near the project area (Bolivar Peninsula, Anahuac NWR, and Harris/Waller counties). The Bolivar Peninsula, site of the Houston Audubon Society’s Bolivar Flats Shorebird Preserve, had the greatest shorebird concentrations with over 17,000 birds observed. The most abundant species observed during the surveys were American avocet, western sandpiper, long-billed and short-billed dowitchers, semi-palmated sandpiper, pectoral sandpiper, black-bellied plover, dunlin, sanderling, willet, semi-palmated plover, least sandpiper, and snowy plover. All of these species occur on the Refuge Complex. Common nesting shorebirds species on the Refuge Complex include killdeer, black-necked stilt, and willet. Other shorebird and related species commonly observed on the Refuge Complex include long-billed curlew, Wilson’s snipe, ring-billed gull, laughing gull, herring gull, least tern (a nesting species), royal terns, and Caspian terns (USFWS 1997a).

Small rookeries of colonial-nesting waterbirds occur throughout the project area, including rookeries containing the following wading birds: Great Egret, Snowy Egret, Cattle Egret, Green Heron, Great Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, and Roseate Spoonbill. Nesting colonies of other colonial nesters including Least Terns and Black Skimmers occur on beaches, washover terraces, and occasionally on man-made sites such as oil and gas well pads. On the Refuge Complex,

nesting wading, marsh and waterbird species include Great Blue Heron, Little Blue Heron, Green Heron, Tri-colored Heron, Great Egret, Snowy Egret, American Bittern (Whitbeck 2004), Least Bittern, White-faced Ibis, Common Moorhen, Purple Gallinule, Pied-billed Grebe, Least Tern, and American Coot. Additional species that are commonly observed but are not known to nest on the Refuge Complex include the Double-crested Cormorant, White Ibis, Roseate Spoonbill, and Eared Grebe (USFWS 1997a). All six North American species of rails occur in the marshes and wet prairie grasslands of the Refuge Complex. King and Clapper rails nest here and are present year-round. The Black Rail has not been documented as nesting on the Refuge Complex, but is also present year-round. Sora, Virginia and Yellow rails utilized these habitats primarily during winter and spring and fall migrations.

**d. Migratory and Resident Landbirds**

Many passerines that nest in temperate North America and winter in Central and South America migrate through the project area, crossing the Gulf to Mexico during spring and fall migrations. During spring migration, coastal woodlots, alluvial forests and other wooded habitats in the project area provide the first landfall for these trans-Gulf neotropical migrants. Migrant passerines that use the Refuge Complex include many species of warblers, vireos, tanagers, thrushes, and buntings, including many Avian Species of Conservation Concern (USFWS 2005). Songbird species nesting on the Refuge Complex include the Seaside Sparow, Orchard Oriole, Eastern Kingbird, and Scissor-tailed Flycatcher.

Native prairie remnants and other upland grassland habitats on the Refuge Complex provide wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow and Sedge Wren, and nesting habitat for species including Dicksissel and Eastern Meadowlark. These are also important nesting habitats for Mottled Ducks.

Several species of raptors commonly observed on the Refuge Complex include Red-tailed Hawk, Red-shouldered Hawk, Turkey Vulture, American Kestrel, White-tailed Kite, Northern Harrier, and Short-eared Owl (USFWS 1997a). Many other raptor species are observed during spring and fall migrations.

Several hundred thousand people, including many international visitors, visit the project area annually from late March to early May to observe and photograph birds during spring migration. Popular destinations include the Refuge Complex, local State Wildlife Management Areas and State Parks, the Audubon Society preserves at High Island and Bolivar Flats, and the Texas Ornithological Society Sabine Woods Sanctuary.

**e. Avian Species of Conservation Concern**

Conservation priorities for North American avian species and recommendations for habitat protection, management and restoration in support of conservation of these species have been developed and identified recently through several international, national and regional avian conservation plans. These plans include the North American Waterfowl Management Plan (NAWMP), the U.S. Shorebird Conservation Plan, the North American Waterbird Conservation Plan, and the Partners in Flight Landbird Conservation Plan. At a regional level, several step-down plans have been developed to guide conservation efforts at a more local scale. Examples applicable to avian conservation on the Refuge Complex and the project area as a whole include the Gulf Coast Joint Venture Chenier Plain Initiative Area Plan (Esslinger and Wilson 2001) and the Mottled Duck Conservation Plan (Wilson 2005) under the North American Waterfowl Management Plan and the Lower Mississippi/Western Gulf Coast Region Plan (Elliot and McKnight 2000) under the U.S. Shorebird Conservation Plan. A shared outcome of these avian conservation planning efforts has been identification of the need for "All Bird Conservation", i.e., addressing species and habitat conservation and management priorities across all avian species guilds. Conservation priorities identified in these international, national, and regional plans have been stepped-down and incorporated as strategies into this CCP/EIS.

Wetland habitats on the project area provide important wintering and migrational habitat for many species of Central Flyway waterfowl, including several species whose continental populations are below goals established under the North American Waterfowl Management Plan and/or listed by the USFWS as

Game Birds Below Desired Condition (USFWS 2004). These species include Northern Pintail, Lesser Scaup, and Ring-necked Duck. The Mottled Duck is a year-round resident of Gulf Coast, and conservation and management of this species is a major goal of the NAWMP's Gulf Coast Joint Venture Chenier Plain Initiative Plan (Esslinger and Wilson 2001). Steep declines in Mottled Duck numbers on coastal national wildlife refuges in Texas have been documented in recent years (USFWS. Division of Migratory Birds unpublished reports), and this species is considered to be Rare and Declining in the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Coastal marsh, coastal prairie and agricultural habitats within Chambers, Jefferson and Orange counties, including the project area, historically supported the highest densities of breeding Mottled Ducks in Texas (Stutzenbaker 1988), and continue to be critically important to the long-term conservation of this species. Meeting the waterfowl population objectives established by the GCJV Chenier Plain Initiative Plan requires several habitat protection, management and restoration actions for coastal marshes and enhancement of agricultural habitats to increase their value to waterfowl (Esslinger and Wilson 2001). These include several strategies for reducing marsh loss (conversion to open water) and restoring already degraded marshes, prescribed burning, controlled grazing, exotic/invasive species control, additional habitat protection through land acquisition and cooperative agreements, and increased technical assistance for waterfowl habitat enhancement on private lands.

In 2005, the USFWS published a national list of "Avian Species of Conservation Concern (USFWS 2002). Thirty-seven of the 48 Avian Species of Conservation Concern listed by the USFWS for the Gulf Coastal Prairie Bird Conservation Region (BCR) occur on the Refuge Complex and can be expected to occur within wetland, prairie and woodland habitats in areas identified in the Refuge Boundary Expansion Alternatives (Table 3-15). Wetland-dependent Avian Species of Conservation Concern occurring on the project area include Yellow and Black rails, American Bittern, White Ibis, Hudsonian Godwit, Long-billed Curlew, Short-billed Dowitcher, Least Tern, Seaside Sparrow, Nelson's Sharptailed Sparrow, and Sprague's Pipit. Avian Species of Conservation Concern utilizing prairie grassland habitats on the project area include LeConte's Sparrow, Henslow's Sparrow, Buff-breasted Sandpiper, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk. Neotropical migrant landbirds listed as Avian Species of Conservation Concern which utilize woodland habitats on the project area include Swainson's Warbler, Prothonotary Warbler, Kentucky Warbler and Swallow-tailed Kite.

The Partners in Flight (PIF) Conservation Program is an international, multi-agency and multi-organization conservation initiative for North American landbirds and waterbirds. PIF recently completed an assessment of the status and conservation needs of all North American land and waterbirds. This assessment included consideration of population trends, habitat trends, and threats on breeding and

Table 3-15.
Avian Species of Conservation Concern in the Gulf Coastal Prairie Bird Conservation Region (U.S. portion only) (USFWS 2002). (**Bolded species documented on the Refuge Complex**)

| | | |
|---|---|---|
| **American Bittern** | **Marbled Godwit** | Bewick's Wren |
| **Reddish Egret** | **Red Knot** | **Sedge Wren** |
| **White Ibis** | **Stilt Sandpiper** | **Sprague's Pipit** |
| **Swallow-tailed Kite** | **Buff-breasted Sandpiper** | Tropical Parula (TX) |
| **Northern Harrier** | **Short-billed Dowitcher** | **Prothonotary Warbler** |
| **White-Tailed Hawk (TX)** | **Gull-billed Tern** | **Swainson's Warbler** |
| **Peregrine Falcon** | **Least Tern** | **Kentucky Warbler** |
| **Yellow Rail** | **Black Tern** | **Henslow's Sparrow** |
| **Black Rail** | **Black Skimmer** | **LeConte's Sparrow** |
| **American Golden-Plover** | Ferruginous Pygmy Owl (TX) | **Nelson's Sharptailed Sparrow** |
| **Snowy Plover** | **Short-eared Owl** | **Seaside Sparrow** |
| **Wilson's Plover** | Buff-bellied Hummingbird | Botteri's Sparrow |
| **American Oystercatcher** | Red-headed Woodpecker | Grasshopper Sparrow |
| **Whimbrel** | Northern Bearded-Tyrannulet (TX) | **Painted Bunting** |
| **Long-billed Curlew** | **Loggerhead Shrike** | Hooded Oriole (TX) |
| **Hudsonian Godwit** | Bell's Vireo | Audubon's Oriole (TX) |

wintering grounds. National, regional, and more local conservation priorities were determined. These species represent conservation priorities for the USFWS and other PIF partners including state wildlife agencies, the U.S. Forest Service, and other governmental and private partners. Multi-agency PIF conservation strategies for Texas are currently under development, and these strategies will guide management activities at the local and regional scale. In Texas, the PIF partners have identified priority species for conservation, monitoring and management in relation to specific habitat types and seasons within the Texas Coastal Prairies region (Texas Parks and Wildlife Department 2000), which includes the project area. Habitats on the project area provide wintering, migrational and/or nesting habitat for 16 species of wetland-associated birds, 10 species of grassland birds, and 13 species utilizing woodland habitats which are listed as Rare and Declining within the Texas Coastal Prairies Region (Table 3-16). Avian species listed as Rare and Declining which breed in the Coastal Prairie Region of Texas are found in Table 3-17.

The coastal wetland habitats identified in the project area lie within the Gulf Coast Prairie (GCP) Region under the U.S. Shorebird Conservation Plan (USSCP). Thirty-nine shorebird species occur in this Region, and it is considered to be of "extremely high importance" to 14 species and of "considerable importance" for 21 additional species (Table 3-18). Of these 35 species, 17 are considered to be species of conservation concern under the USSCP. Four are considered "Highly Imperiled" – Snowy Plover, Piping Plover, Long- billed Curlew, and Eskimo Curlew (believed extirpated). Thirteen species are considered "Species of High Concern" – American Golden Plover, Wilson's Plover, Mountain Plover, American Oystercatcher, Whimbrel, Hudsonian Godwit, Marbled Godwit, Ruddy Turnstone, Red Knot, Sanderling, Buff-breasted Sandpiper, American Woodcock, and Wilson's Phalarope. The GCP Region Shorebird Plan recommends several management actions for maritime and non-maritime shorebirds including increased protection and enhanced management of beach nesting areas, additional habitat protection through land acquisition, restoration of beach and barrier island habitat, incorporation of shorebird conservation into U.S. Army Corps of Engineers projects, addressing freshwater inflow needs of estuaries as part of water resources planning and development, expansion and enhancement of exotic/invasive species management efforts (Chinese tallow), continued use of prescribed burning to enhance shorebird habitat in wetland and prairie habitats, and expanded and enhanced management of rice agriculture, crawfish impoundments, and moist soil units to benefit shorebirds. Standardization and coordination of systematic population monitoring of priority shorebird species is also recommended.

Table 3-16.
List of Rare and Declining Birds in the Coastal Prairie Region of Texas (Shackleford and Lockwood 2000) occurring on the Texas Chenier Plain Refuge Complex.

| Wetlands | Grasslands | Woodland or Shrub |
|---|---|---|
| Piping Plover | Dicksissel | Swainson's Warbler |
| Snowy Plover | Scissor-tailed Flycatcher | Prothonotary Warbler |
| Brown Pelican | White-tailed Hawk | Kentucky Warbler |
| Bald Eagle | Loggerhead Shrike | Hooded Warbler |
| Peregrine Falcon | Northern Bobwhite | Painted Bunting |
| Reddish Egret | Barn Owl | Golden-winged Warbler |
| Mottled Duck | Short-eared Owl | Cerulian Warbler |
| Seaside Sparrow | Sprague's Pipit | Blue-winged Warbler |
| Clapper Rail | LeConte's Sparrow | Bay-breasted Warbler |
| Black Rail | Bobolink | Yellow-billed Cuckoo |
| Yellow Rail | | Swallow-tailed Kite |
| Forster's Tern | | American Woodcock |
| Least Tern | | |
| Wood Stork | | |
| Hudsonian Godwit | | |
| Buff-breasted Sandpiper | | |

Table 3-17. List of Priority Avian Species Identified as Breeding in Habitats of the Coastal Prairie Region of Texas (Shackleford and Lockwood 2000). **(Bolded species are known breeders on the Texas Chenier Plain Refuge Complex)**

| Habitats | Breeding Species |
|---|---|
| bottomland forest (understory) | chuck-will's widow, wood thrush, hooded warbler |
| bottomland forest (canopy) | **yellow-billed cuckoo**, eastern wood pewee, great crested flycatcher, yellow -throated vireo, prothonotary warbler, yellow-throated warbler, summer tanager, bald eagle, Mississippi kite |
| bottomland forest (mid- story) | white-eyed vireo, Acadian flycatcher, Bell's vireo, red-shouldered hawk |
| prairie freshwater wetland | **Mottled Duck, common yellow throat, marsh wren, King rail** |
| coastal saline marsh | black rail, **clapper rail, seaside sparrow** |
| coastal mud/sand flat | snowy plover, Wilson's plover, **horned (Texas) lark** |
| prairie grassland (upper Texas coast) | grasshopper sparrow, Henslow's sparrow, **dickcissel** |
| prairie savannah | painted bunting, **orchard oriole**, **scissor-tailed flycatcher, loggerhead shrike**, white-tailed hawk |
| thorn-scrub | curve-billed thrasher, Bell's vireo |
| urban | chimney swift, **purple martin** |

The North American Waterbird Conservation Plan (Kushlan *et a*l. 2002) classified colonial and semi-colonial breeding waterbird species into one of several "at risk" categories, including "not currently at risk", "low", "moderate", "high", "highly imperiled", and identified those species for which there is "insufficient information available to assess risk". Wetland habitats on the project area provide important wintering, migrational and/or nesting habitat for 14 colonial and semi-colonial waterbird species deemed at moderate risk, and 6 species deemed at high risk (Table 3-19). High risk species include Tricolored Heron, Little Blue Heron, Snowy Egret, Least Tern (all four nest on the Refuge Complex), Wood Stork, and Gull-billed Tern. The population status of solitary breeding marshbirds will be assessed in the second version of the NAWCP. The project area is extremely important for many of these species, including several already identified by the USFWS as Avian Species of Conservation Concern. These include Yellow Rail, Black Rail, and American Bittern. For the Southeast U.S. Region, the NAWCP identifies major concerns or threats to waterbirds to be fisheries "by-catch", loss and deterioration of habitat, disturbance of nesting areas (particularly to beach-nesting terns and skimmers), and effects from contaminants. Standardization and coordination of systematic population monitoring of priority waterbird species is also recommended.

Table 3-18.
Shorebirds Occurring within the Gulf Coast Prairie Region, Documented on the Refuge Complex, and Classified as "Highly Imperiled" or "Species of High Concern" Under the U.S. Shorebird Conservation Plan, Lower Mississippi/Western Gulf Coast Regional Shorebird Plan (Elliot and McKnight 2000).

| Shorebird Species | Importance of GCP Region | USSCP Conservation Status |
|---|---|---|
| Snowy Plover | Considerable | Highly Imperiled |
| Piping Plover | Extremely High | Highly Imperiled |
| Long-billed Curlew | Extremely High | Highly Imperiled |
| Eskimo Curlew | Historic Range | Highly Imperiled |
| American Golden Plover | Extremely High | Species of High Concern |
| Whimbrel | Extremely High | Species of High Concern |
| Hudsonian Godwit | Considerable | Species of High Concern |
| Marbled Godwit | Considerable | Species of High Concern |
| Ruddy Turnstone | Considerable | Species of High Concern |
| Red Knot | Considerable | Species of High Concern |
| Sanderling | Considerable | Species of High Concern |
| Buff-breasted Sandpiper | Considerable | Species of High Concern |
| American Woodcock | Considerable | Species of High Concern |
| Wilson's Phalarope | Considerable | Species of High Concern |

Table 3-19.
Waterbird species classified into risk categories as "High" or at "Moderate" under the North American Waterbird Conservation Plan which occur on the Texas Chenier Plain Refuge Complex.

| Avian Species | At Risk Level |
|---|---|
| Tricolored Heron | High |
| Little Blue Heron | High |
| Snowy Egret | High |
| Wood Stork | High |
| Gull-billed Tern | High |
| Least Tern | High |
| Eared Grebe | Moderate |
| American White Pelican | Moderate |
| Brown Pelican | Moderate |
| Neotropic Cormorant | Moderate |
| Anhinga | Moderate |
| Reddish Egret | Moderate |
| Black-crowned Night-heron | Moderate |
| Yellow-crowned Night-heron | Moderate |
| White Ibis | Moderate |
| Roseate Spoonbill | Moderate |
| California Gull | Moderate |
| Franklin's Gull | Moderate |
| Forster's Tern | Moderate |
| Black Tern | Moderate |
| Glossy Ibis | Low |
| White-faced Ibis | Low |
| Herring Gull | Low |
| Caspian Tern | Low |
| Common Tern | Low |

**2. Fisheries Resources**

The region's coastal fishery is classified as a warm water fishery resource with moderate to high numbers of salt and brackish water species occurring in the Gulf of Mexico and large estuarine bay systems. Over 95% of the marine organisms found in the Gulf of Mexico depend on estuarine habitats (salt, brackish, and intermediate marshes) for their survival, and estuaries are often referred to the food pantry for the ocean. This natural resource base is the cornerstone of a very important commercial and sport fishing industry based on the harvest and sale of seafood. Millions of tons of penaid shrimp, crabs, finfish, oysters, clams, and other marine life are dependent on the biological richness afforded by the estuaries. Segments of the estuarine habitats are important nursery habitats for a variety of living marine resources, especially in their early life stages.

Estuarine marshes and associated habitats have been identified by the Gulf of Mexico Fishery Management Council (GMFMC) as Essential Fish Habitat (EFH) for juvenile white shrimp (*Litopenaeus setiferus*) and brown shrimp (*Farfantepenaeus aztecus*), and juvenile red drum (*Sciaenops ocellatus*). EFH known to occur in the project area includes estuarine emergent wetlands, estuarine mud, sand and shell substrates, submerged aquatic vegetation, and estuarine water column. Detailed information on red drum, shrimp, and other Federally managed fisheries and their EFH is provided in the 1998 amendment of the Fishery Management Plans for the Gulf of Mexico prepared by the GMFMC. The 1998 EFH amendment was prepared as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (P.L. 104 - 297).

In addition to being EFH designated for red drum and shrimp, estuarine habitats provide nursery and foraging habitat that supports various life stages of forage species and recreationally important marine fishery species such as spotted seatrout (*Cynoscion nebulosus*) Southern flounder (*Paralichthys lethostigma*), Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), Gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), blue crab (*Callinectes sapidus*), spot (*Leiostomus xanthurus*), pinfish (*Lagodon rhomboides*), silver perch (*Bairdiella chrysoura*), sheepshead (*Archosargus probatocephalus*), gizzard shad (*Dorosoma cepedianum*), bay anchovy (*Anchoa mitchilli*), sheepshead minnow (*Cyprinodon variegatus*), Gulf killifish (*Fundulus grandis*), and silversides (*Menidia spp.*) (Nelson 1992). Estuarine habitats support many benthic animals, including marine worms and crustaceans, which are consumed by higher trophic level predators such as shrimp, crabs, and black drum. Benthic organisms also have a key role in the estuarine food web because: (1) they mineralize organic matter, releasing important nutrients to be reused by primary producers; (2) they act as trophic links between primary producers and primary consumers; and (3) they can also aggregate dissolved organics within estuarine waters, which are another source of particulate matter for primary consumers.

The inland fishery resources on the Refuge Complex and the project area support low numbers of game fishes and high numbers of forage and rough fishes. Important inland game fish include flathead catfish, blue catfish, channel catfish, largemouth bass, white bass, and white and black crappie. The most common bait fish include striped mullet and gizzard and threadfin shad. Some species of rough fish include common carp, small mouth buffalo, freshwater drum, bowfin, and three species of gar fish: alligator, long nose, and spotted.

The Refuge Complex provides both saltwater and freshwater fishing and crabbing opportunities. Both are popular activities on Anahuac, McFaddin and Texas Point NWRs.

### 3. Threatened and Endangered Species

Several Federally-listed Threatened and Endangered Species (T&E species), listed under the Endangered Species Act of 1973, occur within the project area (Table 3-20). Several of these species, as well as several additional species, are listed by the State of Texas as endangered, threatened, or species of concern (SOC).

Several recent actions by the USFWS under the Endangered Species Act have changed the status of Threatened and Endangered species occurring within the project area. In 1999, the USFWS de-listed and removed the Arctic Peregrine Falcon from the list of T&E species. The Bald Eagle was down-listed from Endangered and reclassified as Threatened in 1995.

There are no known Federally-listed Threatened or Endangered plant species present in the project area.

The project area lies within the historic ranges of four Federally-listed T&E species: Attwater's Prairie Chicken, red wolf, Eskimo Curlew, and West Indian Manatee. These species have been extirpated within the project area.

Table 3-20.
Federal and State-listed Threatened and Endangered Species occurring within the project area.

| Common Name | State Status | Federal Status |
|---|---|---|
| American Alligator | ** | T* |
| Loggerhead Sea Turtle | T | T |
| Green Sea Turtle | T | T |
| Atlantic Hawkbill Sea Turtle | E | E |
| Kemp's Ridely Sea Turtle | E | E |
| Alligator Snapping Turtle | T | ** |
| Leatherback Sea Turtle | E | E |
| Texas Horned Lizard | T | ** |
| Smooth Green Snake | T | ** |
| Brown Pelican | E | T |
| Reddish Egret | T | ** |
| White-faced Ibis | T | ** |
| Wood Stork | T | ** |
| Swallow-tailed Kite | T | ** |
| Bald Eagle | T | T*** |
| White-tailed Hawk | T | ** |
| Arctic Peregrine Falcon | T | ** |
| Piping Plover | T | T |
| Interior Least Tern | E | E |

*Threatened due to similarity in appearance with American Crocodile (*Crocodylus acutus*)

** Not listed

***Proposed delisting

### a. Federally-Listed Threatened and Endangered Species

*Sea Turtles*
Three species of sea turtles, the Kemp's Ridley, Leatherback and Hawksbill are federally-listed as Endangered, and two species, the Loggerhead and Green, are federally-listed as Threatened. All five species occur in the project area's nearshore Gulf waters, and the Kemp's Ridley, Loggerhead and Green sea turtles can be found in shallow bays typical of East Galveston Bay adjacent to the Anahuac NWR. Strandings of dead and injured sea turtles occasionally occur along the Gulf shoreline within the Texas Point and McFaddin NWRs.

Historically, all five of these sea turtles nested on the Texas Gulf Coast. The Kemp's Ridley is the most endangered of the sea turtles. The number of Kemp's Ridley sea turtles nesting in Texas appears to be increasing, and this species is now nesting again in parts of its historic range to include the upper Texas Gulf Coast. Nesting activity on Galveston Island was first documented in 2002 with 2 nesting attempts, and 7 nesting attempts were documented in 2005. In 2004, two nesting attempts were documented on the western portion of the Bolivar Peninsula in Galveston County, the furthest north to date. In 1996, a nesting attempt by a loggerhead sea turtle was documented on the western portion of the Bolivar Peninsula. No nesting attempts by Kemp's Ridley sea turtles or any of the other sea turtle species have been documented on the Refuge Complex.

*Bald Eagle*
The nesting range of the Bald Eagle (Federally-listed as Threatened) includes portions of the project area, but they do not nest on the Refuge Complex. Bald eagles are frequently observed during winter on the Refuge Complex, in association with large concentrations of waterfowl.

*Brown Pelican*
The Brown Pelican is Federally-listed as Endangered. Its listing status is currently being reviewed by the USFWS. Populations in coastal Texas appear to be increasing. New nesting colonies have recently been documented in Galveston Bay (USFWS, unpublished data). Within the project area, Brown Pelicans typically congregate on open waters and along shorelines of the Gulf, Galveston Bay, Sabine Lake, and the GIWW. On the Refuge Complex, they are frequently observed in small to medium flocks on the Gulf shoreline within the Texas Point and McFaddin NWRs, and are frequently observed flying over all of the refuges.

*Piping Plover*
The Gulf Coast of Texas attracts a large population of wintering Piping Plovers, a Federally-listed Threatened species (USFWS 1998). In 2001, the USFWS designated Critical Habitat for the wintering Piping Plovers in Texas. Within the project area, this designation included an area within Rollover Bay, near Rollover Pass on the Bolivar Peninsula. Piping Plovers can be observed in small numbers during the winter feeding on invertebrates found along exposed mudflats along bayous on the Refuge Complex, the Galveston Bay shoreline on Anahuac NWR during extremely low tides, and on the Gulf beaches of McFaddin and Texas Point NWRs during spring and fall migration. There have been no records to date of nesting Piping Plovers within the project area.

*American Alligator*
Alligators received protection under the Endangered Species Act in 1974, when they were listed as Endangered. Following population increases, the listing status was changed to Threatened due to similarity of appearance with the Endangered American crocodile.

### b. State of Texas-Listed Threatened and Endangered Species

*Arctic Peregrine Falcon*
The Arctic Peregrine Falcon is State-listed in Texas as Threatened. Due to similarity of appearance, the TPWD also affords protection to the American peregrine falcon. The Arctic peregrine falcon's wintering range includes all of the Texas Gulf Coast. The American and Arctic peregrine falcon are attracted to large concentrations of ducks and other birds during the winter. The southern coast of Texas appears to

be a major spring migration staging area, and most falcons are observed on the Refuge Complex during spring and fall migration. Peregrine falcons are also regularly observed during fall and spring migrations along the Gulf of Mexico shoreline on McFaddin NWR.

*Bachman's Sparrow*
The Bachman's Sparrow is State-listed as Threatened. The breeding range of the Bachman's sparrow includes the Texas Gulf Coast. However, its distribution in the project area is uncommon and local, and most observations are of wintering birds and those seen during fall and spring migration. A ground nester, the Bachman's sparrow prefers habitat consisting of open pine stands with grassy ground cover and dense herbaceous cover. This species has not been documented on the Refuge Complex.

*Reddish Egret*
The reddish egret is State-listed as Threatened. Reddish egrets are observed on the brackish and intermediate marshes on Anahuac NWR, especially large flats found on the Roberts-Mueller and Pace tracts. Preferred habitats include shores, lagoons, saltmarshes, and salt flats where they primarily forage on fish. Breeding activity generally occurs on coastal islands where they will nest in colonies, although rarely east of Galveston, Texas. There is no documentation of nesting activity by reddish egrets within the project area.

*Wood Stork*
Currently, the TPWD lists the wood stork as Threatened. Wood storks are Federally-listed as Endangered, but this status only applies to populations in Alabama, Florida, Georgia and South Carolina. Some of the latest nesting records in Texas come from Chambers and Jefferson counties (1930 and 1960, respectively) (Oberholser 1974) (DeGraaf *et al*. 1991). The wood stork generally nests in colonies in trees bordering swamps, marshes, or ponds. Wood storks typically utilize brackish marsh habitats on the Anahuac and McFaddin NWRs during late summer. It is believed that these birds are dispersing post-breeding from Mexico, where nesting populations occur.

*White-faced Ibis*
The White-faced Ibis is State-listed as Threatened. This species is a colonial nester that is commonly observed throughout the year on the Refuge Complex. White-faced ibis have nested on the Refuge Complex on McFaddin NWR. Populations of this species in the Chenier Plain region are believed to have been negatively-impacted by the use of pesticides and herbicides used in rice production (DeGraaf *et a*l. 1991). Preferred habitats include freshwater marshes, sloughs, and ponds with emergent vegetation.

*Least Tern*
Currently, the TPWD lists the interior Least Tern as Endangered. The entire Texas Gulf Coast, including the project area, is included within the wintering range of the interior least tern. Interior Least Terns nest inland of the coast, and are considered a separate population than the coastal Least Tern which is a common nester in the project area. The interior Least Tern is observed on the Refuge Complex only rarely during spring and fall migration.

*American Swallow-tailed Kite*
The American Swallow-tailed Kite is State-listed as Threatened. Preferred habitats consist of river bottom forests where they nest in the tree tops near habitat edges and other openings. In recent years, nesting has been documented just north of the project area in bottomland forests along the Trinity River (TPWD, unpublished data). They have been observed on the North Unit of McFaddin NWR.

*Alligator Snapping Turtle, Smooth Green Snake, Texas Horned Lizard*
The alligator snapping turtle, smooth green snake and Texas horned lizard are State-listed as Threatened. The smooth green snake is believed present in disjointed populations in Chambers County and other parts of southeast Texas, but there has not been a verified siting of a smooth green snake in Texas since the late 1960's. The preferred habitats include grassy fields, meadows, low brush, and bog sites. Alligator snapping turtles and Texas horned lizards have been documented on the Refuge Complex, but their distribution and abundance are currently not known.

Several species listed by the State of Texas as Species of Concern are known to occur on the Refuge Complex. These include the diamondback terrapin, Gulf saltmarsh snake, black rail, cerulean warbler, loggerhead shrike, and Henslow's sparrow.

**4. Mammals, Reptiles, Amphibians, and Invertebrates**

Some of the more common mammals in the project area include raccoon, river otter, bobcat, nine-banded armadillo, swamp cottontail rabbit, Virginia opossum, muskrat, nutria, white-tailed deer, coyote, striped skunk, and feral pig.

Both muskrat and nutria populations are cyclical, and populations of these species in the project area have been relatively low in recent years. Marsh habitats now part of the Refuge Complex included some of the highest quality muskrat habitat in the project area. Muskrat populations in the project area and the Chenier Plain region as a whole supported a once-thriving fur trapping industry. Muskrat populations on the Refuge Complex were low throughout most of the 1990's, but are currently increasing on the Anahuac and Texas Point NWRs (USFWS, unpublished data). Nutria are not native to North America, but were introduced in Louisiana in 1937. In Louisiana and some other coastal ecosystems, overpopulations of nutria have resulted in significant damage to native habitats and negative impacts to native wildlife species. Although nutria have historically reached high densities within the project area, these concentrations have been localized and widespread damage has not been reported in Texas.

Common reptiles in the project area and on the Refuge Complex include the American alligator, western cottonmouth, speckled kingsnake, red-eared slider, and snapping turtle. Common amphibians include the pig frog, southern leopard frog, Gulf Coast toad, bullfrog, and several species of salamanders. The lesser siren and two-toed amphiuma are probably common though seldom-seen amphibians found in freshwater habitats. A total of 46 species of frogs and toads has been documented to occur in Texas, and 23 of these potentially could be found within the project area.

Alligators currently occur in over 90% of their historic range with the largest concentrations in Texas occurring in the middle and upper coastal counties and suitable inland habitats. Preferred habitats include river valleys, streams, oxbow lakes, marshes, swamps, estuaries, bayous, and slow moving creeks where they will feed on various species of fish, turtles, snakes, and small mammals such as nutria and muskrat. American alligator populations on the Refuge Complex have trended upward since surveys of this species were initiated in the mid-1980s (USFWS unpublished data). Alligators now can be found in all wetland habitats on the Refuge Complex.

Alligators received protection under the Endangered Species Act in 1974, when they were listed as Endangered. Following population increases, the listing status was changed to Threatened due to similarity of appearance with the Endangered American crocodile. Harvest of alligators in Texas was reinitiated in 1980. Alligators are harvested on the Refuge Complex, and this program is managed as a compatible refuge economic use. Harvest quotas for the refuges are set by the Texas Parks and Wildlife Department. Annual harvests on the Refuge Complex from1998 to 2004 ranged from 211-649 alligators and averaged 382 alligators (USFWS unpublished data).

Invertebrate populations are an essential food resource for migratory birds and estuarine fishery species. Various amphipods, midges, mysid shrimp, grass shrimp, crayfish, and numerous crabs are present within all marsh habitats in the project area. Some of these invertebrate populations occur in tremendous quantities. Mosquitoes, biting flies, chiggers, and imported fire ants are other common invertebrates.

Recent surveys have documented 38 butterfly and 16 dragonfly species on the Anahuac NWR (USFWS unpublished data). Common butterfly species include monarch, little yellow and Gulf fritillary butterflies. Common dragonfly species include the common green darner and seaside dragonlet.