CHAPTER 3: AFFECTED ENVIRONMENT

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 Draft EIS/CCP.

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. Refuge Complex and Anahuac NWR staffs are 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 (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 proves to be 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, 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 restricted 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 (Morton *et al*. 1996). 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 (Stewart *et al*. 1996). 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.

Approximately 3,235 acres of 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.

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 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 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 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 framing 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. Product from the wells is transported via gathering lines to an off-refuge separator/tank battery facility located north of F.M. Road 1985.

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 lost 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.

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.

Table 3-2. Common Plants of Wetland and Aquatic Habitats	
Marsh Type	Associated Plant Species (Common and *Scientific* Name)
Saline	smooth cordgrass *Spartina alterniflora* glassworts *Salicornia spp.* marshhay cordgrass *Spartina patens* maritime saltwort *Batis maritima* seashore saltgrass *Distichlis spicata* blackrush *Juncus roemerianus* saline marsh aster *Aster tenuifolius* Carolina wolfberry *Lycium carolinianum* bushy sea-oxeye *Borrichia frutescens*
Brackish	saltmarsh bulrush *Bulbuschoesus robustus* widgeon grass *Ruppia maritima* dwarf spikerush *Eleocharis parvula* marsh pea *Vigna luteola* water hemp *Amaranthus australis* marshhay cordgrass *Spartina patens* seashore saltgrass *Distichilis spicata*
Fresh	maiden cane *Panicum hemitomon* duckweed *Lemna spp.* giant cutgrass *Zizaniopsis miliacea* fanwort *Cabomba caroliniana* rice cutgrasses *Leersia oryzoides* watershield *rasenia schreberi* marsh millet *Echinochloa spp.* American lotus *Nelumbo lutea* arrowheads *Sagittaria spp.* blatterworts *Utricularia spp* white waterlily *Nymphaea elegans* marshhay cordgrass *Spartina patens* alligatorweed *Alternathera philoxeroides* Jamica sawgrass *Cladium jamaicense* Southern naiad *Najas quadalupensis* smartweed *Polygonum spp.* flat sedges *Cyperus spp.* sand rush *Eleocharis montevidensis* sprangletop *Leptochloa spp.* longtom *Paspalum lividum* burheads *Echinodorus spp.* squarestem spikerush *Eleocharis quadrangulata* rattlebox *Sesbania texana*
Inland Open water*	sago pondweed *Potamogeton pectinatus* duckweed *Lemna spp.* Southern naiad *Najas guadalupensis* waterlettuce *Pistia stratiotes* wigeon grass *Ruppia maritime* alligatorweed *Althenathera philoxeroides* water hyacinth *Eichlornia crassipes* waterlettuce *Pistia stratiotes*
Forested Wetlands (true swamps)	bald cypress *Taxodium distichum* water tupelo *Nyssa aquatica* buttonbush *Cephalanthus occidentalis* swamp privet *Ligustrum sinense*
*Inland Open Water (rivers, estuaries, drainage ditches, tidal creeks, bayous, reservoirs, lakes, ponds, navigation canals)	

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 loss 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 (USFWS 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 (USFWS 1979, 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 (USFWS 1979, 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 (USFWS 1979, 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 (USFWS 1979, 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, shortgrass, 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. 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* knotroot bristlegrass *Setaria geniculata* seaside goldenrod *Solidago sempevirens* eastern baccharis *Bachharis halimifolia*
Native Prairie (non-saline)	little bluestem *Schizachyrium scoparium* Indiangrass *Sorghastrum nutans* switchgrass *Panicum virgatum* brownseed paspalum *Paspalum plicatulum* southwestern waxmyrtle *Myrica cerifera* bushy bluestem *Andropogon glomeratus* Panicum grasses *Panicum spp.*
Prairie Grasslands (non-saline)	broomsedge bluestem *Andropogon virginicus* bushy bluestem *Andropogon glomeratus* brownseed paspalum *Paspalum spp.* vaseygrass *Paspalum urvillei* common Bermudagrass *Cynodon dactylon* blue verbena *Verbena brasiliensis* seacoast sumpweed *Iva annuua* giant ragweed *Ambrosia trifida* Southern dewbwerry *Rubus trivialis* Eastern baccharis *Bachharis halimifolia* Chinese tallow *Sapium sebiferum*
Upland Forests and Woodlots	hackberry *Celtis occidentalis* mulberry *Morus rubra* black willow *Salix nigra* live oak *Quercus virginiana* common persimmon *Diospyros virginiana* sugarberry *Celtis laevigata* prickly ash *Zanthoxylum clava-herculis* slash pine *Pinus elliotii* salt cedar *Tamarix gallica* Chinese tallow *Sapium sebiferum*
Alluvial Forests	water oak *Quercus nigra* red maple *Acer rubrum* box elder *Acer negundo* carolina ash *Fraxinus caroliniana* overcup oak *Quercus lyrata* bald cypress *Taxodium distichum* water tupelo *Nyssa aquatica* swamp privet *Ligustrum sinense* poison ivy *Toxicodendron radicans* trumpet creeper *Campsis radicans* greenbriar *Smilax spp.* peppervine *Amelopsis arborea*

Table 3-3. 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* whorled dropseed *(sporobolus pyramidatus*) saltmeadow cordgrass *(Spartina patens)* bitter panicum *Panicum amarum* white morninglory *Ipomoea stolonifera* camphor daisy *Haglopappus phyllocephalus* silver croton *Croton punctatus* Virginia dropseed *Sporobolus virginicus* Goat-foot morninglory *Ipomoea pes-caprae* beach evening primrose *Oenothera drummondii* glassworts *Salicornia spp.* salt heliotrope *Heliotropium curassavicum* sea-lavender *Limonium carolinianum* 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, cased 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, blue 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 (USFWS 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 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 and 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	---

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.

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.

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.

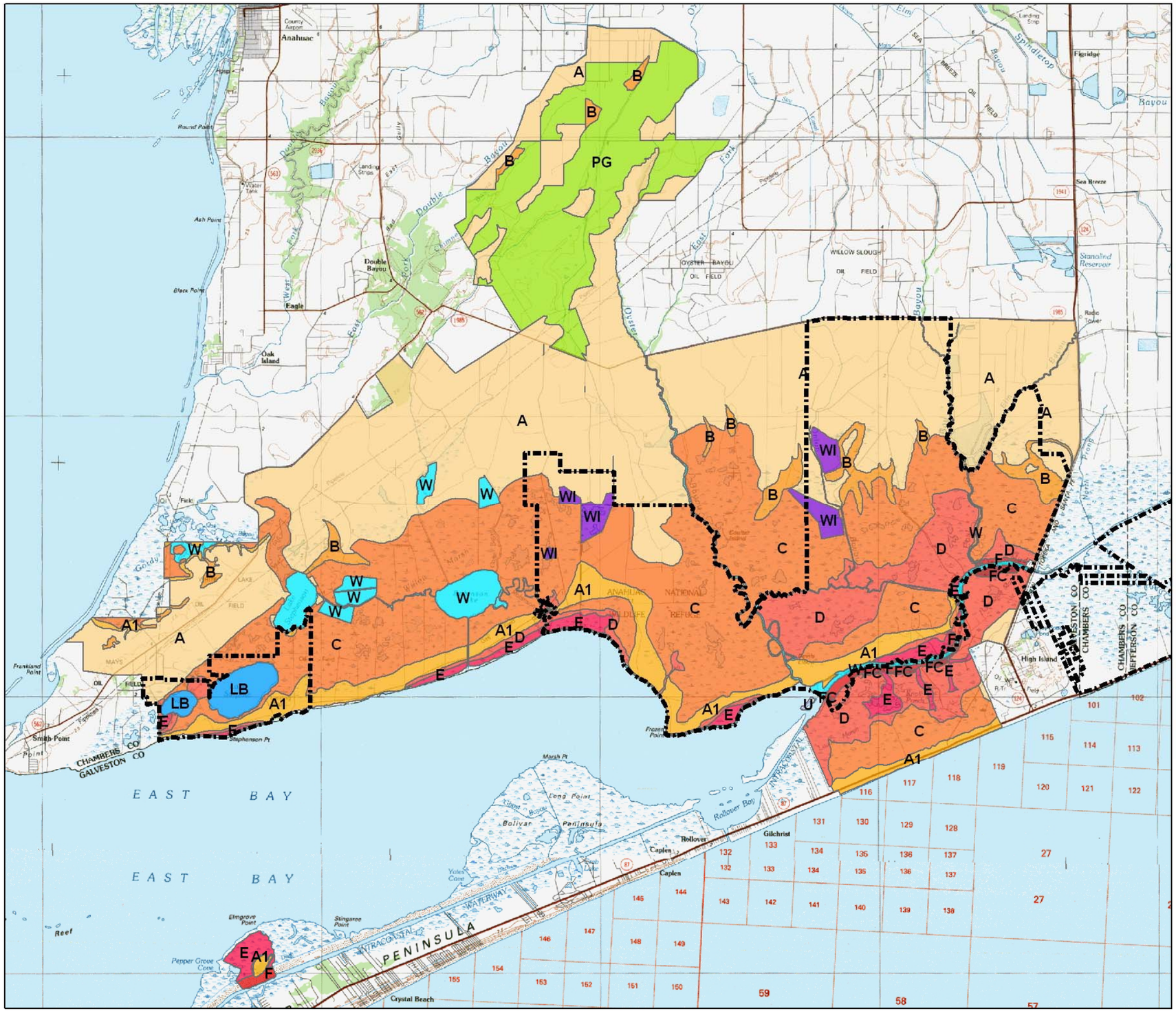
- **Taylors Bayou** – Over 60% of this area contains forested wetlands which provide a high quality habitat for migrating neotropical migratory birds and wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species. Forested wetland is one of the nationally 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.

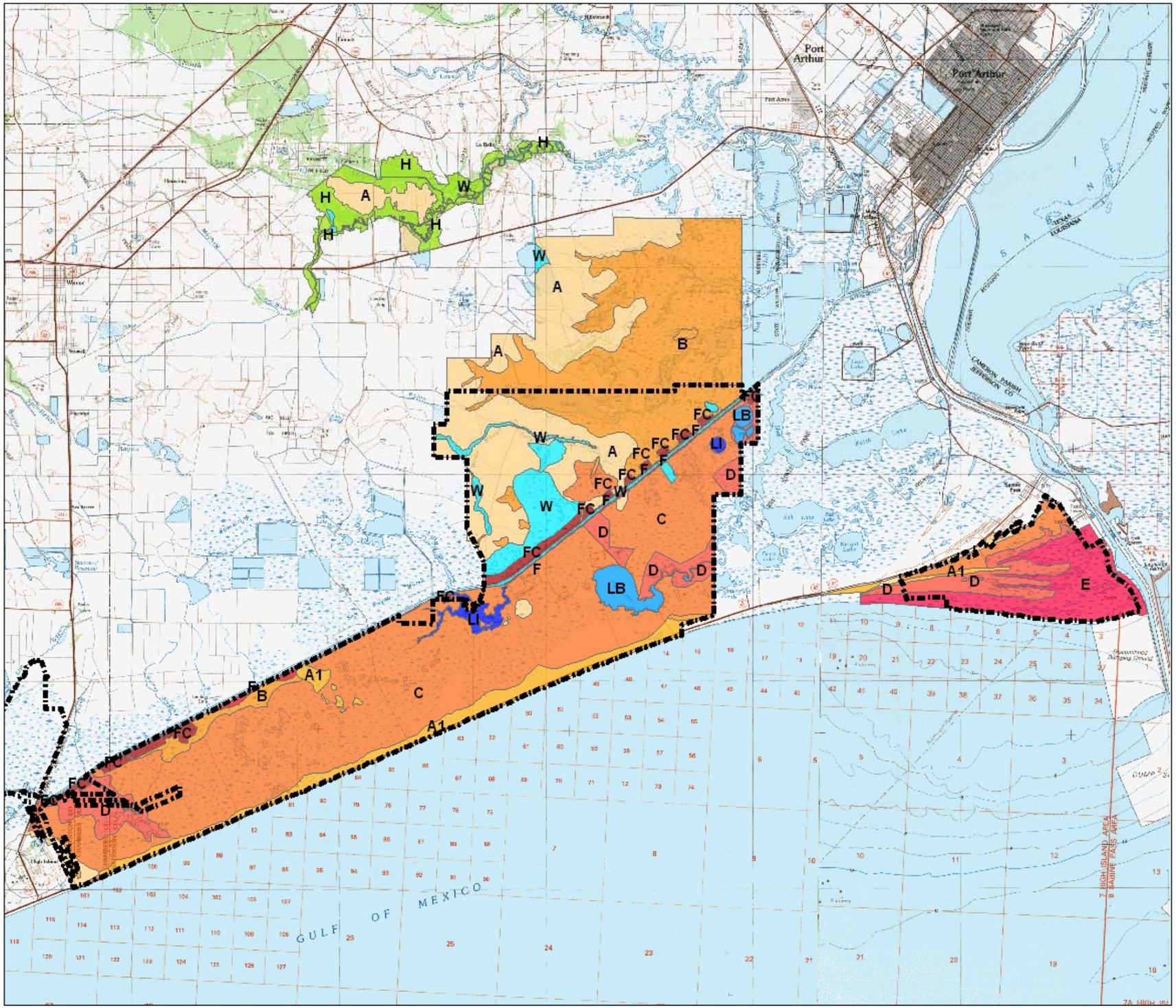
Scale = 1:135,996

0 1.5 3 6 Kilometers

0 1 2 4 Miles

N W E S

U.S. Fish and Wildlife Service
Southwest Regional Office - Division of Planning
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*), Canada 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 Shorebirds 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 1992, 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, Least Bittern, 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-faced ibis, 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 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 Nelson's Sharptailed Sparrow, 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 2005). 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, and Sprague's Pipit. Avian Species of Conservation Concern utilizing prairie grassland habitats on the project area include LeConte's Sparrow, Nelson's Sharptailed 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 2005). (**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 Rail		Yellow-billed Cuckoo
Forster's Tern		Swallow-tailed Kite
Least Tern		American Woodcock
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 (Collins 1981). 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 found in disjointed populations in Chambers County and other parts of southeast Texas. The preferred habitats include grassy fields, meadows, low brush, and bog sites. These species 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 (Arroyo 1992). 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.

III. CULTURAL RESOURCES

Cultural resources are expressions of human culture and history in the physical environment, which are considered to be important to a culture, subculture, or community. Cultural resources can include prehistoric or historic archeological sites, buildings, structures, objects, districts or other places including natural features and biota. Cultural resources also include traditional life ways and practices, and community values and traditions.

Under a USFWS contract, the Texas Archaeological Research Laboratories (TARL) conducted a search of National Register of Historic Places (NHRP) listed properties in Chambers, Jefferson, and Galveston Counties. Four NHRP listed sites and one archeological district were identified in Chambers County. Eighteen sites and one commercial district are listed on the NHRP in Jefferson County. Four historic districts and 66 sites are listed on the NHRP in Galveston County. No properties have been identified to date on the Refuge Complex that are listed on the NHRP. Of the 23 Archaic and Post-archaic shell middens identified within the Refuge Complex, only two shell midden sites on McFaddin NWR, three shell midden sites on Anahuac NWR, and one shell midden site on Moody NWR were determined to be eligible for the NHRP due to the amount of material intact at the sites, but have not been submitted for consideration.

The Refuge Complex has not been fully surveyed for cultural resources. Surveys that have occurred are usually initiated on a project-specific basis, such as for oil and gas or water projects, to comply with the requirements of Section 106 regulations of the National Historic Preservation Act (NHPA), 36 CFR Part 800. Shell middens are the primary cultural resource identified through previous project-specific surveys. The shell middens are hardly noticeable since they are buried under dense vegetation and are typically not identified until a field survey is initiated.

The following cultural resource discussion is a compilation of information gathered from the Handbook of Texas Online (http://www.tsha.utexas.edu/), data forms obtained from TARL from surveys conducted for sponsor-initiated projects on the Refuge Complex, and published information on the archeological and ethnohistoric resources of the project area, for which the primary sources are Davis (1984), Aten (1883), Patterson (1995), Gardner (2001), Fox (1983), and Story *et al*. (1990).

Prehistory Period

Small and scattered populations of nomadic people, predominantly the Atakapa and Karankawa Indians, once frequented Jefferson and Chambers Counties. Karankawa, Coapite, and Copane Indians lived in the area when the first expeditions traveled the lower Trinity River, which later became Chambers County. The Atakapa Indians lived on the Lower Neches and Sabine Rivers in an area that later became Jefferson County and occupied two villages near present-day Beaumont. The Akokisa (also known as Orcoquiza) Indians occupied the area of Jefferson County from the Neches River to halfway between the Trinity and the Brazos Rivers. Archeological excavations in Chambers County have produced artifacts dating to A.D. 1000. Atakapan artifacts dating to year one and A.D. 500 have been found in Jefferson County. The nomadic tribes frequented the area until their disappearance by the 1820s, which has been attributed to migration or smallpox epidemics with the arrival of European settlers.

It has been postulated that in late prehistoric times, the region may have served as a trade corridor between Mesoamerican societies and the advanced Mississippian cultures of the southeastern United States. If so, the hypothetical trade system left no mark on the landscape. There are no intermediary sites, or sites exhibiting evidence of trade, both of which would be expected if an overland trade network had been in existence.

The entirety of prehistoric and historic indigenous occupation of the Texas Chenier Plain was non-agricultural and non-sedentary. Populations were small and dispersed, and the region never supported large population aggregates. The seasonally nomadic, hunting-gathering patterns of subsistence and occupation established after 5,000 BC survived, unchanged, into the historic era. Throughout the

continuous and uneventful millennia of prehistoric occupation, the region witnessed no important phases of cultural adaptation or innovation, other than the acquisition of the bow and arrow, and simple ceramics. All indigenous coastal groups shared common cultural traits, and consequently sites in the project area show little variation. Sites are typical of the Gulf Coast and fall into two categories: shell middens on the coastal shoreline, and campsites on the inland coastal plain. Since modern sea levels were established within the last 4,000 years, coastal sites occupied prior to that time are now submerged.

The nomadic tribes fished, hunted, and gathered available plant and animal resources in the region. Domestic refuse, including shells and bones, was discarded adjacent to the campsites, villages, and fishing and hunting sites. The discarded mollusk shells and animal bones accumulated into large mounds, called middens. Over time, the middens elevated the temporary villages above the marsh. Shell middens occur in areas that were conducive to shellfish growth at the time of early occupancy. Size may vary among middens from small piles to large mounds that may contain millions of shells. Information about Native American settlement patterns, archaeological context, and past natural habitats can be gathered from the locations of shell middens. The calcium carbonate leached from the shells neutralizes acidic soils and preserves bone material in the deposit. The middens are also conducive to tree growth, establishing small groves of trees in grassland-dominated prairies. Many middens along the Gulf Coast have been eroded, inundated by water, or destroyed by human uses, such as use for construction material or cleared to create a roadway. Coastal sites occupied before 4,000 years ago were submerged by the changing coastline and rise in sea levels. As a result, remaining shell middens are increasingly valuable resources.

The shell middens in the Refuge Complex are primarily composed of brackish-water clam (*Rangia cuneata*) and bay oyster (*Crassostrea virginica*), but may also contain debris from estuarine mussels, clams, snails, and marine and freshwater shellfish. Other refuse in the middens include bones of fish, mammals, reptiles, and other vertebrates and artifacts such as projectile points, potsherds, and other tools. On occasion, human remains have been discovered in the shell middens along the Texas Gulf Coast. Human remains found in the middens are reported to the local coroner and law enforcement agency for proper identification, handling, and removal. The USFWS is obligated to comply with the tribal consultation requirements prior to planned excavations or undertakings under the Native American Graves Protection and Repatriation Act and Executive Order 13175, Consultation and Coordination with Indian Tribal Governments. Since many of the tribes that frequented the area dissipated with European settlement, no federally recognized Native American Groups have shown a known interest in lands contained within the Chenier Plain NWR Complex to date

Anahuac NWR has thirteen shell middens scattered along East Galveston Bay. Three of which, occurring on East Bay Bayou, were determined to be eligible for the NHRP. McFaddin NWR has three shell middens along the Gulf of Mexico and Clam and Willow Lakes. A site on McFaddin beach contains evidence of Paleoindian occupation (12,000 – 6,000 B.C.) and a shell midden on Clam Lake were determined eligible for the NHRP. The McFaddin site is located on a shallow reef about 40 meters from the low tide line across a seven-mile stretch that deposits lanceolate spear points and large vertebrate fossils on the beach (Long 1977). There are seven shell middens on Moody NWR along Surprise Lake and East Galveston Bay. The shell midden on Stephenson Point along the Bay on Moody NWR was determined eligible for the NHRP. No archaeological sites have been discovered on Texas Point NWR to date.

Twenty-five shell middens are situated within the proposed refuge boundary expansion areas, two of which were determined eligible for the NHRP, but have not been submitted for consideration. Under Boundary Expansion Alternatives B and C, seventeen shell middens are situated within the lands proposed for acquisition near Anahuac NWR: seven at Lake Stephenson, seven at Robinson Lake/Willow Marsh, one in Oyster Bayou, one along East Bay Bayou, and one village site near High Island. The shell midden site along East Bay Bayou adjacent to Anahuac NWR is determined to be eligible for the NHRP. Under Refuge Boundary Expansion Alternative D, twenty-five shell middens are situated within the lands proposed for acquisition. In addition to the seventeen shell middens identified in Refuge Boundary Expansion Alternatives B and C, there are eight shell middens in the potential Taylor Bayou expansion area. One shell midden site in Taylors Bayou near the Port Arthur Country Club was

determined to be eligible for the NHRP. Human remains were removed from a shell midden near Lake Surprise and the NHRP eligible shell midden along the Galveston Bay near Stephenson Point, both in an expansion area south of the Moody NWR in Refuge Boundary Expansion Alternatives B, C, and D. Human remains were potentially observed at a shell midden site in Taylors Bayou within the expansion area under Refuge Expansion Alternative D.

First sustained contact with Europeans came in the late 1600s. Indigenous coastal cultures declined rapidly following European contact. In just over a century, all indigenous cultures had been extirpated from the coast.

Four generic chronological phases for the prehistory period have been defined for the district. These are summarized as follows:

Paleoindian: 12,000 - 6,000 B.P.

The highly mobile, broad-based hunting/gathering lifeway of the Gulf Coast probably originated at the beginning of human occupation. In the Texas Chenier Plain, there is little archeological evidence of this early period, other than the well known McFaddin Beach site between High Island and Sabine Pass (Long 1977). During the post-Pleistocene, the seacoast was 40 to 50 miles further out. In the higher and drier environment, prehistoric hunter gatherers had access to large game herds, as is evident in the lanceolate spear points and a few large vertebrate fossils recovered from McFaddin Beach. Yet, despite the limited evidence for big game resources in the area, Paleoindian groups may not have been specialized as big game hunters. Instead, they may have followed a more generalized subsistence strategy that relied on the consumption of shellfish, small game, fishing, and wild plant harvesting. Other than the wave-deposited evidence from the McFaddin Beach site, no kill sites or butchering sites have been recorded on the Gulf Coast.

Archaic: 6000 B.P. - A.D. 100

The rapid rise in sea level that began to occur about 6,000 years ago corresponds with the onset of modern climates. By 4,000 year ago, sea level had reached its present level. This period commences at a time when all large game species had become extinct, and small, nomadic hunting/gathering bands had fully adapted to the generalized subsistence strategies which characterized the coast for the remainder of the prehistoric era. Archeologically, the period is known as the “Archaic”, although on the Texas coast the term could just as easily be applied to the entire continuum of prehistory. There is little to distinguish “Archaic” from the succeeding archeological expressions of the Late Prehistoric and early historic periods.

Like the Paleoindian era before it, evidence of the Archaic is extremely limited on the Gulf Coast, and is inferred mostly from isolated artifact finds, rather than occupation sites. Diagnostic artifacts of the Archaic are principally made up of corner-notched and expanding stemmed dart points, which supplant the lanceolate spear points of the Paleoindian phase. Also, bone, antler, and shell tools, polished stone weights and axes, and some ground stone artifacts such as milling stones, when found in locations without ceramics or small bow and arrow projectile points, may be evidence of Archaic occupation.

Late Prehistoric / Early Historic: A.D. 100 to 1800

The introduction of the bow and arrow, trade ceramics, and a minor local ceramic tradition are the only hallmarks of the final phase of prehistoric and early historic occupation. There is no evidence to suggest a burgeoning of population, nor any aggregations of population or changes in demography. Agriculture was impossible in the marshy coast, and in the absence of farming there was nothing resembling movement toward a settled village life. In every respect, the Gulf Coast remained isolated and unaffected by the evolutionary cultural changes which had come to much of Native America, in the final centuries prior to the arrival of Europeans.

Aten (1983) places the project area within the ethnohistoric territories of the Atakapa and Akokisa. The small and dispersed populations of the Tunican-speaking Atakapans shared many cultural characteristics

with the Karankawa Indians who occupied the Gulf zone west of Galveston Bay. By the time of early Mexican and American settlement in south Texas, the Atakapans had been extirpated or assimilated, and ceased to occupy their millennia-old homeland on the coast.

Historical Period

The Spanish were the first to explore the southern United States along the Gulf of Mexico in 1528. Álvar Núñez Cabeza de Vaca and fellow castaways are assumed to have been the first white men to set foot on the Texas Gulf Coast when their vessel was beached during a storm. The French sought to establish a colony north of Mexico on René Robert Cavelier, Sieur de La Salle's expedition to the Louisiana and Texas Gulf Coast in 1685 during the war between France and Spain. The French and Spanish disputed ownership of the area during the eighteenth century, after the French sought to trade with local tribes in 1754. Spanish missions were set up in the region near Wallisville and near the mouth of the Trinity in 1756 to protect Spanish interests from French traders. The Spanish missions included the San Agustín de Ahumada Presidio and Nuestra Señora de la Luz Mission near the mouth of the Trinity. The 1763 Treaty of Paris awarded Louisiana to the Spanish and removed the threat of French intrusion in the area. The Spanish moved their missions in 1766 due to storms and Native American hostility, and abandoned those settlements by 1772. The United States assumed ownership of the area in 1803 as part of the Louisiana Purchase.

Anglo-American colonization began in the area during 1821 and 1836 at the invitation of the Mexican government. The first settlements were located in the present-day areas of Beaumont, Anahuac, Orange, and Wallisville. Early settlers to the area included T.J. Chambers, James Taylor White, and the Wallis family. Settlers were primarily from the South, the Cajuns settled near Taylors Bayou, and the Germans moved to inland areas. James Taylor White supposedly introduced a herd of longhorn cattle at Turtle Bayou in 1827. Importing cattle became a significant livelihood of the area. Other settlers predominantly farmed rice and cotton, with some corn, sweet potato, and sugar cane production as well. The lumber industry, shingle manufacturing, brick manufacturing, shipbuilding, leatherwork, and soap and candle making supported the local economy by the 1840s and 1850s.

In the late 1800s and early 1900s, a system of railways and canals were initiated in the area to facilitate production. A series of railroad towns, include Winnie and Stowell, were created as a result. The Texas and New Orleans (now the Southern Pacific Transportation Company) built from Houston to Orange, the Gulf and Interstate Railway was completed from Beaumont to Bolivar Peninsula, and the Eastern Texas Railroad served from Sabine Pass to Beaumont. The Lone Star Canal Company, the Port Arthur Rice and Irrigation Company, McFaddin Canal Company, Jefferson County Irrigation Company (later renamed Beaumont Irrigation Company), and the Treadaway Canal Company (later renamed Neches Canal Company) developed a series of canals to foster rice farming.

Sabine Pass, a the natural opening between Sabine Lake and the Gulf of Mexico, served as important seaport connection that fostered the growth of Port Arthur. A civil war battle occurred at Sabine Pass in 1863. The United States Navy barricaded the Texas coast beginning in the summer of 1861, while Confederates defended the major ports. Lt. Richard W. Dowling led the Confederates during the Battle of Sabine Pass to turn back one of several Union attempts to invade and occupy part of Texas during the Civil War. Federal efforts to improve navigation across the bar that once blocked the entrance of deepwater vessels to the Sabine River began during the 1870s. The Sabine-Neches, or Port Arthur Ship Canal, was dug during 1897 and 1898 from Sabine Pass to Port Arthur.
The Spindletop oilfield was discovered on a salt dome formation south of Beaumont in eastern Jefferson County in 1901. The discovery marked the birth of the modern petroleum industry. The Texas Company (now Texaco), Gulf Oil Corporation (now Chevron), Sun Oil Company, Magnolia Petroleum Company (now Mobil), and Humble (now Exxon) were a few of the major corporations. The discovery of oil and the development of the Spindletop oilfield provided a major impetus for further canal development. The Rivers and Harbors Act authorized a second major survey of inland waterways in 1905. By 1920, the Gulf Intracoastal Waterway (GIWW) had crossed the southern part of the Jefferson County. By 1940, major industries included oil refining, shipbuilding, rice milling, food processing, and the manufacture of machinery, chemicals, garments, and crates.

Despite the rich history of the project area, the lands encompassed in the Texas Chenier Plain Refuge Complex were never permanently settled. The area was frequently flooded and subject to the wrath of strong Gulf storms. Prominent evidence indicates that the land was primarily used for ranching and rice farming, which still continues on Refuge Complex lands subject to regulations. The lands incorporated into the Refuge Complex were acquired with the existing infrastructure, including extensive ditches and water delivery structures, limited roadways, and limited ranching structures.

There are two historic ranching sites currently within the Refuge Complex, located on the interior of Anahuac NWR. The sites are not eligible for the NHRP. There are no historic sites discovered on the existing Texas Point, McFaddin, and Moody NWRs. One historic site is situated within the proposed land expansion areas, which is eligible for the NHRP. Under Refuge Boundary Expansion Alternatives B, C, and D, an historic shipwreck associated with Lt. Dowling and the Battle of Sabine Pass lies within the area proposed for acquisition at the southeast corner of the Texas Point NWR. The shipwreck is the only historic site that is potentially eligible for listing on the NHRP.

IV. REFUGE COMPLEX MANAGEMENT PROGRAMS

A. Habitat Management and Restoration

1. Wetland Specific Management and Restoration

a. Water Management in Coastal Marshes

Water management, in coordination with prescribed burning and controlled livestock grazing, is used on the Refuge Complex to enhance habitat values in coastal marshes for wintering and migrating waterfowl, shorebirds, wading birds, and other marsh and waterbirds. The integrated use of these habitat management tools is aimed at creating and maintaining a mosaic of plant communities which include several “early successional” plant species which provide food resources for migratory birds, and at creating and maintaining structural characteristics of the vegetation (such as the proper interspersion of open water with emergent vegetation and proper vegetation height) and water levels which promote the use of these habitats by migratory birds for feeding and resting.

The extensive modifications to the region’s natural hydrology described in *Chapter 3, Section I.C. Hydrology* have impacted coastal marshes on the Refuge Complex in several ways. These include increased saltwater intrusion, loss of freshwater inflows, increased frequency of precipitation-driven flood events, and more rapid drainage during normal or drier than normal precipitation cycles. Water management is therefore necessary to maintain the historic continuum of fresh, intermediate, brackish and saline marshes and their natural hydroperiods (wetting and drying cycles), and the natural biological diversity supported by these complex estuarine ecosystems.

These objectives are accomplished on the Refuge Complex by concurrently managing saltwater and freshwater inflows and releases utilizing an extensive management infrastructure comprised of water control structures, levees and water delivery and drainage systems including ditches, canals and pumps. This infrastructure is used to manage and manipulate water and soil salinities and water levels within managed marsh units on the Refuge Complex. Water control structures are designed to either passively or through active manipulation control the amount of saltwater and/or freshwater entering or leaving the unit. Most freshwater inflows on the Refuge Complex occur through direct local precipitation. On Anahuac NWR, freshwater is also diverted or pumped from Oyster and Onion bayous and delivered to managed marsh units via a system of interior canals and ditches. Freshwater to support rice production and to manage rice and moist soil units for migratory birds on Anahuac NWR is also supplied via irrigation canals operated by the Chambers-Liberty Counties Navigation District, and water utilized for rice farming and moist soil management ultimately provides freshwater inflows to marsh units when released.

Managed marsh units within the Refuge Complex are under varying degrees of structural control, and may best be described as marsh semi-impoundments. A small number of units lie almost entirely behind

man-made levees and water control structures, which allows for relatively intensive management of water levels and salinities through manipulation of the water control structures. Conversely, hydrologic regimes in less-intensively managed marsh units are influenced primarily by daily and seasonal tidal fluctuations, precipitation and natural topography.

In general, the typical water management regime for managed marshes on the Refuge Complex involves maintaining salinities within the range of the particular marsh type being targeted. Salinity inputs may be increased to higher than target levels if required to control some invasive plant species. The general water level management regime across most of the Refuge Complex involves maintaining water levels which provide favorable conditions for dabbling ducks and geese during fall and winter. Following the wintering migratory bird season, marsh units are allowed to draw down gradually to create soil conditions favorable for the germination of a variety of seed producing annual plants in emergent marshes and water levels conducive to the germination and establishment of submerged and floating aquatic plants in open water habitats. Summer water levels and salinities are maintained to promote the growth of these species. The above notwithstanding, periodic climatic events such as riverine and tidal flooding, high rainfall events, and prolonged drought are often the dominant factors controlling hydrologic regimes in these coastal marshes.

Anahuac NWR: Direct precipitation, bayous and an extensive system of irrigation canals and ditches provide freshwater inflows to the wetlands of Anahuac NWR. Portions of the Refuge are tidally-influenced either daily or seasonally, and the entire Refuge is subject to tidal inundation from tropical storm and hurricane-generated storm surges.

Approximately 12,000acres of marsh habitats on the Anahuac NWR are under varying degrees of structural management. Large water control structures on Oyster Bayou, Onion Bayou, East Bay Bayou, Jackson Ditch, Oil Field Ditch and their associated levees and canal/ditch systems are the major water management infrastructure for these marsh units. Water management infrastructure on this refuge is extensive and includes over 100 smaller water control structures, and numerous smaller levee and canal/ditch systems. There are also four marsh impoundments on Anahuac NWR. These leveed units are generally managed as deeper permanent freshwater habitats, although periodic drawdowns and mechanical manipulations of soil surfaces are needed to manage vegetation and maintain a desired mosaic of open water and emergent marsh habitats. These include the 250-acre Shoveler Pond on the northwest portion of the Refuge, and Rail Reservoir (150 acres) and the two East Unit reservoirs (98 and 162 acres) located on the west side of the East Unit. The East Unit reservoir extends onto private land so its management must be coordinated with that landowner.

McFaddin NWR: The GIWW bisects the McFaddin NWR, and divides the Refuge into two distinct units, the 7,188-acre North Unit and the 51,573-acre South Unit. The GIWW cut-off freshwater inflows to the marshes of the South Unit by diverting freshwater which formerly flowed to the marshes from the vast contiguous watersheds to the north. Freshwater inflows to marshes south of the GIWW are now restricted to the direct precipitation. Portions of the Refuge's South Unit are tidally-influenced either daily or seasonally, and the entire Refuge is subject to tidal inundation from tropical storm and hurricane-generated storm surges and other high tidal events.

Approximately 18,000 acres of the McFaddin NWR's marsh habitats are under varying degrees of structural marsh management. Willow Slough is the major watershed on the North Unit. The Willow Slough semi- impoundment, historically a reservoir supporting local rice production, is a large freshwater marsh now maintained via a 2,000-linear foot levee, water control structure, and two low-level armored spillways located on the Refuge. The impoundment itself encompasses 1,500 acres of the Refuge with the remaining 1,000 acres on private land. Willow Slough has historically wintered large numbers of waterfowl, including one of the larger concentrations of Ring-necked Ducks in Texas. This freshwater marsh supports high densities of water shield, a floating aquatic plant that is a preferred food source for this diving duck species.

The primary watershed for the McFaddin NWR South Unit is Salt Bayou, which drains the eastern two-thirds of the Refuge through a series of interconnected lakes and waterways including Star Lake and

Clam Lake eastward to the GIWW and the Sabine-Neches Ship Channel. Two major water control structures on Star Lake, one connecting it to the GIWW and the second at the outlet to Salt Bayou (5-mile Cut portion), prevent saltwater intrusion from the GIWW and provide management capability to impound or release freshwater to help maintain the historically fresh and intermediate marshes in the central portion of the Refuge. Whenever possible, freshwater from this portion of the watershed is moved through the outlet water control structure into Salt Bayou, creating a freshwater head that helps maintain a salinity gradient in the marshes further east.

The 5000-acre Wild Cow Bayou Management Unit is located in the eastern portion of the Refuge. This leveed marsh semi-impoundment is intensively managed as an intermediate marsh habitat. Three water control structures, one outletting to Salt Bayou and two to the GIWW, are used to maintain target water levels and salinities in this unit.

Refuge water control structures on the South Unit along Salt Bayou are part of a joint Texas Parks and Wildlife Department-USFWS water management plan, the Salt Bayou Project (TPWD 1990). This management plan was developed for the entire 60,000 acres of federal and state wetlands located in southeastern Jefferson County, including the McFaddin NWR, Sea Rim State Park, and the J.D. Murphree Wildlife Management Area.

The western two-thirds of the Refuge drains westward to the GIWW through an outlet ditch via Mud Bayou. Water management in this portion of the Refuge is passive. Natural and man-made elevated features (several north-south levees and levees along the GIWW) control hydrology. Water sheet flows and moves through the north-south levees through a series of culverts.

The elevated banks of the GIWW, comprised of soils excavated during the canal's construction, are eroding rapidly. Maintenance of these levees is a key management strategy to protect the interior marshes of the North and South units from saltwater intrusion.

Texas Point NWR: Water management on Texas Point NWR is passive. The Refuge is drained from west to east through several branches of Texas Bayou and interconnected tidal cuts and streams. Three rock weirs, located in man-made ditches, were constructed in 2001 and 2002 to protect and restore emergent marshes in the eastern portion of the Refuge. These structures are reducing saltwater intrusion and dampening tidal energies which were causing emergent marsh loss (conversion to open water), while allowing ingress and egress of marine organisms. A north south levee, historically built as an access road to an oil and gas well, traverses the central portion of the Refuge and is maintained with culvert water crossings.

b. Marsh Restoration

An important wetland restoration tool in the Chenier Plain region involves the use of dredged materials to augment sediment supply in sediment poor marshes. In 2000, approximately 50 acres of emergent marsh were restored and created on and adjacent to Texas Point NWR through a U.S. Army Corps of Engineers, Galveston District beneficial use of dredge material project. This project was conducted in partnership with the Texas General Land Office, which provided non-Federal matching funding through the Texas Coastal Erosion and Response Act program. Approximately 850,000 cubic yards of dredge material from the Sabine-Neches Ship Channel were placed to increase elevation in a subsided marsh which had converted into open water, and on an adjacent to the Gulf shoreline to reestablish emergent marsh which had eroded into the Gulf.

Methodologies such as terracing, which use dredged materials to artificially augment marsh elevation, have been used in project area, but not to date on the Refuge Complex, to restore emergent marshes in areas which have been converted to open water. Other means of increasing accretion involve sediment diversions, and water level and salinity management.

Shoreline stabilization (see below) methodologies have included restoration of intertidal marshes, primarily in the intertidal zone between existing shorelines and constructed offshore wavebreaks.

Smooth cordgrass rootstock is planted by hand in these areas and rapidly colonizes, creating habitat important to marine organisms and which also are heavily used by many wading bird species. Approximately 30 acres of estuarine intertidal emergent marsh have been restored on the Refuge Complex for this purpose, along the Galveston Bay shoreline on Anahuac NWR and along the GIWW shoreline on McFaddin NWR.

c. Cooperative Rice Farming Program

Anahuac NWR is the only Refuge on the Refuge Complex with a farming program. Farming on the Refuge is accomplished through cooperative agreements with local farmers. Almost all of the agricultural production in the Refuge is rice farming. Cooperators are allowed to take the first rice crop and are required to flood fields after harvest. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second or ratoon crop of rice which is left for wildlife. Most of the farm fields are in the Beaumont Clay-Morey Silt Loam Association which is ideal for rice farming but unsuitable for other cultivated crops. The variable weather conditions dictate the timing of planting and type of planting method which ultimately affects harvest time. Generally rice is harvested in September or October.

Rice and grain production serves several management outcomes for the Refuge: creating forage for migrating and wintering waterfowl, spring habitat for migrating shorebirds, and fresh water habitat for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in fields. Managed rice fields provide wintering and migrational habitat for blue-winged teal, northern pintail, green-winged teal and snow geese, several shorebirds species including long-billed dowitchers and semi-palmated, western, least, white-rumped, Baird's, pectoral, stilt and buff-breasted sandpipers, and for several wading bird species. Rice farming also helps to offset waterfowl depredations on adjacent croplands. Sorghum, rye grass, and wheat or oats have been occasionally planted on the Refuge to provide late winter forage for wintering snow geese. These crops are now only used when red rice problems preclude planting rice in a field. The additional tillage required when producing sorghum, winter wheat, rye or oats helps to reduce the dominance of red rice.

The USFWS currently has cooperative agreements with three farmers who farm rice on 500-700 acres per year. Twenty-five active rice fields totaling 2,290 acres are still being farmed. The refuge farm program currently has 1716.1 acres of farm base as defined by the USDA. This base is used to calculate the farm subsidy payments to the cooperators. This amount of base is distributed to cooperative farmers annually. Not all of the 1716.1 acres of base are farmed each year. Cooperators farm between 500 to 700 acres annually on a three year rotation, leaving approximately 1,200 to 1,000 acres of the Refuge as "maintenance" acreage. The farmers receive payments on acres farmed and those in maintenance. All cooperators are required to disc, spray, or mow noxious weeds on all maintenance acres each year according the USDA farm program. The current land rent being charged to cooperators is $20/acre of base. Cooperative farmers are dependent on the USDA deficiency payments. Participation in the program involves close coordination with the USDA Farm Services Administration.

Several cooperators have raised organically grown rice on the Refuge during the past ten years. Today, almost 80% of the rice produced on the Refuge is organically grown. Organically produced rice reduces the overall input of herbicides on the Refuge.

Pest management problems associated with rice production at Anahuac NWR are infestations of red rice, annual grasses, sheath spot or blight (*Rhizoctonia oryzae-sativae*) and army worms. Flooding fields is a valuable technique used to limit insect damage to rice. Therefore, insecticides are seldom required. Crop diseases can occur, but no fungicides have been approved for use on the Refuge because they are incompatible with the grazing program. Cropland management involves techniques to reduce the infestations of the native red rice, which is a non-marketable form of rice. Since fallow fields provide ideal conditions for red rice growth, most fields are drained until the field is cultivated prior to planting. Fields lay fallow for one to two years before being planted again to prevent insects or red rice problems. Red rice can be removed by foraging waterfowl (Baldwin 1981). Ordram is the primary chemical herbicide

used to control red rice in the project area, but is rarely used on the Refuge and only in circumstances when infestations reach the point requiring its use. Most applications of herbicides and fertilizer in rice farming operations in southeast Texas are done by air. Fields in crop rotations are disced every three years to prevent exotic species like Chinese tallow and deep-rooted sedge from establishing.

Rice production has declined during the last decade in counties surrounding the Refuge Complex, reducing this type of agricultural wetland habitat for waterfowl, shorebirds and other wetland-dependent species. The Freedom to Farm Act of 1995 reduced subsidies for rice farming over a seven-year period. The reduced subsidies in combination with low rice prices have created an economic hardship for many farmers. In addition, rice yields are typically lower in the project area than in other rice producing areas in Texas and Louisiana, and the cost of rice farming is now exceeding the economic return for many area farmers. This trend is expected to continue until rice prices increase substantially. The organic market appears to be more stable and may provide the best opportunity for the Refuge to continue to produce rice for wildlife.

d. Moist Soil Management

Moist soil management is the process of exposing soils by lowering water levels and/or mechanically manipulating vegetation or soils to create a seed bed for native wetland plants to germinate, grow and reproduce. The seeds, tubers, rhizomes and vegetative portions of moist soil plants provide important foods for waterfowl and other migratory birds.

On Anahuac NWR, approximately 504 acres of moist soil units are managed annually to provide shallow freshwater wetland habitat for wintering and migrating waterfowl, shorebirds and other wetland-dependent wildlife. Water management (drawdowns and flooding) in moist soil units is accomplished with water control structures, levees, and water delivery systems including pumps and canal systems. Conventional farm machinery with discs and roller choppers are used to manipulate soils and vegetation. Water management and mechanical soil manipulations are timed to provide optimal conditions for germination and growth of preferred waterfowl food plants including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato and purple ammenia. The freshwater wetland habitat on the Refuge provided by moist soil management is important to several species of waterfowl, including Blue-winged Teal, Green-winged Teal, Northern Pintail, Northern Shoveler, Mallard, Mottled Duck, Fulvous Whistling Duck, Greater White-fronted Goose, and Lesser Snow Goose.

Approximately 100-150 acres of the Refuge moist soil units are managed specifically for shorebirds during the spring and fall migrations. This involves manipulation moist soil units in early spring and/or late fall, removing vegetation to create mudflats and shallow water habitat required by shorebirds. This management is implemented to provide habitat for several shorebirds species including Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudonian and Marbled godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted sandpipers. Several wading and marsh bird species also utilized moist soil habitats, including American Bittern, Great Blue Heron, Great Egret, Snowy Egret, Little Blue Heron, Tri-colored Heron, Black-crowned and Yellow-crowned Night herons, White Ibis, White-faced Ibis, and Roseate Spoonbill. Approximately 150 acres of moist soil habitat are managed for perennial moist soil plants and are flooded through the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks.

Southern environments have more moist soil plant species and longer growing seasons. This complicates moist soil management strategies. There are more species of favorable waterfowl foods to manage for and unfavorable plants to manage against. Longer growing seasons also require multiple manipulations of vegetation to create conditions favorable for target wetland species and structural conditions favored by waterfowl.

The diversity of native plants and invertebrates produced utilizing moist soil management provides habitat for more species of waterfowl and other wetland wildlife than do commercial row crops. The efficiency of modern harvesting equipment leaves less waist grain for waterfowl. The total energy of moist soil foods is

often as high as or higher than corn, milo and soybeans (Frederickson and Taylor 1982). Waterfowl foods produced by moist soil management are not as affected by weather events, fungus or disease that can reduce production or cause entire cultivated crops to fail. Natural wetlands also provide greater numbers of invertebrates than do cereal grain crops. Moist soil management practices that favor perennial plants like smartweed or submerged aquatics which have more finely dissected leaf structures produce more invertebrates. Invertebrates are also important to waterfowl during the wintering period. Several species of wintering waterfowl molt during the winter, and invertebrates provide important sources of protein required to complete these winter molts.

2. Upland Specific Management and Restoration

a. Native Prairie Restoration

Native coastal prairie is perhaps the most imperiled habitat component of the western Gulf of Mexico coastal region. It is estimated that less than one percent of the original prairie, which once covered over nine million acres of coastal Louisiana and Texas and Mexico, remains today. Upland area on the Refuge Complex and the in project area were historically part of over nine million acres of coastal prairies that once thrived in Texas. These upland areas are made up of clayey, nonsaline soils that tend to be waterlogged during the winter months and dry in the summer. These conditions, combined with periodic wildfires and native grazers, supported an amazingly diverse tallgrass prairie community with over 590 plant species (recorded in comparable remnant prairies in Louisiana).

With the arrival of European settlers, agriculture, and urbanization, industrialization directly replaced native prairie. Extensive drainage impacted much of the remaining area. Naturally occurring wildfires were suppressed, native grasslands were overstocked with domestic cattle, and nonnative plants and animals were introduced.

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 revegetated over time by native and non-native grasses, forbs and woody vegetation. 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. Once a prairie grassland stand is successfully established, prescribed fire and rotational grazing are used to maintain the habitat.

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. 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. Grassland habitats on these refuges have not been cultivated, but have been reduced in quality by a variety of factors including invasion by exotic Chinese tallow and McCartney rose.

Some permanently fallowed croplands on the Anahuac NWR have been intensively restored to native prairie. Prairie restoration on the Anahuac NWR typically requires as an initial step of removal of Chinese tallow using fire, mechanical removal or treatment with herbicides. The second step involves restoring the natural hydrology of the area. Rice field levees are removed to restore natural contour of the land and facilitate natural drainage. The next step is the introduction of native prairie plant seeds or plants. Sprigging of native grasses and forbs has been successfully used on a small scale. Availability of a viable seed source for prairie restoration in the region is very limited, as most commercially available native prairie seed sources are not suitable for restoration here. Most seed for prairie restoration projects on the Refuge Complex has been collected locally or is from seeds produced in the Texas Mid-Coast region. To date, approximately 441 acres of permanently fallowed cropland have been intensively restored to native prairie using these techniques on Anahuac NWR's East Unit.

b. Coastal Woodlot Restoration and Protection

Although comprising less than 1 percent of the Refuge Complex acreage, coastal woodlots help support a diverse avian community, which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in the Refuge Complex's coastal woodlots. Migratory birds also depend on coastal woodlots for cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier Plains prior to or immediately after crossing the Gulf of Mexico (Barrow *et al*. 2000). Trans-Gulf or circum-Gulf migratory songbirds use Texas Coastal woodlots as stopover habitat (Mueller 1981), which is critical at a time when the birds are depleted of water and energy reserves (Leberg *et al*. 1996).

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 woodlot restoration and protection activities on the Refuge Complex include: 1) native tree and shrub plantings; 2) exotic/invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

3. General Habitat Management and Restoration Activities

a. Fire Management

The coastal prairies and marshes of the Chenier Plain region are a fire-adapted ecosystem. Although little is known of the historic fire regime, natural wildfires are thought to have been regularly occurring and widespread due to the region's year-round electrical storm activity and lightning strikes. Fire is thus a major part of the natural disturbance regime which influenced the region's habitats and plant and animal communities and under which these resources evolved.

Fire has long had a role in the ecology of the Chenier Plain region's marshes and prairies. Pre-European settlement, fire frequency for these marshes is estimated to be 1-3 years (Frost 1995). Lightning caused wildfires were common in coastal marshes (Hoffpauer 1968, Frost 1995). Additionally, Native Americans used fire to facilitate hunting and travel (O'Neil 1949, Givens 1962). Fire has been used by people to enhance the agricultural lands and wildlife habitats on public and private lands in the Chenier Plain region. For example, prescribed fire has been used on area national wildlife refuges since the 1940's, when it was first used on Sabine NWR in southwestern Louisiana (Walther 1982). It has since been considered an important habitat management tool on most coastal national wildlife refuges in the region.

In the past, fires in the Gulf coast prairies and marshes probably varied greatly in spatial extent. Natural firebreaks existed in many forms. Bayous, tidal creeks, fault lines, animal trails, and areas previously disturbed by fire or animal herbivory all may limit the spread of wildfires. Weather, fuel conditions, and water levels influence the effectiveness of the natural firebreaks and ultimately the size of the fire. Anecdotal data suggest that prior to the settlement and the major changes in hydrological regimes which followed, much of the vegetation that dominated these fresher marshes (i.e. Sawgrass (*Cladium mariscus* subsp. *jamaicence*), maidencain (*Panicum hemitomon*), giant cutgrass (*Zizaniopsis miliacea*), and bullwhip (*Schoenoplectus californicus*)) was less pyrogenic than common vegetation found today, such as marshhay cordgrass. This may have reduced the frequency and size of historical fires in the region's marshes compared to current vegetative conditions. Conversely, natural fire starts in the region have undoubtedly been significantly reduced because of the landscape-level conversion of upland prairie habitats to agricultural uses. Navigation canals, ditches, levees and roads constructed throughout upland and wetland habitats effectively serve as firebreaks and have greatly affected fire spread and the ultimate size of present-day natural fires.

Generally, three types of fires in coastal marshes are recognized: cover, root, and peat burns (Lynch 1941). Soil moisture and organic content, as well as surface water at the time of the fire, determine the type of burn that occurs. Water levels and soil conditions must be considered carefully to meet management objectives of prescribed burns (Bacchus 1995, Hungerford *et al*. 1995). The USFWS

carefully considers these parameters in implementing its fire management program on the Refuge Complex.

The most common and widely used fire in coastal marshes is the cover burn (Hoffpauer 1968). This type of fire, taking place when water levels are at or near the marsh surface, removes the aerial portions of the vegetation. Recommended water levels for a cover burn range from marsh surface to five inches (Lynch 1941, O'Neil 1949, Hoffpauer 1968). Cover burns temporarily remove dense emergent vegetation and attract wildlife and cattle to the new growth (Lynch 1941, Hoffpauer 1968). Cover burns would be thought of as a surface fire by most fire researchers.

Marshes recover quickly after winter cover burns. Soil moisture or surface water protects the subterranean plant parts from damage. Gabrey and Afton (2001) found in the Chenier Plain of Louisiana, that the total above ground biomass was reduced for two years while dead above ground biomass was reduced for three years post fire compared to unburned control plots. In addition, they found that plant species composition in burned plots was the same as unburned plots, with a slight increase in richness during the first growing season post-fire.

Root burns occur in marshes under dryer conditions. The roots of plants may move into the litter layer in marshes that have not burned in several years (Lynch 1941). If the litter layer is dry enough to support combustion, a root burn may occur. Root fires burn away the litter layer and destroy shallow root systems. This type of burn can create significant changes in the plant community. Climax species such as maidencane and marshhay cordgrass are often set back, allowing subclimax species to increase. Because the fire is in the litter layer and soil is not consumed, this type of burn would also be classified as a surface fire by most fire researchers, though the results of the fire would be very different.

The last type of marsh fire is the peat burn. This takes place under the driest soil conditions. In a peat burn, the fire removes the organic subsurface fuels and in some instances will burn down to the underlying clay pan. This type of fire typically removes existing vegetation and creates open water conditions that may last for decades (Lay and O'Neil 1942, O'Neil 1949, Hoffpauer 1968). Peat burns can create quality waterfowl habitat by burning holes into the marsh that later become open water (Lynch 1941, Uhler 1944, Baldassare and Bolen 1994). Despite this, peat burns are not a management goal in most instances. The prolonged smoldering involved in peat burns would likely cause smoke management problems in surrounding communities. With the alarming loss of coastal wetlands to sea-level rise and subsidence, these types of burns cannot be justified in most situations (Nyman and Chabreck 1995). The general fire management community would classify peat burns as a ground fire.

The objective of the Refuge Complex fire management program is to manage prescribed fire and unplanned wildland fires in a manner beneficial to native plant and animal communities and ecological functions, while providing for public and employee safety and protecting surrounding communities through effective management of hazardous vegetative fuels. Suppression of wildland fires on the Refuge Complex involves utilization of "Appropriate Management Response", with the priority placed on protecting safety of firefighters and the public and protecting natural resources (USFWS 2001). Reducing smoke impacts to surrounding communities is an important consideration in planning and implementing suppression actions on all wildland fires occurring on the Refuge Complex.

Patterns of fire occurrence on the Refuge Complex are most heavily influenced by climate, proximity of hunting/grazing season, and previous occurrence of wildland fires or prescribed burns. Fire models (FIREBASE) implemented in developing the Refuge Complex Fire Management Plan (USFWS 2001) defined the fire season for the Refuge Complex as June 30 to April 10, but the vegetative fuels on the Refuge Complex are capable of supporting fire spread year-round. Analysis of a recent 10-year fire occurrence history (1993 to 2002) for the Refuge Complex documented an average of 28 fires per year with an average fire size of approximately 425 acres. The relatively large average fire size is indicative of the flashy fuels present on the Refuge Complex and the fact that a common suppression strategy involves burning out from established fuel breaks.

Most prescribed burning on the Refuge Complex is conducted in emergent marsh habitats during fall and early winter (September through November), with some burning in upland grassland habitats during late winter and spring (February to April). The Refuge Complex' overall annual burning objective is 12,000 - 15,000 acres. In general, areas within the Refuge Complex are burned on a two-year rotation; however, the actual vegetation condition of the unit dictates the need for a burn.

In marsh habitats, prescribed fire is used in combination with water management and controlled livestock grazing to provide high quality wintering habitat for waterfowl, shorebirds and other marsh and waterbirds. Fire helps to maintain early successional plant communities which provide foods for wintering and migrating waterfowl, and creates openings in otherwise dense stands of vegetation including areas of sheet water utilized by ducks feeding on invertebrates and annual seeds. The desired plant diversity includes several seed producing annual grasses (sprangletops, millets), and tuber producing plants such as Olney bulrush. Snow geese heavily use recent marsh burns because they can readily access roots, tubers, and young green shoots of the regrowth. Both geese and ducks use burned areas as roosts or loafing areas. In prairie grassland habitats, prescribed fire is used to encourage the growth of many native grasses and forbs which have evolved with fire, and to reduce woody vegetation. Without disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by several woody plants, which in turn reduces habitat quality for many avian species and other wildlife. Fire is used to reduce woody species such as Eastern baccharis and big-leaved sumpweed, and is an important tool (among several used) in control efforts for Chinese tallow (a highly invasive exotic plant species).

The USFWS minimizes potential for smoke impacts from prescribed burning operations through strict adherence to legal requirements of the Texas Commission on Environmental Quality, found in Section 111.211 of the Outdoor Burning Rule. The limits are (1) no sensitive downwind receptors within 300 feet; (2) burning must occur no earlier that one hour after sunrise and no later than one hour before sunset; (3) burning is not permitted when surface winds are less than six mph or more than 23 mph; and (4) burning is not permitted during periods of persistent (actual or predicted) low level atmospheric temperature inversions (USFWS 2001,Therriault 2001). To further mitigate negative impacts from prescribed burns, the USFWS implements an independent smoke screening process which includes a 360-degree review of potential smoke sensitive targets. Current and predicted weather and atmospheric conditions are monitored using National Weather Service spot weather forecasts and on-site weather stations. Smoke movement and dispersal is modeled using a smoke modeling tool call SASEM to verify that prescribed atmospheric parameters will prevent smoke from adversely impacting sensitive targets. Larger prescribed burns (500 acres or more) are conducted only on days with a northerly wind component, transporting smoke over the Gulf of Mexico. For prescribed burns less than 500 acres, burning can occur with a southerly wind component, but only under dispersal days of 4 or better (very good to excellent). These are days that the smoke will move quickly up into the atmosphere and over and above smoke sensitive targets. Every prescribed burn on the Refuge Complex is planned and executed within these parameters (USFWS 2001).

b. Controlled Livestock Grazing

Controlled livestock grazing is an economic use of Refuge Complex and an important habitat management tool. Cattle grazing is an inexpensive, dependable, and effective tool used to: 1) open up dense vegetation; 2) depress perennial plants; 3) encourage growth of annual grasses and sedges; and 4) reduce tall, rank grass types and encourage creeping grass species.

The grazing program on the Refuge Complex involves cow-calf operations with some bulls introduced for breeding. The cow bloodline is a mixed breed of Zebu ancestry, with Brahma, Angus or Charolais bulls used for breeding. Using a graze-rest strategy, permittees typically graze coastal marshes during the cool season, generally October through April. Some warm-season grazing on non-saline upland grasslands currently occurs on Anahuac NWR. Between 1998 and 2005, an average of 11,501 (range 8,884 – 14,451) animal unit months (AUMs) occurred annually on Anahuac NWR, an average of 10,489 (range 4,778 – 14,275) AUMs occurred annually on McFaddin NWR, and an average of 761 (range 0 – 1,140) animal unit months (AUMs) occurred annually on Texas Point NWR. Grazing strategies include variations in stocking rates, timing (cool vs. warm season) and duration. Stocking rates and rotations are

determined annually according to management objectives for the various grazing units and the quantity and condition of forage in those units, and are often influenced by the availability of freshwater. Grazing does not take place uniformly across units, particularly in coastal marshes. Cattle tend to concentrate grazing pressure adjacent to upland areas with decreased grazing pressure with increasing distance from high ground. Acres grazed and grazing pressure varies from year to year.

Prescribed burning is an integral part of using cattle to meet management objectives. Fire can be used to create favorable foraging conditions for cattle and focus grazing pressure. Excluding high priority uplands, such as salty prairie sites, from burning can reduce grazing pressure where it is less desirable while focusing it on adjacent wetlands.

Management tools used to set back plant succession on the Refuge Complex (grazing, fire, mechanical disturbance, and herbicides) benefit most wetland-dependent species. The extent to which these tools are applied can be detrimental to some species, while benefiting others. An example of this would be an intensive grazing regime that reduces emergent wetland vegetation, benefiting waterfowl, shorebirds and wading birds, but detrimental to species requiring ranker conditions, such as sedge wrens and seaside sparrows. In the practical application of a tool like grazing, the available herd is focused in certain areas to achieve the moderate grazing regime desired, leaving large areas lightly grazed or ungrazed to the benefit of the species desiring the cover of emergent vegetation. Neither intensive grazing nor the lack of grazing is desired over the whole Refuge. Rather, a mosaic of heavily, moderately, and ungrazed habitats is the target of the grazing management program on the Refuge Complex.

c. Shoreline Restoration / Stabilization

Shoreline erosion along the Gulf of Mexico on McFaddin and Texas Point NWRs is causing coastal land loss at rates as high as or higher than those in coastal Louisiana. Average annual rates of shoreline retreat on most of Texas Point NWR are over 40 feet per year, and much of the shoreline on McFaddin NWR is eroding at rates of 8-13 feet per year (Morton *et a*l. 1998). Losses of important coastal habitats including wetlands, salty prairie and beaches and dunes are occurring as the shoreline retreats. On McFaddin NWR, coastal erosion and tidal storm damage have destroyed Texas State Highway 87, a coastal highway which has been closed since 1989.

The USFWS is involved in several interagency efforts to address coastal land loss in the project area and on the Refuge Complex. In 2001, over 1700 linear feet of dunes were restored on the eastern portion of McFaddin NWR, adjacent to Sea Rim State Park, in partnership with the Texas General Land Office. The Texas Coastal Erosion Planning and Response Act (CEPRA) Program, administered by the Texas GLO, provided cost sharing on this project. The USFWS is currently participating in the U.S. Army Corps of Engineers Sabine Pass to San Luis Pass Shoreline Erosion Feasibility Study, which is being locally sponsored by Galveston and Jefferson Counties. This study is evaluating potential solutions to shoreline erosion and resulting coastal land loss. In 2004, the Corps initiated an experimental shoreline stabilization project along the Gulf on an adjacent to the McFaddin NWR. This project is being funded under the Corps' National Shoreline Demonstration Project, Section 227 of the Water Resources Development Act of 1996.

Erosion along the GIWW is also resulting in direct habitat loss and is threatening large areas of intermediate marshes with saltwater intrusion. Over 20 miles of GIWW shoreline occurs on McFaddin and Anahuac NWRs. Erosion abatement and shoreline stabilization projects on the Refuge Complex along the GIWW have included construction of offshore rock breakwaters with smooth cordgrass plantings and placement of rip rap and articulated revetment along the shoreline. Approximately 1 mile of rock breakwaters were constructed along the GIWW on McFaddin NWR in 2002, along with 2,500 linear feet of levee reconstruction and placement of revetments.

Shoreline restoration/stabilization efforts on Anahuac NWR have been ongoing for the last 25 years. The north shore of East Galveston Bay has experienced steady erosion over time. Some areas have been eroding at 1.2 meters annually (Carrol 1974, USFWS 1992). Continuous erosion threatens approximately 6,000 acres of inland brackish and intermediate marshes from excessive saltwater intrusion and roads

with destructive wave action. Several shoreline stabilization studies were conducted on the Anahuac NWR to develop effective shoreline protection techniques which involved locating the most suitable native plant species capable of establishment for stabilizing the shoreline and determining an effective material to serve as a wave stilling device (Webb 1974, Webb and Dodd 1976, 1977). Breakwaters enhance marine habitat in the bay as they function as an artificial reef and provide excellent opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. The smooth cordgrass provides habitat for snails, shrimp, crabs, insects, and numerous benthic organisms. Breakwater structures also enhance recreational fishing opportunities along the bay shoreline. Numerous efforts to stabilize the eroding shoreline on Anahuac NWR have involved the placement of barriers of shell and stone on the eroding shoreline, restoring vegetation along Galveston Bay, and the construction of offshore wave breaks and sprigging smooth cordgrass transplants immediately behind it. The latter methodology has been the most effective.

d. Exotic / Invasive Species Management

The Refuge Complex implements control activities for several invasive plant species and a few exotic animal species to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program is implemented, whereby several strategies are implemented to manage invasive species. Of paramount importance to the success of the IPM program is early detection. Monitoring habitats throughout the Refuge Complex for new infestations of invasive species is carried out concurrent with all other field habitat and wildlife surveys. Actual control of invasive species is implemented using herbicide application, mechanical control, prescribed burning, controlled grazing and water level and salinity management, often in some combination of strategies. An objective of the IPM program is to reduce the quantity of chemical pesticides used on the Refuge Complex to the extent possible, while maintaining adequate pest control. Public education is also an important component of the IPM program. Efforts are made to increase public awareness of threats posed by invasive species and of ways to help in controlling their spread. As an example, informational signage has been posted at refuge boat ramps to educate boaters about *Salvinia* and how to prevent inadvertently spreading this aggressive invasive plant.

In general, mowing and burning are used on undisturbed native prairie and other grassland habitats to control upland exotic and invasive species. Burning and controlled grazing are the primary tool used in marsh habitats. Discing or roller chopping are used in rice fields and moist soil units to manage invasive species. Herbicides are used only when necessary. Spot treatments or herbicides are typically used in aquatic environments and when target stands are small enough to treat by hand. Broadcast herbicide spraying is rarely used in aquatic environments. These types of treatments also remove beneficial plants and create conditions most favorable for re-growth of aggressive invasive species. Combinations of treatments often are most successful and provide more long lasting results.

Invasive species control efforts on the Refuge Complex have been implemented for crop pests, exotic and nuisance native upland and aquatic plants, feral hogs, and nutria. Exotic plant control efforts have focused on Chinese tallow, deep-rooted sedge, Johnson grass, water hyacinth, water lettuce, Vasey grass, giant Salvinia, and common Salvinia. Native invasive species targeted by control activities include common reed, cattail, Eastern baccharis, sumpweed, and several Sesbania species. Crop pest management has focused on control of red rice, grasses, broadleaf plants and army worms. The Refuge Complex also support populations of feral pigs and nutria (*Myocastor coypus*). Feral pigs are controlled. Nutria have caused extensive damage to marsh habitats in some coastal ecosystems, and can cause damage to levees and water control structures and remove beneficial vegetation. In recent years, nutria have not occurred at densities which have required the Refuge Complex to implement control programs.

Various control activities are also implemented by the local irrigation and drainage districts holding easements on the Anahuac NWR. Target species are water hyacinth in canals and ditches, and Chinese tallow along canal and ditch banks.

The following are brief descriptions of the invasive species for which control activities are implemented on the Refuge Complex.

Chinese Tallow (Sapium sebiferum)
Chinese tallow is an aggressive exotic tree native to China. Invasion by this species has converted coastal prairie habitat into woodlands, and degraded native woodlands and freshwater wetlands throughout the Chenier Plain region. Fallowed and abandoned croplands and pasturelands in the region are highly susceptible to invasion by Chinese tallow. It is a significant threat to the small remnant stands of native coastal prairie in the region. Chinese tallow also aggressively invades levees and other artificial upland habitats, which creates seed reservoirs for invasion of adjacent grassland and wetland habitats. It has the ability to invaded disturbed or undisturbed habitats. It is very resistant to flooding and drought and thrives in poorly drained soils. Water may be one of the most significant seed dispersal methods.

Chinese tallow provides very little value to most native wildlife species. Monocultures of Chinese tallow inhibit growth of native understory plants including grasses, forbs and shrubs. Overall, the widespread invasion of Chinese tallow has negatively impacted the region's biological diversity.

Chinese tallow grows extremely rapidly, which can limit control techniques. Plants reach diameters too large to mow or disc in three years, and to create monocultures in 3-5 years. Control activities for Chinese tallow on the Refuge Complex include prescribed burning, mechanical removal and herbicide application. Fire, if applied when the plant is actively growing, is effective in controlling smaller trees. Significant fuels must be present around the base of the plants such that very hot burning conditions are created (Grace 1998). Hot fires can also damage large trees, but root sprouting general occurs. Aerial and basal bark applications of herbicide are effective control techniques for Chinese tallow.

Since 1992, approximately 800 acres of Chinese tallow have been treated on the Refuge Complex, primarily enhancing prairie habitats, but also enhancing several woodlots. On Anahuac NWR and Texas Point NWR, all major stands of Chinese tallow have been controlled. Spot treatments with herbicides, prescribed burning and mechanical control are required on an annual basis on these refuges to prevent large-scale reinfestations. Some larger stands of Chinese tallow remain and will require control on the North Unit of McFaddin NWR.

Water hyacinth (Eichhornia crassipes)
Water hyacinth is an exotic floating aquatic plant introduced from South America. It reproduces very rapidly and can cover small slow moving fresh water streams, bayous and small wetlands in a single year. Water hyacinth is typically found in waters with salinities less that 0.5 ppt (Stutzenbaker 1999) and where permanent year round waters found. When colonies completely cover water bodies they shade out beneficial aquatic plants similar to an effect of pulling a black tarp across the water. Water hyacinth also clogs navigation channels, water delivery canals and water control structures. Water hyacinth is most likely introduced from whole plants attached to boats, boat trailers or any equipment which moves through established stands. Once the plant becomes established it is very difficult to eradicate. Hyacinth is controlled with water level draw downs which expose plants to extreme frosts, water with salinities greater than 10 ppt, mechanical removal and spot herbicide treatments. Entry points to water delivery locations and pumps must be screened off to prevent plant from clogging infrastructure or infesting new areas. Water hyacinth control activities are carried out on an annual basis on the Refuge Complex.

Water lettuce (Pistia stratiotes)
Water lettuce is an exotic floating aquatic plant found in fresh water habitats. It is found in stable fresh water habitat protected from wind and current. The plant can form dense mats which can cover open water and shade out beneficial native plants. It spreads from seeds and plant fragments. Water lettuce is found in several reservoirs on the refuge complex. Water lettuce also clogs navigation channels, water delivery canals and water control structures. Water lettuce is likely introduced from whole plants attached to boats, boat trailers or any equipment which moves through established stands. Once the plant becomes established it is very difficult to eradicate. Water lettuce is controlled using water level draw downs which expose plants to extreme frosts, water with salinities greater than 10 ppt, mechanical

removal and spot herbicide treatments. Entry points to water delivery locations and pumps must be screened off to prevent plant from clogging infrastructure or infesting new areas.

Alligatorweed (Alternanthera philoxeroides)
Alligatorweed is an exotic perennial root plant introduced from South America which forms dense floating mats in deep freshwater. Alligatorweed is common in all freshwater habitats on the Refuge Complex. Alligatorweed clogs navigation channels, water delivery canals and water control structures. Dense floating colonies shade out native aquatic species and clog water management infrastructure. Alligatorweed does well in salinities less than 0.5ppt. (Stutzenbaker 1999). It is managed on the Refuge Complex using prolonged salinities greater than 3.0 ppt, herbicide applications and heavy livestock grazing (Stutzenbaker 1999). Plants are also removed mechanically on a small scale.

Deeprooted Sedge (Cyperus entrerianus)
Deeprooted sedge is an aggressive exotic plant introduced from South America. It establishes in disturbed sites. It displaces native prairie and shallow fresh water wetland plants. A single plant can produce a million viable seeds per year. This plant threatens all native prairie and grassland habitat on the refuge. It is particularly problematic in recently restored native prairies. Cattle appear to avoid the plants, causing the plants to increase under medium to heavy grazing. Establish stands quickly expand. Flooding, cattle, construction equipment, mowing and soil disturbing activities spread plants. Extensive control activities for this species have yet to be implemented on the Refuge Complex. Repeated discing can remove the plant. Mowing repeatedly at 2-4 week intervals and herbicides are other possible control methods. To date, invasion by this species has been most extensive in croplands and former croplands being restored to native prairie and freshwater prairie wetlands on the Anahuac NWR.

Johnson grass (Sorghum halepense)
Johnsongrass is a vigorous perennial which was introduced from the Mediterranean region. It establishes on disturbed sites and spreads by seed or rhizomes. Johnsongrass is common in refuge agricultural fields, recently restored prairie fields and road ditches and levees. Seeds attached to vehicles and equipment is likely the cause the expansion of this plant on the refuge. Spot herbicide treatments, or repeated discing and mowing prior to seed set are effective control techniques utilized on the Refuge Complex.

Vasey grass (Paspalum urvillei)
Vaseygrass is a large exotic perennial bunch grass which occurs in upland areas. It quickly invades disturbed areas and creates monocultures. It has poor forage and wildlife values. It is common on agricultural fields, recently restored prairies and any disturbed upland sites. Seeds attach to equipment and vehicles and spread quickly to new sites. The plant is so established throughout the refuge seeds are likely present in most upland soils. Discing and cool season burning are the best methods to control this plant.

Common Salvinia (Salvinia minima)
Common salvinia is an aggressive exotic fern which spreads quickly in slow moving fresh water habitats. The plant is intolerant of higher salinities and does well in salinities less than 0.5 ppt (Stutznebaker 1999). It spreads from spores and plant fragments. Small fragments attached to boat trailers and boats can quickly colonize new areas. Plants fragments can migrate on the backs of alligators or on birds legs and invade new wetlands. Established stands will create dense floating carpets which eliminate sunlight penetration shading out native aquatic plants. This plant is common in the Taylors Bayou watershed and poses a significant threat to fresh water wetland habitats on the North Unit of McFaddin NWR. It has been discovered on the North and South Units of the Refuge. Control on the North Unit of McFaddin NWR has been affected by physically removing the plant. Saltwater or herbicides are other possible control mechanisms. The best way to prevent spread is to carefully wash boats, boat trailers and other equipment prior to entering non-infested waters.

Giant Salvinia (Salvinia molesta)
Giant salvinia is an extremely aggressive exotic fern which can rapidly cover slow moving streams and wetlands. The plant is not tolerant of high salinities. It spreads from spore and plant fragments. Small

fragments attached to boat trailers and boats can quickly colonize new areas. Established stands will create dense floating carpets which eliminate sunlight penetration shading out native aquatic plants. This exotic plant has to date been found at only on location on the Refuge Complex - the boat canal at Anahuac NWR. Giant salvinia was likely introduced to this location from a boat trailer launching at the boat ramp. The plant was mechanically removed and treated and has not been found again since this initial discovery. A biological control agent, a beetle, is now being tested by the USDA in parts of Texas. Herbicides and salinity management are other potential control methods. The best way to prevent spread is to carefully wash boats, boat trailers and other equipment prior to entering non-infested waters.

Control activities are also implemented on the Refuge Complex for the following invasive native plants.

Cattail (Typha spp.)
Cattail is a native perennial plant found primarily in fresh water marshes. Cattail does occur in intermediate marshes and brackish marshes. *Typha domingenis* can tolerate salinities as high as 10 ppt. (Stutzenbaker 1999). Plants aggressively spread in disturbed fresh stable water conditions by seeds and rhizomes. Fresh water and fresher intermediate habitats on the refuge complex are plagued with dense colonies of cattail. Dense stands of cattail reduce the presence and diversity of aquatic plants reducing use of marshes by many wetland wildlife species. Cattail can invade the edges of open water habitat reducing open water habitats important to shorebirds, wading birds and migratory waterfowl. Small stands can be managed with spot treatments of herbicides labeled for aquatic use. Large stands are managed by post frost prescribed burning followed by heavy herbivory by cattle. Introduction of prolonged high salinities can also reduce the dominance of some stands. Muskrat herbivory, when population densities are high enough, may also reduce cattail density and serve as a natural biological control.

Common reed or Phragmites (Phragmites australis)
Common reed is a tall native perennial plant that forms dense stands in fresh and intermediate marshes. It is very tolerant of drawdowns and deep flooding. It has extensive rhizomes that form dense monotypic stands particularly near leaves or spoil sites. It also occurs along the edges of open water habitats, ditches and canals on the refuge complex. This plant can obstruct water delivery systems and reduce the value of open water wetlands to shorebirds, wading birds and migratory waterfowl. Common reed expands rapidly from rhizomes out from established stands reducing the diversity of aquatic plants within stands. Post frost burning or mowing followed by aggressive grazing can reduce the expansion of established stands. Mechanical manipulations are only temporarily successful in reducing stands of this plant. Spot treatments of herbicide can eliminate or reduce stands of common reed.

Eastern baccharis (Baccharis halimifolia) and big-leafed sumpweed (Iva frutescens)
Eastern baccharis and big-leafed sumpweed are perennial shrubs which grow in elevated sites in coastal marsh habitats. Sumpweed is normally found in brackish or more saline areas while baccharis can be found in fresh, intermediate and brackish marshes. Baccharis and sumpweed are very tolerant of periodic flooding. Both plants can for dense thickets which reduce plant diversity and preclude utilization by many marsh species. Baccharis and sumpweed are prevalent throughout the refuge complex. Growing season burns can reduce the dominance of dense stands. Burning followed by livestock grazing is most effective in controlling stands. Frequent mowing can reduce plant vigor and cause some shrubs to ultimately die (Stutzenbaker 1999). Herbicides are also effective in controlling both shrubs.

Sesbania, coffee bean-rattle box, bag-pod (Sesbania spp.)
There are several species of Sesbania which occur on the Texas Gulf Coast. All of the sesbania species can form dense colonies which can preclude use by many marsh wildlife species. Dense colonies cover valuable refuge open water habitat, reservoirs, rice fields and moist soil impoundments precluding use by shorebirds, wading birds and migratory waterfowl. *Sesbania macrocarpa* seeds do have some wildlife value while *Sesbania vesicaria* and *Sesbania drummondii* provide few wildlife values. *Sesbania vesicaris* and S. *drummondi* are found in fresh water habitats while S. *macrocarpa* can be found in salinities as high as 10 ppt (Stutzenbaker 1999). When these plants form dense stands they can shade out beneficial food plants used by migratory waterfowl. All plants have abundant seeds sources and typically germinate in summer when soils are exposed or during droughts. Roller chopping can be use to control S. *vesicaris*

and S. macrocarpa, however when possible a summer draw-down and mowing and/or discing is necessary to remove dense stands of *S. drummondi*. *S*. d*rummondi* is a perennial and plants can reach 4-5 inches in diameter at the base making control difficult. Herbicides labeled for aquatic use can be used to treat on small stands.

Japanese honeysuckle (Lonicera japonica)
Japanese honeysuckle is found in wooded habitats on the refuge including Texas Point woods, The North Unit of McFaddin and East Bay Bayou Tract and the Willows on Anahuac NWR. It is an aggressive invasive species that covers shrubs, young trees and other beneficial native plants. It will ultimately shade out and kill plants when it forms dense stands. It also prevents re-growth of new trees and shrubs. Honeysuckle does provide important nectar sources for humming birds and butterflies. When populations begin covering beneficial trees and shrubs refuge staff have used herbicides to control populations.

Feral Animals
Feral animals occurring on the Refuge Complex include dogs, cats and pigs. Feral pigs pose a significant threat to natural resources on the Refuge Complex. They occur in significant numbers on the Anahuac and McFaddin NWRs. Rooting and wallowing by feral pigs causes significant habitat and infrastructure damage. These soil disturbances in marsh and upland sites allow invasive plants to establish and reduce the value of the habitats to wildlife. Feral pigs are particularly damaging to water management infrastructure. They wallow and root extensively on levees and within rice fields and moist soil units effecting the management of thousands of acres habitat. Feral hogs are very prolific and are able to exploit wetland and upland habitats.

Feral dogs and cats are normally removed from the Refuge Complex and taken to nearby humane societies. Control activities for feral hogs implemented on the Refuge Complex primarily utilize State animal damage control agency personnel who capture and remove hogs or kill on-site. In addition, Refuge law enforcement personnel conduct periodic lethal control activities.

Nutria
Nutria are an exotic mammalian species that has caused significant habitat damage in coastal wetlands in many states including neighboring Louisiana. Nutria were introduced in Louisiana during the early twentieth century to augment the region's fur trade. Nutria are periodically controlled on the Refuge Complex to protect wetland habitats by trapping under Special Use Permit.

Red Imported Fire Ants
The fire ant was imported from Brazil, South America between 1933 and 1945 on boat shipments to Alabama. The present infestation occupies nine southern states, 113 of the 254 Texas counties, and the project area. Mounds interfere and damage mowers and other farm machinery. Ants harm or kill livestock and wildlife. Fire ants enter and take up residence inside walls of buildings and homes. Ant colonies are attracted to electrical units and have caused significant damage to pumps and electrical components. Their colonies are prolific and closely spaced. When an area becomes infested with fire ants birds, mice, lizards, and other insects are significantly impacted. Fire ants can be a significant cause of mortality in ground nesting birds. No broad scale efforts to control fire ants have been implemented on the Refuge Complex. Treatment around electrical units and sites used for outdoor events and outdoor education class rooms to protect participants and infrastructure.

B. Biological Program – Surveys, Monitoring, and Research

The primary mission of the biological program on the Refuge Complex is to collect sound and accurate data for use in guiding refuge management and making management decisions. This program collects data that are applicable at various scales. Some work relates to flyway or continental level populations, while other projects are only applicable to Refuge or unit level. Regardless of the scale of the project, inventory, monitoring and research is generally designed to provide feedback in the adaptive management cycle. Well designed data collection and analyses provide the basis for good resource management decisions.

The biological program conducts inventory and monitoring on habitat, waterfowl, shorebirds, wading birds and other marsh birds, landbirds, mammals, reptiles and amphibians, fisheries and invertebrates. The Refuge Complex also facilitates and supports occasional research studies on priority species and topics through partnerships with universities and the U. S. Geological Survey Biological Resources Division.

1. Habitats and Vegetation

Habitat monitoring typically consists of qualitative assessments that provide feedback on management actions and offer recommendations. Primarily because of time constraints, quantitative monitoring has to be restricted to the highest priorities. Currently, detailed monitoring programs exist for intermediate marsh and upland grassland communities on the Refuge Complex. These monitoring programs are designed to assess the effectiveness of fire in achieving and maintaining desired habitat conditions. Additional grassland monitoring occurs in non-saline uplands where point intercept transects and grazing exclosures are designed to monitor the effects of grazing on establishment of native prairie species. A monitoring project began in 2006 where the frequencies of invasive exotic plants are recorded in key areas. This project is designed to provide feedback on the status of invasive plants on the Complex and progress towards controlling their spread.

A series of monitoring efforts recently came to a conclusion on McFaddin NWR and adjacent state lands. This project was designed to assess habitat conditions in four reference areas, two managed with water control structures and two unmanaged. Habitat parameters evaluated included ground elevation change, wildlife utilization, emergent vegetation and submergent vegetation.

Salinity and water level monitoring is conducted on the Refuge Complex to document long term trends in hydrological conditions and to quantify the effects of water management activities. On McFaddin NWR, sediment accretion associated with shoreline protection projects on the GIWW is being monitored.

Current research projects on the Refuge Complex include evaluation of control strategies for deep rooted sedge (*Cyperus entrerianus*) and use of Mycorrhizal fungi in the restoration of brine disposal areas. Research is currently being designed and planned to study the effects of fire on soil formation and marsh accretion.

2. Waterfowl – Wintering and Migrating

The Refuge Complex is part of the principal wintering areas for migratory waterfowl of the Central and Mississippi Flyways. Data collected on waterfowl populations on these Refuges have provided vital assistance to waterfowl habitat and population managers for the past 20 years. Data collected include waterfowl harvest and body condition, snow goose banding and body condition, and monthly Refuge waterfowl surveys.

Harvest data are collected at staffed check stations during the regular waterfowl season and intermittently during the Light Goose Conservation Season. Waterfowl check station data provide trends in waterfowl harvest and provide an indication of 1) wintering waterfowl movements, 2) migration patterns, 3) proportions of species being harvested on the Texas coast, and 4) response by species to habitat management on the Refuge Complex. Additionally, age, sex, wing chord, and mass data are collected on a subset of harvested birds. These data allow for the calculation of body condition indices and are valuable in assessing the health of waterfowl populations on the upper Texas coast (Haukos *et a*l. 2001).

During the 1970s, snow geese were banded on the Anahuac NWR with returns as recent as 2001. In 2001-2002, banding of snow geese was one again initiated on the Refuge. This species has received considerable attention because large increases in some populations are impacting both wintering and breeding habitats. As a result, special harvest regulations have been implemented to reduce populations. Continued banding of snow geese on Anahuac NWR will provide insight to spring migration corridors and the impacts of the Light Goose Conservation Order.

Since 1986, monthly (September through March) aerial surveys of all National Wildlife Refuges along the Texas Gulf Coast are conducted by Refuge Complex staff. With exception of the May breeding ground surveys, these surveys are unique and unmatched by any other waterfowl data set in North America. The wealth of data from these surveys has countless uses by managers, researchers, biologists, regulators, and others interested in the waterfowl of the Central Flyway. Seasonal, monthly, and area trends of waterfowl populations are provided by these data.

Appraisals of annual productivity of Greater White-fronted and Snow geese are conducted by the Refuge Complex staff. Appraisals for Greater white-fronted geese are conducted in Colorado and Wharton counties, Texas. Snow goose productivity appraisals are done on Anahuac NWR and local private lands. These surveys provide and index of annual reproductive success for mid-continent Lesser Snow and Greater White-fronted geese.

Waterfowl disease surveys conducted monthly (September through March) on area with incidents of reoccurring waterfowl disease breakouts are conducted aerially by Refuge Complex staff.

3. Waterfowl – Resident (Mottled Ducks)

Data on Mottled Ducks are collected in many of the surveys discussed in the Wintering and Migratory Waterfowl section above. Harvest and body condition data is collected at staffed check stations. In addition, with the hunter's permission, a wing and gizzard are collected from harvested Mottled Ducks. Wings are collected and a post-season 'wing bee' is held for Mottled Ducks harvested on the upper Texas coast. This provides an estimate of age and sex ratios for the area. Gizzards collected from harvested birds are visually analyzed for lead shot ingestion. Lead shot data has been collected on the Refuge Complex annually since 1982 and serves to document trends in Mottled Duck lead ingestion.

The monthly aerial surveys provide winter data on Mottled Duck distribution and abundance. September aerial surveys are conducted to establish an index of Mottled Duck production from the preceding summer on the Refuge Complex and across the Texas coast by complex staff. Additionally, the Mottled Duck Breeding Pair survey is conducted in March of each year. This aerial survey incorporates transect sampling and calculation of an annual visibility index to estimate the density of breeding Mottled Ducks on the upper coast. These data are the only source of long-term breeding data for Mottled Ducks in Texas and Louisiana.

Since 1997, the Mottled Duck banding program on the Refuge Complex has contributed to the banding efforts in Texas and Louisiana. Banding on the Refuge Complex is the only consistent effort of all sites in the state of Texas. Critical data on movements, survival, and recovery rates of Mottled Ducks is calculated from these data.

Work was recently done evaluating Mottled Duck pair pond use and selection on the Refuge Complex. Research is currently being conducted to evaluate mortality factors for female Mottled Ducks and broods as well as brood movements and habitat utilization.

4. Shorebirds, Wading Birds, and other Marsh and Waterbirds

The extensive wetland habitats of the Refuge Complex support a wide array of wetland-dependent birds. The National Audubon Society Christmas Bird Count monitors winter populations of this group of species. Occasional research studies on priority species are conducted through partnerships with universities and the U. S. Geological Survey Biological Resources Division. Recently, research projects on the Refuge Complex have included the effects of fire on breeding seaside sparrows, genetic structure of seaside sparrow populations, effects of fire and grazing on yellow rails, latitudinal origin of wintering rails, genetic species determination work with Clapper and King Rails, movement of wintering American bitterns, and contaminant levels in migratory shorebirds.

In addition, periodic spring and fall shorebirds surveys are conducted in various wetland habitats. Recent periodic shorebird surveys have accumulated sufficient data to qualify Anahuac NWR as a Site of

International Importance under the Western Hemisphere Shorebird Reserve Network. Annual surveys are done for colonial nesting waterbirds on Gulf shoreline of Texas Point NWR and McFaddin NWR.

5. Landbirds (Passerines, Raptors, and Non-passerines)

Breeding, wintering and migratory landbirds make up a large portion of the avian diversity on the Refuge Complex. Populations of wintering landbirds are recorded in the National Audubon Society Christmas Bird Count. In 2006 a monitoring project was initiated to assess the relative use various woodlots on the Refuge Complex by landbirds during the spring migration.

6. Fisheries

Occasional fisheries monitoring of Refuge Complex waters has been conducted by the USFWS Division of Fishery Resources. The Texas Parks and Wildlife Department conducts annual fisheries monitoring in waters on and adjacent to the Refuge Complex. Seasonal fisheries sampling by TPWD has been ongoing in Clam Lake on McFaddin NWR since 1990.

7. Threatened and Endangered Species, Species of Concern

The Refuge Complex participates in the coast-wide wintering piping/snowy/Wilson plover survey. Staff from the McFaddin and Texas Point NWRs have assisted with the International Piping Plover Survey since 1996. Refuge Complex staff coordinate with the National Marine Fisheries Service on strandings of T&E sea turtles on Gulf of Mexico beaches. The occurrence of T&E species and other species of concern are documented on the Refuge Complex when encountered.

8. Mammals

An inventory of mammals that occur on the Refuge Complex is currently being completed through use of Sherman traps and field observations. The Refuge Complex facilitates and supports occasional research studies on mammals through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

9. Reptiles and Amphibians

Most monitoring activities included in this group of species focuses on the American alligator. Night spotlight surveys are conducted annually to index populations on the Refuge Complex. Additionally, a mark and recapture project as well as aerial basking and nest counts have been conducted in recent years. Harvest data is collected at check stations during the alligator harvest.

A research project was recently conducted by USFWS Division of Ecological Services staff (Environmental Contaminants program), examining contaminant levels in anurans found in agricultural areas on the Anahuac NWR.

10. Invertebrates

The Refuge Complex participates in the North American Butterfly Association annual butterfly count. A two day inventory of moth species was conducted on Anahuac NWR in July 2005.

C. Public Use Program

Guidance for authorizing public uses on National Wildlife Refuges (NWRs) is provided in the National Wildlife Refuge System Improvement Act (the Act) of 1997 (P.L. 105-57). The Act states, “Compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System . . . through which the American public can develop an appreciation for fish and wildlife.” The Act recognizes that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation, when determined to be compatible, are legitimate and

appropriate public uses of the Refuge System that should receive priority consideration in refuge planning and management.

The Refuge Complex offers a variety of recreational opportunities to visitors. All six priority wildlife-dependent recreational uses are offered among the three refuges, and include hunting, fishing, wildlife observation, photography, environmental education and interpretation.

Combined, the Refuge Complex received over 172,000 visitors during Fiscal Year 2002. Highest visitation in FY02 occurred on McFaddin NWR, which received 94,600 visitors, with the primary use being beach use along the Gulf of Mexico shoreline. Anahuac NWR received over 71,000 visitors in FY02, with wildlife observation being the primary use, while Texas Point NWR received 7,300 visitors whose primary purpose was fishing. Table 3-21 summarizes the visitation on the Refuge Complex during 2002.

Table 3-21.
Estimated Visitation on the Texas Chenier Plain Refuge Complex during Fiscal Year 2002.

	Anahuac NWR	McFaddin NWR	Texas Point NWR	Complex Total
Total Visits	**71,016**	**94,585**	**7,315**	**172,916**
Waterfowl Hunting	4,813	5,000	1,500	**11,313**
Fishing	32,157	6,250	5,475	**43,882**
Wildlife Observation/Interpretation	42,354	1,150	250	**43,754**
Environmental Education (on-site)	1,408	0	0	**1,408**
Beach and Water Use	1,607	82,000	40	**83,647**
Education Outreach	3,048	560	60	**3,668**

Anahuac and Texas Point NWRs are open twenty-four hours a day, seven days a week, for designated wildlife-dependent uses and in designated areas, as are the Gulf of Mexico beaches on and adjacent to the McFaddin NWR. The inland portion of McFaddin NWR is open from the Refuge entrance to 10-mile Cut (Salt Bayou) from 6:00 am to sunset every day, with the portion beyond 10-mile Cut open Monday through Friday from 7:30 am to 4:00 pm. Office hours for all three refuges are from 7:30 am to 4:00 pm Monday through Friday. Permanent restroom facilities are located at the main entrance to Anahuac NWR and at the East Bay Bayou Tract. A Visitor Information Station is also located on Anahuac NWR at its main entrance.

1. Hunting and Fishing

a. Hunting

Waterfowl hunting has been a tradition along the upper Texas coast for generations. Prior to the establishment of the refuges, all three refuges were hunted through private ownership or lease. Currently, waterfowl hunting is offered on all three refuges, ranging from free, first-come, first-serve programs to a more formal fee permit reservation system. Different hunt units are open on different days of the week to provide hunting opportunities throughout the week, as well as periods of rest for waterfowl. Approximately 40% of the Refuge Complex is open for waterfowl hunting, the maximum allowable on lands acquired under authority of the Migratory Bird Conservation Act, (16 U.S.C. 715d.).

Hunting on the Refuge Complex requires a general waterfowl hunting permit for each refuge. These permits are free and available at each refuge office, check station, and electronically on-line. The permit contains all waterfowl hunting regulations and a map of the refuge hunt units. Hunters may enter Refuge hunt units no earlier than 4:00 am. Hunting is permitted from legal shooting time (1/2 hour before sunrise) until 12:00 pm. Hunters must be off refuge hunt units by 12:30 pm. All hunt units are closed on holidays, including Thanksgiving, Christmas and New Year's Day.

(1). Anahuac NWR

Three hunt units are open for waterfowl hunting on Anahuac NWR: the Pace Tract (1,509 acres) and portions of the East Unit (10,723 acres) and Middleton Tract (1,488 acres). These areas are open for waterfowl hunting only, and are closed to the public at other times of the year. The Pace Tract, accessible by boat only, is free and open seven days a week during the early teal and regular waterfowl seasons.

The East Unit is currently open on Saturdays, Sundays and Tuesdays during the regular waterfowl season for a $10.00 day use or a $40.00 annual fee. The East Unit provides walk-in and non-motorized access to hunt areas on a first-come, first-serve basis to the first 100 hunters entering the unit through the check station. Special duck hunt areas (available via random drawing the morning of the hunt) and special goose hunt areas (available on a first-come, first-serve basis) provide those hunters unfamiliar with the hunt unit with areas that are clearly identified and easily accessed. All hunters accessing the East Unit must check in and out at the check station, with the exception of those accessing ponds via boat from Jackson Ditch or East Bay Bayou. Motorized boats are permitted only in ponds accessible from Jackson Ditch. An accessible hunt blind is available on the East Unit on a first-come, first serve basis for those hunters with disabilities.

The Middleton Tract is free and open daily during the early teal season, and on Wednesdays, Saturdays, and Sundays during the regular waterfowl season. Primary access to the Middleton Tract is by boat. Motorized boats with motors exceeding 25 hp are prohibited in inland waterways. Two boat rollers are located on East Bay Bayou for access. Walk-in access, although difficult, is possible.

(2). McFaddin NWR

Four hunt units are available for waterfowl hunting on McFaddin NWR. The Spaced Hunt Unit is available by reservation for a $10.00 day use fee on Saturdays, Sundays and Tuesdays during the regular waterfowl season. Reservations are taken alternately between hunters present at the check station and telephone callers the Friday prior to the hunt week. Permits are issued to registered hunters beginning at 4:00 am the day of the hunt at the waterfowl check station. Areas not claimed by 5:00 am are issued to standby hunters on a first come, first serve basis. An accessible hunt blind is available to those hunters with disabilities. All hunters must check in and out through the waterfowl check station.

The Star Lake/Clam Lake and Central Hunt Units are free and open daily during the early teal season and on Saturdays, Sundays, and Tuesdays of the regular waterfowl season. All hunters accessing the Star Lake/Clam Lake Hunt Unit must check in and out through the waterfowl check station.

The Mud Bayou Hunt Unit is also free and open daily during the early teal season, and on Sundays, Wednesdays, and Fridays of the regular waterfowl season. Access to the hunt units on McFaddin NWR are by foot, non-motorized boat, outboard motor boat, or airboat. Airboats may not exceed 10 hp with direct drive with a propeller length of 48 inches or less and engines may not exceed 2 cylinders and 484 cc. A primitive 4-WD access trail along the beach provides access to portions of the McFaddin hunt units. High tidal events, debris, wash-outs and loose sand can limit access along this trail..

(3). Texas Point NWR

Texas Point NWR offers free waterfowl hunting in designated areas daily during the early teal season and on Saturdays, Mondays, and Wednesdays of the regular waterfowl season. Access to the hunt area on Texas Point NWR is by foot, non-motorized boat, outboard motor boat, or airboat. Airboats may not exceed 10 hp with direct drive with a propeller length of 48 inches or less and engines may not exceed 2 cylinders and 484 cc.

b. Fishing

Both saltwater and freshwater fishing opportunities are available on the Refuge Complex. Saltwater fishing opportunities on Anahuac NWR are focused along the shoreline of East Galveston Bay, where many anglers fish for prized species including red drum, speckled trout, and flounder. Designated pull-offs along Frozen Point Road provide easy access to the bay. Additionally, anglers may fish along West Line Road, and roadside ditches provide opportunities to catch bait for personal use. On McFaddin NWR, saltwater fishing opportunities are found along 15 miles of beach along the Gulf of Mexico, as well as in Salt Bayou (10-mile Cut), Mud Bayou, Star Lake, Clam Lake, and in designated areas along the shoreline of the Gulf Intracoastal Waterway and roadside ditches. Five fishing piers located along the banks of Clam Lake and the bridge at 10-mile Cut provide additional locations for fishing. Texas Point NWR provides saltwater fishing opportunities via boat in Texas Bayou and other Refuge waterways, as well as from roadside edges bordering the Refuge. Crabbing is a popular activity on all three refuges, especially along West Line Road on Anahuac NWR, and along Clam Lake and 10-mile Cut on McFaddin NWR.

Freshwater fishing opportunities are available on Anahuac NWR along East Bay Bayou on the East Bay Bayou Tract. Whether fishing from a non-motorized boat, or along the banks from three small bank piers located on the bayou, anglers here have the opportunity to catch species like crappie, largemouth bass, gar, bowfin, channel and blue catfish. Also on Anahuac NWR, freshwater anglers may fish along the canal from the Oyster Bayou Boat Ramp to the southwest corner of Shoveler Pond for species like gar and catfish.

On Anahuac NWR, boating is not permitted on inland waters of the refuge with the exception of the boat canal, and in designated areas during hunting season. Two boat ramps are located on Anahuac NWR providing access to Oyster Bayou and East Galveston Bay. Additionally, small, non-motorized boats may be launched along East Bay Bayou at a primitive canoe launch located on the East Bay Bayou Tract.

On McFaddin NWR, several boat ramps provide access to Clam Lake, Star Lake, 5-mile Cut, and 10-mile Cut. On Texas Point NWR, shallow water boats can launch at a private dock at Texas Bayou, or from the nearby Dick Dowling State Park for a small fee.

2. Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Public Uses

a. Wildlife Observation and Photography

Wildlife inhabiting the coastal marshes, prairies and woodlands on the Refuge Complex are abundant and diverse. Dozens of migratory bird species utilize habitat on the refuges to feed, rest, and nest. Over 27 species of waterfowl can be found throughout the winter months, and flocks of snow geese in excess of 100,000 can sometimes be seen. Spring and fall are prime time for migrating shorebirds and songbirds. Migrating shorebirds primarily utilize beach areas and mudflats on McFaddin and Texas Point NWRs, and moist soil units and rice fields on Anahuac NWR. Small and colorful neotropical songbirds can be found in the small woodlands or riparian corridors located primarily on Anahuac and Texas Point NWRs. Of special interest to the birding community are the secretive rails that occupy refuge marshes. All six species of North American rails can be found on the Refuge Complex at some time during the year. In addition, resident waterbirds are visible in wetland habitats throughout the year.

All three refuges are designated by the American Bird Conservancy as Globally Important Bird Areas of the United States. Anahuac, McFaddin and Texas Point NWRs are also designated sites on the Great Texas Coastal Birding Trail. A cooperative effort between the Texas Parks and Wildlife Department and the Department of Transportation, the trail designates hundreds of birding sites along the Texas coast, with detailed maps, directions, and overviews of each site.

Although birds are often the focal point for many visitors, other wildlife species attract the attention of visitors. American alligators, year-round residents on the Refuge Complex, are most visible during spring

and fall. Western cottonmouths, red-eared sliders, bull frogs, bobcats, river otter, and raccoons are just a few of the refuge inhabitants that draw interest from visitors.

Wildlife watching is the most popular activity on Anahuac NWR, with 59% of visitors in FY02 indicating that wildlife observation was their primary reason for visiting the Refuge. Anahuac NWR offers fourteen miles of graveled roads, a 750-foot boardwalk, four miles of trails, a photography blind, and several observation platforms to view and photograph wildlife.

Although viewing opportunities on McFaddin and Texas Point NWRs are limited, eight miles of gravel roads on McFaddin NWR provide opportunities to view waterfowl, shorebirds and waterbirds in Clam Lake, the Gulf Intracoastal Waterway, and adjacent marshes. A primitive ¼ mile trail through a small woodlot on Texas Point NWR provides viewing opportunities for migrant songbirds in the spring and fall. Roads south of Sabine Pass and adjacent to the marshes of Texas Point NWR provide opportunities to look and listen for secretive rails, wrens, and sparrows, as well as flocks of wintering waterfowl.

b. Environmental Education and Interpretation

Most educational and interpretive programs on the Refuge Complex occur on Anahuac NWR. In 2001, a new Visitor Information Station (VIS) was constructed at the main entrance of the Refuge. The VIS includes interpretive exhibits and materials focusing on refuge habitats and wildlife. Volunteers staff the VIS daily throughout the spring and on weekends the remainder of the year, providing information to and answering questions from visitors. In addition, the Friends of Anahuac Refuge manages a small nature store located in the VIS, selling educational materials related to the natural resources of the refuge and the surrounding upper Texas coast. All proceeds from the sale of merchandise go towards educational, interpretive, or habitat management needs of the Refuge.

An Outdoor Education Program on Anahuac NWR developed by the Friends of Anahuac Refuge enables students to learn about the natural world through hands-on educational activities. Designed for students in kindergarten through 5th grade, the programs are free to interested schools, are taught by volunteers, and take place outdoors on the Refuge. During the 2001-2002 school year, over 1,300 students participated in the Outdoor Education Program.

Refuge staff also provide interpretive tours and programs to interested schools and organizations upon request. During FY02, over 900 individuals participated in interpretive tours of the refuge.

Special events are held on the Refuge Complex throughout the year to promote an awareness and understanding of the important natural resources found along the upper Texas coast. On Anahuac NWR, Family Fishing Day, Youth Waterfowl Expo, and Yellow Rail Walks are held annually. Marsh Madness was initiated on McFaddin NWR in 2003.

On Anahuac NWR, the Visitor Information Station houses a small interpretive exhibit and offers refuge brochures and bird checklists to visitors. Several outdoor interpretive signs describing the fish and wildlife resources found on the refuge are also located throughout Anahuac NWR.

Off-site educational programs are given throughout the year upon request. On Anahuac NWR, the Wild Things Reading Program, co-sponsored by the Friends of Anahuac Refuge, has encouraged 5th grade students in Chambers County to read more about the natural world by offering prizes to students reading the most books. Off-site educational programs have also been presented to Boy Scout and Girl Scout Day Camps, Science Days at local schools, and summer reading programs at the county libraries. Refuge Complex staff also provide education to the community through booths at local events including GatorFest, RiceFest, Dick Dowling Days, and Southeast Texas Great Outdoors.

c. Beach Uses

The beaches along the Gulf of Mexico on and adjacent to the McFaddin NWR support recreational uses including surf fishing, swimming, sunbathing, wildlife observation, and camping. The beaches on

McFaddin NWR are considered an area of joint Federal and State of Texas jurisdiction. The beach inland of the Mean High water line lies within the Refuge. Motorized vehicular traffic occurs on the beach from the vegetation line seaward to mean low tide line, on the public beach easement established under the State of Texas "Open Beaches Act" (Texas Natural Resources Code, Chapter 61: Use and Maintenance of Public Beaches). Beach use is the most common activity on McFaddin NWR, with 87% of refuge visits taking place on the beach. The fifteen-mile stretch of beach along the Gulf of Mexico is most visited from April through September.

With the closure of State Highway 87 (officially closed in 1989), direct road access to the beach has been limited to extant portions of the highway near High Island on the west and the Refuge entrance at Clam Lake Road in the east. Coastal processes including ongoing shoreline retreat and a severe coarse sediment (sand) deficit often restrict or preclude travel and beach use activities, especially in the central portion of the Refuge. Erosive events include tropical cyclone-generated tidal surges and wave activity during summer and early fall, and elevated water levels and wave activity prior to frontal passages during winter. These events at least temporarily remove the thin veneer of sand currently found on the beach and carry it offshore or deposit it inland, exposing underlying clay deposits . These conditions predominate on an approximate 10-mile section of beach in the central part of the Refuge. Beaches at the eastern and western ends remain in the best condition and support most recreational beach use.

Loss of State Highway 87 has increased the remoteness of the Gulf beaches on and adjacent to the McFaddin NWR. Deteriorating travel conditions have restricted the presence of local law enforcement agencies. Protection of public safety and natural resources in these remote areas has increasingly become dependent on USFWS law enforcement efforts.

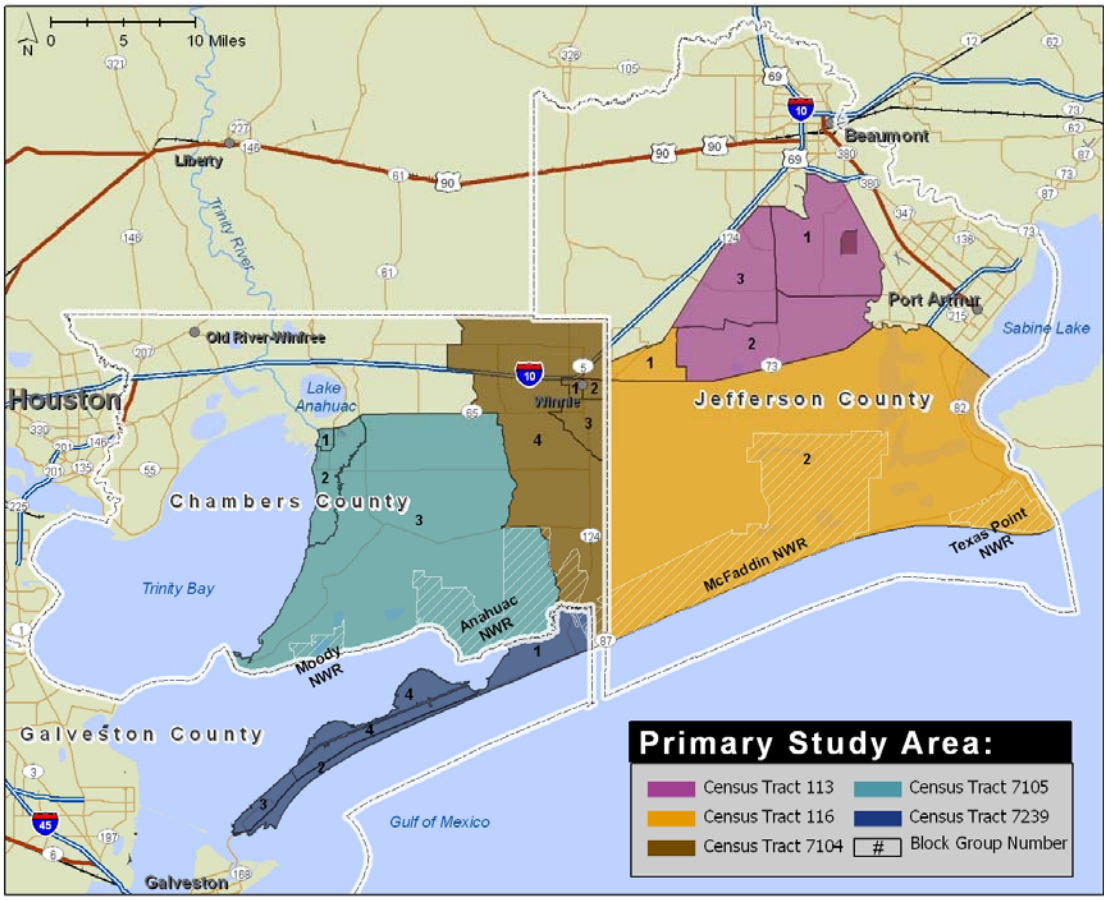
d. Other Public Uses

Additional recreational activities occurring on the Refuge Complex include camping, bicycling, and horseback riding. There are no camping facilities on the Refuge Complex. Overnight stays for night-time fishing are permitted on Anahuac NWR along the Frozen Point Road at bayshore pull-offs adjacent to East Galveston Bay. On McFaddin NWR, camping occurs on the Gulf of Mexico beach. Bicycling is permitted on designated refuge roads and levee trails, and horseback riding only on designated gravel roads which are open for public transportation. These activities occur infrequently, and are considered means of access and travel within the refuges for wildlife-dependent uses including hunting, fishing, wildlife observation and photography.

D. Community Outreach and Partnerships

The Refuge Complex establishes and maintains partnerships with other State and Federal agencies including the Texas Parks and Wildlife Department, the Texas General Land Office, the U.S. Army Corps of Engineers, the Galveston Bay Estuary Program and the National Marine Fisheries Service, with conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters, and with industry and community organizations. Two citizen support groups, the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance have formed with primary missions to support conservation, education and research on the Refuge Complex. Refuge volunteers now contribute over 10,000 hours annually on the Refuge Complex. These partnerships are actively supporting and have greatly enhanced many refuge management programs.

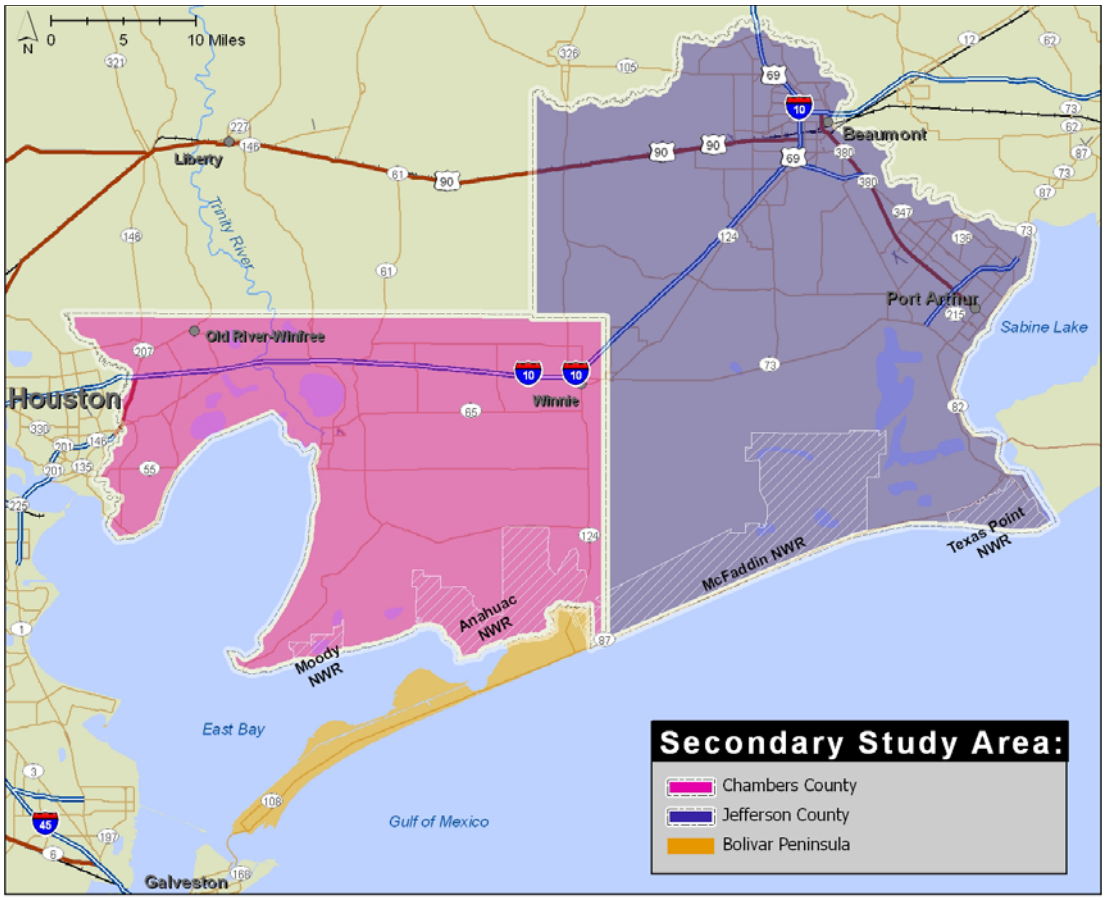
The Refuge Complex has also established partnerships with several private landowners in the area to restore and enhance wetland and upland habitats on private lands. Refuge Complex staff provide technical assistance on habitat restoration and management activities and facilitate development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project. Recently, Anahuac NWR staff worked with 2 private landowners to develop wetland restoration projects under the Department of Interior's Cooperative Conservation Initiative. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.



V. SOCIOECONOMIC ENVIRONMENT

For purposes of describing the socioeconomic environment, two study areas have been identified as illustrated in the figures on this and the following page. The **primary study area** (above figure) includes areas that are most likely to be directly impacted by a change in management strategies and/or land acquisition activities of USFWS related to the Chenier Plain Refuge Complex. This area in general is located within the southern portions of Chambers and Jefferson counties south of Interstate 10. For Chambers County the primary study area includes all areas east of the Trinity Bay to the county line. In Jefferson County the primary study area runs from the county line on the west to just west of Port Arthur. In addition, a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass, is included in the primary study area. The primary study area includes all of the Refuge Complex and those areas within the Refuge Boundary Expansion Alternatives.

The **secondary study area** (see figure on following page) is defined as areas where indirect impacts of land acquisition and change in Refuge Complex management are likely to occur. For this analysis, the secondary study area is defined as all of Jefferson and Chambers counties and Bolivar Peninsula in Galveston County.



A. Land Use

The use and ownership of land has a major correlation to social and economic characteristics, conditions, and activities of the area. Potential land uses in the study area are limited by such factors as geography, topography, moisture, and soils. For example, much of the land in the study area lies in water, and use of this land in its natural state for many purposes is impractical. Therefore, the inter-relationships of land characteristics and ultimate potential uses with the socioeconomic environment are extensive. Different land uses/ownership situations provide different opportunities for economic development, employment, and income, where people live, how people live (e.g., lifestyle), and one's sense of quality of life and well-being.

Since land use issues are an important focal element in socioeconomic analysis, a summary of land use/ownership considerations is presented. Consideration of land use conditions and issues is especially important for alternatives evaluated in the Environmental Impact Statement process that involve additional land acquisitions by the USFWS.

1. Land Use Overview

The study area includes lands within Chambers, Jefferson, and Galveston Counties, from the western end of Bolivar Peninsula in Galveston County to Port Arthur-Sabine Lake in Jefferson County. Generally speaking, Chambers County is the most "rural" in character. Bolivar Peninsula in Galveston County has more potential for residential development, and Jefferson County is greatly influenced by industrial development in the Beaumont/Port Arthur area.

Land in water is a major consideration of land use characteristics and conditions within the study area. This substantially reduces potential land use options for these lands. In addition, a substantial portion of land in the primary study area is marshland.

The existing area under management by the USFWS in Jefferson County totals approximately 62,000 acres, or about eleven percent of the total land in the county. The existing area under management by the USFWS in Chambers County totals 37,817 acres, or about seven percent of the land in the county. Generally, land held by the USFWS would be suitable only for agricultural activities and grazing as alternative land uses.

Most of the active cropland and farming activities in both counties can be found in the more northern areas away from the gulf coast. This is somewhat logical as that land is less susceptible to flooding and therefore less subject to crop damage from storms. Grazing occurs throughout both counties.

The Bolivar Peninsula area is composed of wooded lots, summer homes and undeveloped areas. The principal land use is more closely related to recreational activities and second homes or the support thereof than to farming or other land related uses and activities. Some grazing occurs in undeveloped areas.

The following land uses have been identified to provide the land use context to discussion of socioeconomic characteristics and conditions:

- Land conservation and wildlife/wildlife habitat protection use
- Agricultural use
- Recreational resource use
- Oil and natural gas development use
- Developmental use

Summaries of each of these major land use categories and their context to the study area are provided below. Discussion is focused on the primary study area and on the relationships of existing and potential land uses to the Refuge Complex land holdings.

2. Land Conservation and Wildlife / Wildlife Habitat Protection Use

Direct loss of native habitats to various types of development and conversion to other land uses within the study area has been extensive over the last 25 years. These factors have also had many indirect impacts on these habitats, many of which present ongoing threats to the region's biological integrity and biological diversity. For example, construction of navigation channels, dams, drainage improvements and jetty systems have greatly altered natural hydrological and sediment regimes, resulting in loss or severe restriction of freshwater and sediment inflows to estuaries and the Gulf of Mexico, and increased saltwater intrusion into historically freshwater coastal marshes. These changes have resulted in an ongoing trend of wetland loss and degradation, and a loss of biological diversity. To counter these impacts, various efforts have been underway to use land for conservation and wildlife/wildlife habitat protection purposes.

The Refuge Complex is one example of land used for conservation and wildlife/wildlife habitat protection. The Refuge Complex currently includes approximately 105,668 acres of public land managed and administered by the USFWS as fee lands or as native wildlife habitat under conservation easement. The Refuge Complex areas occupy low lying coastal prairies, near coastal woodlots, and coastal wetlands between Trinity Bay to the west and Texas Point, south of Port Arthur, to the east. Jefferson, Chambers, and Galveston Counties have jurisdiction over portions of the Refuge Complex. Other public lands used for conservation and wildlife/wildlife habitat protection purposes in the area include Sea Rim State Park to the east of McFaddin NWR and the J.D. Murphree State Wildlife Area to the north of Texas Point NWR. Private lands in the area, while not specifically designated as such, can also serve as lands used for conservation and wildlife/wildlife habitat protection purposes.

Lands within the Refuge Complex have been acquired and are managed to protect, enhance, and restore, where appropriate, natural resource values and fish, wildlife, and plant resources and their habitats. Some land uses occurring in the study area, including rice farming and livestock grazing, are used as habitat management tools on the Refuge Complex. These economic uses of the refuges contribute to meeting objectives for habitat and wildlife, and have been determined compatible with the establishment purpose of the refuges and the mission of the National Wildlife Refuge System. Recreational uses such as hunting and fishing occur in the study area, and are also administered as compatible wildlife-dependent uses on the Refuge Complex. The USFWS does not own the subsurface mineral estates underlying the refuges, and must allow use of the surface within the refuges for exploration and development activities.

3. Agricultural Use

Land use is regularly measured as part of the U.S. Department of Agriculture's (USDA) Census of Agriculture. The latest Census of Agriculture (1997) shows that about 63 percent of acreage in Chambers County and 75 percent of acreage in Jefferson County was in farms in 1997 summarized in Table 3-22.

Table 3-22.
Acreage in Farms, Jefferson and Chambers County, 1997*

County	Approximate Acreage	Acreage in Farms	Proportion of Total Acreage in Farms
Jefferson	578,301	433,597	75.0%
Chambers	383,412	241,933	63.1%

*Source: U.S. Census Bureau, "1997 Census of Agriculture"

Croplands, dominated by rice production, and pastureland are the main agricultural habitats in the secondary study area as summarized in Table 3-23. The proportion of lands utilized for rice production and pastureland in the area varies from year to year depending on agricultural market conditions. Higher demand for rice and higher market prices generally result in a greater proportion of lands planted in rice, but the existing Federal subsidy system influences market factors for rice production. The recent trend of rice production in the primary study area is downward, and this trend is expected to continue because of both market and non-market factors.

Table 3-23.
Cropland Acreage, Jefferson and Chambers County, 1997*

County	Total Cropland Acreage	Harvested Cropland	Pasture or Grazing Acreage	Other Cropland
Jefferson	180,719	46,709	88,166	45,844
Chambers	118,316	32,609	44,934	40,733

*Source: U.S. Census Bureau, "1997 Census of Agriculture"

Rice as a major agricultural product in the area depends on cultivation to maximize production. This crop is primarily used for human consumption, but it also provides food for wildlife. Agricultural lands supporting rice cultivation can be significant contributors of nutrients and toxins in marshes and other habitats that are lower in elevation, especially in areas where fertilizers and pesticides are readily applied. Conversion of current rice croplands to other uses would have negative impacts on waterfowl, other wetland-dependent migratory birds, and other wildlife in the area. In addition, abandoned ricelands in the area are susceptible to invasion by undesirable plants such as Chinese tallow. This situation is a major threat to the area's biological diversity.

Many rice farmers recognize the benefits of these lands to wildlife and also manage them for this purpose. Industry groups promote farming practices that provide habitat and food for a variety of species, including waterfowl. These farming practices not only benefit the target wildlife species, but also provide additional income to the farmers through leasing for hunting purposes. These lands serve as a model for other rice farmers in the area. In addition, partnership programs such as the Texas Prairie Wetlands Project are supporting the establishment of long-term wildlife habitat enhancement projects on agricultural lands.

Pastureland in the area consists of improved and unimproved pasture. Improved pasture contains low successional native grasses and forbs characteristic of native prairie, but may also contain forage crops for cattle. These areas primarily support cattle production through cow-calf operations, but they also

support a variety of wildlife including several species of reptiles, a number of amphibian species, and several species of resident mammals. These lands also provide habitat for a number of migratory birds.

Management of pastureland is aimed at maximizing agricultural forage production. Higher yields of available forage support more cattle. Similar to ricelands, acreage left in pastures can also be managed to benefit wildlife. By monitoring stocking rates and rotating grazing areas during the various seasons of the year, these lands can be more productive for this purpose. Pastureland in the area is also susceptible to invasion by undesirable plant species, primarily through under utilization and/or ground disturbance which allows invasive species to become established.

4. Recreation Resource Use

Outdoor recreational activities in the area include hunting, fishing, wildlife observation, hiking, camping, and boating. Demand for these activities has increased with population growth, increased leisure time, and higher family income. The highest local demand for recreational opportunities has been for waterfowl hunting, recreational fishing, and birding.

Refuge Complex Recreation - Discussed above in *Chapter 3,Section IV.C., Public Use Program.*

Local State Public Lands Recreation - In addition to activities on the Refuge Complex, the Texas Parks and Wildlife Department (TPWD) offers hunting and fishing opportunities on several of its units in the vicinity, including J.D. Murphree Wildlife Management Area, Sabine Pass Battleground State Park & Historic Site, and Sea Rim State Park. The TPWD has also recently initiated a program to lease private lands in the study area to provide additional public hunting opportunities. These leases open select private lands in the area to the public for dove hunting.

Between fiscal years 2001 and 2002, visitation to Sea Rim State Park decreased by 4 percent from 62,676 to 60,122 visitors. In the same period, visitation to the Sabine Pass Battleground State Park & Historic Site increased by nearly 2 percent from 50,357 to 51,348 visitors.

Ecotourism is becoming an important activity in the Texas Chenier Plain region and in Texas as a whole. Bird watching, a popular form of ecotourism, is already an economic contributor within the area. To promote bird watching and ecotourism in general along the Texas Gulf Coast, the TPWD Nongame and Urban Program is developing the Great Texas Coastal Birding Trail from Brownsville to Beaumont. This project is funded through the Texas Department of Transportation and Intermodal Surface Transportation Enhancement Act. The Birding Trail will link over 50 bird watching sites along the 500-mile route. The trail will include many designated sites on both private and public lands, including parts of Anahuac, McFaddin and Texas Point NWRs.

High Island, Texas is among the most renowned destinations for bird watching in the U.S. The area is visited by thousands of birders during the spring migration (early March to mid-May) when more than 300 species travel through the area. A study completed in 1991 evaluated the characteristics of visitors to High Island and concluded that local residents (those residing in the five counties surrounding High Island, including Houston in Harris County) constituted 42.4 percent of High Island's visitors; 57.6 percent were non-residents from 35 states (including Texas) and five foreign countries. Two popular bird preserves include the Houston Audubon Society's Louis Smith Bird Sanctuary (also known as Boy Scout Woods), which comprises 4 acres, and the Smith Oaks Bird Sanctuary, which comprises 143 acres. Eubanks Woods, comprising 9.5 acres, and S. E. Gast Red Bay Sanctuary, comprising 8.8 acres, also provide additional birding retreats on the Island. The Bolivar Flats Shorebird Preserve, also an Audubon sanctuary, is located west of High Island and protects habitat for the largest shorebird concentrations on the upper Texas Coast.

Private Lands - Waterfowl hunting, dove hunting, and recreational fishing are also widely available on private lands, usually through a lease. Several commercial guiding services, primarily for waterfowl hunting and saltwater fishing, operate in the area.

5. Oil and Natural Gas Development Use

Oil and gas development is a substantial historic activity in the region with Jefferson County being the home of the first Spindle Top gushers. Today, both Chambers and Jefferson Counties still have very active petroleum/natural gas development activities that include both onshore and offshore operations. Most mineral estates (the term "minerals" includes oil and gas resources) within the study area are owned by the surface owner in total, split between the surface owner and third parties, or are entirely by third party ownership. The minerals were severed from the surface estate and reserved in third parties many years ago on the majority of properties. These resources were reserved for the purposes of development sometime in the future.

There is extensive State case law regarding use of land for mineral/oil and gas resource development to protect the rights of mineral owners or lessees. The State's courts have held that the mineral interest owner or his lessee can make use of the surface as is reasonably necessary to produce oil and gas. Consequently the scope of the implied easement is exceeded if the use is unreasonable.

Generally, the USFWS does not purchase mineral rights and those rights are reserved in the land acquisition transaction or had previously been severed from the surface rights.

The mineral estate under Refuge Complex lands, with few exceptions, is in third-party leases. In many cases, minerals under these lands were under lease by oil and gas companies prior to USFWS acquisition and remain under lease today. Exploration for and development of these resources is an ongoing process and includes both drilling and operation of wells and seismic operations.

Mineral exploration and development activity on the Refuge Complex is allowed over a 6-month period between April 15 and October 15 though certain exceptions may be made to allow these activities during other parts of the year. The USFWS administers new oil and gas activities on the Refuge Complex through issuance of a Special Use Permit (SUP). .

6. Developmental Use

As noted above, much of the land within the primary study area is not suitable for traditional developmental uses such as economic infrastructure and housing. This is because of hydrological, soil, and other environmental/natural resource conditions. A substantial portion of the study area is covered by water or considered marshland, which would not be developable in the traditional sense without substantial alteration to the natural environment. Chambers County has a much smaller population base compared to Jefferson County, and Chambers County is essentially rural and unconsolidated in nature. Jefferson County, in addition to being much more heavily populated than Chambers County, also is highly urbanized with as much as 90 percent of its population being concentrated in urban areas, primarily Beaumont and Port Arthur. Both of these cities are actively promoting additional growth and development, and existing trends in Jefferson County are likely to continue. Therefore, traditional economic development and housing activities are likely to be within the urban areas of Jefferson County, and are Development has been somewhat limited in Chambers County because of its smaller population base, but may increase substantially with continued urban sprawl within the greater Houston area. Currently, there are few, if any, direct conflicts between development land uses and the use of Refuge Complex lands for conservation and wildlife/wildlife habitat protection purposes.

However, from a developmental support perspective, there may be indirect conflicts between existing land uses involving Refuge Complex land ownership and management. Some land that could be acquired by the USFWS and added to Refuge Complex land holdings would be developable for residential and industrial purposes, or may be desired by State agencies or local special purpose agencies for use either within State Parks or as part of drainage and flood control districts. Some of these scenarios would result in competing and mutually exclusive land use decisions. Furthermore, some of these uses, such as flood control, could promote economic development of other local areas.

7. Additional Land Ownership Considerations

USFWS efforts to acquire additional lands or conservation easements for inclusion in the Refuge Complex will only occur by working with willing sellers. Land ownership in the primary study area ranges from simple ownership situations (e.g., one owner on a single large tract of land) to complex ownership situations (e.g., disputed ownership, and/or single tracts with more than five undivided owners). Potential purchase transactions involving complex landownership considerations will be more difficult for the USFWS to evaluate and complete with willing sellers.

B. Economic Characteristics

This section focuses on trends associated with certain economic characteristics in the secondary study area. This includes employment, income and earnings, average earnings per job, unemployment and the labor force, and economic base industries.

1. Employment

Total employment by industry for the counties in the secondary study area and Texas were obtained from U.S. Bureau of Economic Analysis (BEA).[1] The largest employers statewide in Texas in 2000 were services and trade (wholesale and retail). Together they comprised approximately 55 percent of total employment in 2000. In Chambers County the largest employers in 2000 were manufacturing, trade, services and government. All industries were between 17 percent and 19 percent of the total. Combined, these categories comprised 72 percent of the total employment within the county. Distribution of employment by industry in Jefferson County was nearly identical to that of the entire state of Texas in 2000 with most of the employment concentrated in services (32 percent) and trade (22 percent).

Industries showing the greatest percentage increase in employment during this period for the state of Texas include construction (32 percent) and services (17.5 percent). Industries showing the greatest percentage decline in employment for Texas between 1990 and 2000 were mining (-36 percent) and manufacturing (-11 percent). In Chambers County, the greatest percentage increases occurred in agricultural services (29 percent) and manufacturing (21 percent). The greatest percentage decline in Chambers County was in the mining sector (-43 percent). The greatest percentage increase in Jefferson County was in the construction industry (19 percent), while the largest percentage decline appeared in the mining industry (-67 percent).

2. Personal Income

Personal income data was also obtained for each county in the primary study area from the BEA. Total personal income increased by over $270 million during the 1990's in Chambers County representing a 69 percent increase while in Jefferson County, personal income increased over $1.1 billion; a 21 percent increase.

Personal income can be broken down into three categories: labor income, investment income and transfer payments. Labor income is derived through wages, salaries and self-employment income. Investment income includes income in the form of rents, dividends and interest earnings. Finally, transfer payments income is largely derived from Social Security benefits, Medicare and Medicaid benefits and other income support and assistance.

Labor income consistently accounts for the greatest percentage of personal income for these two counties and the State of Texas. In 2000 labor income accounted for 72 percent of personal income in Chambers County, 63 percent in Jefferson County and 74 percent statewide. Income derived from non-

1 U.S. Department of Census, Economics and Statistics Administration, Bureau of Economic Analysis, Regional Economic Information System (REIS), 1990-2000, www.bea.gov.

labor sources has remained relatively constant in Jefferson and Chambers Counties averaging 36 percent and 25 percent respectively.

Investment income nearly doubled in Chambers County during the 1990s and accounted for 15 percent of personal income by 2000. The opposite is true for Jefferson County where investment income grew a modest 6 percent during the last decade but accounted for nearly 18 percent of total personal income in 2000. Investment income as a percentage of personal income for Jefferson County in 2000 was higher than the national average (18 percent) and state average (15 percent). The increasing dependence on investment income is common throughout the country with the increasing percentage of the population that is retired.

Transfer payments for the study area grew by 91 percent in Chambers County and 43 percent in Jefferson County during the 1990s. In Jefferson County transfer payments accounted for nearly 19 percent of total personal income in 2000. Dependence on transfer payments for income is lower in Chambers County where transfer payments accounted for 11 percent of total personal income in 2000. Chambers County is similar to state and national trends where transfer payments accounted for 11 percent of personal income for residents of Texas in 2000 and 13 percent nationally. Jefferson County shows signs of higher dependence on transfer payments than other areas.

3. Per Capita Income

Trends in per capita income for the study area and the state for 1990 through 2000 are summarized in Figure 3.1. Growth in per capita income is very similar in the three areas averaging between 21 and 23 percent. The per capita income increase of 30.5 percent in Chambers County, 2.8 percent annually was slightly higher than the overall state increase, while the increase of 14.8 percent in Jefferson County, 1.3 percent annually, was approximately half the state average.

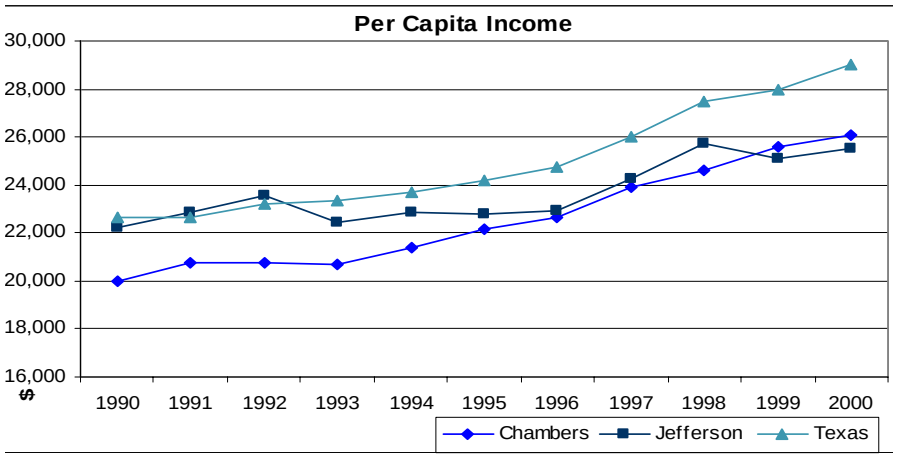
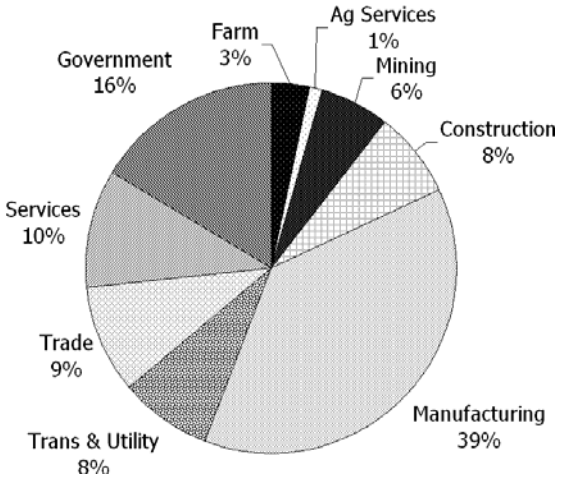


Figure 3.1 Per Capita Income for the Study Area and State of Texas 1990-2000.

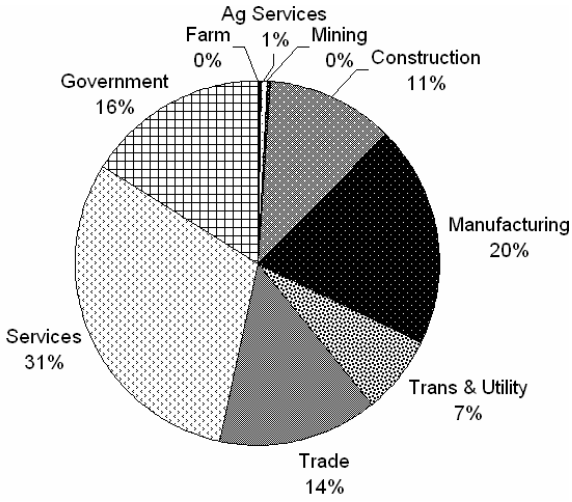
These two counties have consistently reported per capita income levels below the state and national average since 1993. For example, in 2000 per capita income in Jefferson and Chambers counties was between $25,000 and $26,000, which were lower than both the state ($28,004) and national ($30,150) averages.

Total earnings by industry for Texas and the counties in the study area for 1990 through 2000 were also obtained from BEA. Figures 3.2 and 3.3 provide a summary of earnings share by industry for the study area.

Earnings from the services sector comprise the majority of the earnings statewide in Texas accounting for over 25 percent of earnings. The same result also appears in Jefferson County where the service industry accounts for 31 percent of the earnings in 2000. The situation in Chambers County differs substantially from Jefferson County and the statewide condition. Manufacturing is the largest component of earnings with a share of 39 percent. The service sector, which accounted for 10 percent of total earnings in 2000, ranks third in the county behind manufacturing and government sectors.



3.2 Chambers County Earnings by Industry



3.3 Jefferson County Earnings by Industry

Industries reporting the greatest growth in earnings for the two counties and Texas varied noticeably, with the services sector being the only industry to experience a large increase across all three areas. Statewide in Texas, the largest percentage increase appeared in the transportation and public utilities sector (92%), with construction and services following at approximately 80 percent growth. In Jefferson County the largest increase was in the government sector, while the trade and manufacturing sectors had the largest increase in Chambers County. One industry that experienced a large percentage decrease in Chambers and Jefferson County was the mining industry, while statewide no sector experienced a decline.

4. Average Earnings by Industry

Another method of examining the importance of certain industries is to evaluate the trends in average earnings. Manufacturing jobs remain the highest paying in Chambers County followed by transportation and mining. In Jefferson County, manufacturing is also the highest paying industry followed by transportation.

5. Unemployment

Change in the labor force and unemployment can provide information on the health of the local economy. Unemployment in Jefferson County has been consistently higher than unemployment in the state of Texas, Chambers County and the U.S. during the 1990's. Unemployment rates in Chambers County, Texas and the U.S. have been similar over the time period from 1994 to 2000.

Changes in the civilian labor force during the 1990's are summarized for each county and Texas in Table 3-24. The civilian labor force is defined as all persons over 16-years of age in the civilian non-institutional population who either had a job or was looking for a job in the last 12 months. The data shows that the labor force in Jefferson County actually decreased while the labor force in Chambers County increased at a higher percentage that increases at the state level.

Table 3.24
Change in the Civilian Labor Force 1992-2000

Location	Change in Civilian Labor Force (1992-2000)	Change in Civilian Labor Force (1992-2000)
Texas	1,325,764	15%
Chambers County	1,923	19%
Jefferson County	-5,516	-5%

6. Economic Base Industries / Location Quotients

An area's economic base is composed of industries that are primarily responsible for bringing outside income into the local economy. These industries typically export their goods and services outside the region and in turn support ancillary industries such as retail trade, housing construction and personal services. The location of important industries in certain areas has traditionally been tied to such factors as natural resource base, cost factors (transportation and labor) and existing transportation infrastructure. However, technology has affected these location factors.

Location Quotients for Study Area - 2000

	Employment		Income	
Chambers	Texas	US	Texas	US
Farm	2.578364	12.639	3.551728	3.559779
Ag Services	2.772263	10.49976	1.749075	1.693427
Mining	1.836539	28.68622	1.195384	6.544815
Construction	1.183363	0.142469	1.090087	1.168004
Manufacturing	1.934671	1.399469	2.675291	2.159037
Trans & Utility	0.898942	0.799084	0.802267	1.082206
Trade	0.726122	2.914019	0.540174	0.574354
Services	0.571539	2.10537	0.354425	0.318271
Government	1.133798	4.609561	1.05103	0.949322

Table 3-25
Location Quotients for Chambers County

Location Quotients for Study Area - 2000

	Employment		Income	
Jefferson	Texas	US	Texas	US
Farm	0.256501	1.257355	0.206108	0.206575
Ag Services	0.975391	3.694229	1.027126	0.994447
Mining	0.239842	3.746256	0.076593	0.419354
Construction	1.636278	0.196997	1.577498	1.690254
Manufacturing	1.152565	0.833723	1.405414	1.13421
Trans & Utility	0.840156	0.746828	0.681712	0.919585
Trade	0.987607	3.963389	0.81483	0.866391
Services	0.981314	3.614856	1.057546	0.949671
Government	0.94842	3.855889	1.029711	0.930066

Table 3-26
Location Quotients for Jefferson County

To assess the importance of major industries as a basic industry, location quotients were calculated on nine major industries as listed in Table 3-25 and 3-26 for Chambers and Jefferson counties. A location quotient was calculated for both employment and income and compares each industry's share of total local employment or income to the industry's state or national share. This quotient yields a value generally between 0 and 2, where 1.0 indicates an equal share percentage between the local and state or national economies. Location quotients greater than 2 indicate a strong industry concentration while those less than 0.50 indicate a weak concentration.

Table 3-25 and 3-26 indicate the two county study area is similar to the state's economy as a whole. Industries that do show a stronger concentration in Chambers County compared to the state's economy include farming, agricultural services and manufacturing. One industry that is weak in this area compared with the state is the services sector. When compared to the national economy, farming and agricultural services show an even greater industry concentration, while mining becomes less concentrated. In Jefferson County the quotients indicate a stronger reliance on construction and manufacturing compared to the state. The farming and mining sectors show the most significant difference by being much less concentrated. In comparison to the national economy there is a higher employment concentration in the several industries in terms of employment while income concentration is similar to that of the rest of the country.

C. Major Industries in the Study Area

1. Agriculture

The importance of agriculture varies within the study area. For instance, farm and farm services comprised less than one percent of total earnings and less than 2 percent of total employment for Jefferson County in 2000. However, in Chambers County farm and agricultural services are more important to the local economy accounting for 10 percent of total employment and 4 percent of total gross earnings. The importance of this industry by county is also apparent in the location quotients discussed in the last section. A larger percentage of employment and income is concentrated in farm and farm services in Chambers County relative to the State of Texas and the U.S. However, Jefferson County does

Table 3-27
Acreage, Yield and Production for Rice, 2000 and 2001*

Location	Acreage				Yield Per Harvested Acre (lbs)		Production (cwt)	
	Planted (1,000 Acres)		Harvested (1,000 Acres)					
	2000	2001	2000	2001	2000	2001	2000	2001
Jefferson	19.0	19.1	18.5	19.0	5,450	5,210	1,008	990
Chambers	11.8	13.5	11.8	13.5	5,080	5,560	600	750
Texas	215	217	214	216	6,700	6,700	14,342	14,467

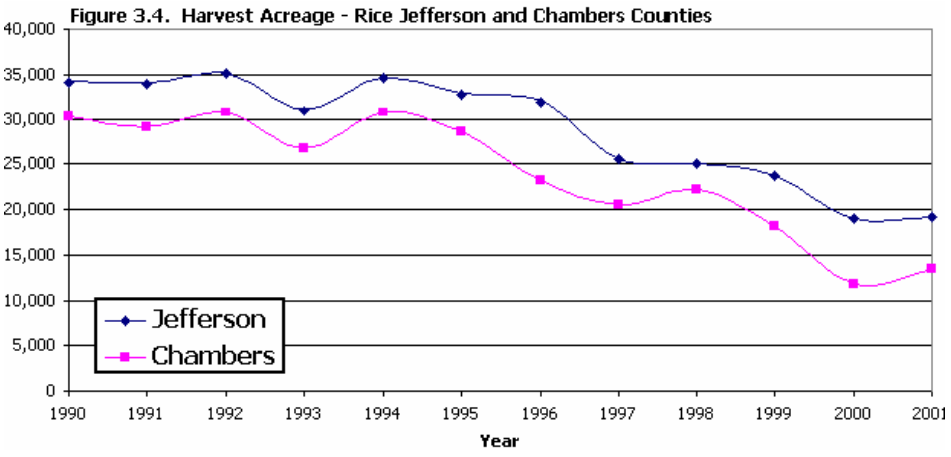
*Source: Texas Agricultural Statistical Service, "2001 Texas Agricultural Statistics", Austin Texas.

not exhibit as strong a relationship to agriculture though it is more important in this county than other areas of the country.

The most recent Agricultural Census conducted by the U.S. Department of Agriculture was completed for year 1997. According to this source, Jefferson County had 562 farms with a total land area of 433,597 acres. The average farm size was 772 acres with a median size of 91 acres. The market value of agricultural products sold in 1997 totaled $25.6 million of which $18.3 million was due to crops and $7.1 was for livestock. Chambers County reported 421 farms with a total land area of 241,933 acres in the 1997 Agricultural Census. The average farm size was 575 acres with a median size of 180 acres. The market value of agricultural products sold in 1997 totaled $15.7 million of which $11.6 million was due to crops and $4.1 was for livestock.

Rice and livestock production remains as important agricultural activities in both counties. According to the Texas Agricultural Statistical Service, Jefferson and Chambers counties ranked 6th and 8th in Texas in terms of total rice production. Current statistics on rice production for Jefferson and Chambers counties are provided in Table 3-27.

Acreage used for rice production has been declining in both Chambers and Jefferson counties throughout the last decade as summarized in Figure 3.4. In 1990 harvest acreage for rice in both counties exceeded 30,000 acres but steadily declined to current levels shown in Table 3-27. Much of this decline follows trends throughout Texas. Rice production[2] has declined in Texas due to increased production cost, decreased profits, and landlord tenant issues created from direct payment changes in the 1996 Farm Bill.



Texas is the highest cost area for production in the U.S due to the three-year rice rotation schedule.

Rice crops planted on this schedule require two-thirds of the acreage to be left fallow for two years without the ability to plant other crops in the rotation. The soils and climate in this area are not suitable for planting

2 Personal communication with David Anderson, Associate Professor and Extension Economist, Texas A&M University, College Station, Texas.

other crops, and rice is prone to weed invasion thus increasing the costs of production. The depressed market for rice has also impacted this area. Falling prices have resulted in reduced profits as well as a reduction in acreage. Throughout the area, more land has been lost west of Houston than east of Houston, however, acreage east of Houston produces lower yields. Land area used for rice production was declining before 1996, but this trend accelerated after 1996.

Another influence to the rice industry in southeast Texas was changes in payment methods for rice subsidies in the 1996 Farm Bill. The Farm Bill changed the payment method for rice—from issuing a payment shared by the tenant and landowner, to a direct payment to the landowner. With this payment structure, landowners are making higher revenues by releasing the tenant and retaining the payment. This has significant impact in the study area due to the large percentage of tenant farmers working here.

Other significant crops produced in Chambers and Jefferson counties include soybeans, sorghum, wheat and corn. Production of these crops is summarized in Table 3-28 and Table 3-29. A certain amount of acreage is also used in Jefferson and Chambers counties for hay production. While annual data on hay production is not available from the Texas Agricultural Statistics, some data is available from the 1997 Census. According to this source 12,517 acres in Jefferson County and 7,632 acres in Chambers County were used for hay production during 1997.

Table 3-28
Acreage, Yield and Production for Sorghum, 2000 and 2001

Location	Acreage				Yield Per Harvested Acre (lbs)		Production (cwt)	
	Planted (1,000 Acres)		Harvested (1,000 Acres)					
	2000	2001	2000	2001	2000	2001	2000	2001
Jefferson	*	1.4		1.4		2,857		40
Chambers	4.8	1.5	4.0	1.5	4,375	5,000	175	75
Texas	3,000	3,500	2,350	2,600	3,416	2,800	80,276	72,800

Table 3-29
Acreage, Yield and Production for Soybeans, Wheat and Corn, 2000 and 2001

Location	Acreage				Yield Per Harvested Acre (bushels)		Production (1,000 bushels)	
	Planted (1,000 Acres)		Harvested (1,000 Acres)					
	2000	2001	2000	2001	2000	2001	2000	2001
SOYBEANS								
Jefferson	*	1.4		1.0		29.0		29.0
Chambers	3.5	1.5	2.7	1.0	19.9	29.9	53.7	29.0
Texas	290	260	260	210	27	27	7,020	5,670
WHEAT								
Jefferson								
Chambers	1.5	5.0	0.5	1.5	28.0	40.0	14	60
Texas	6,000	5,600	2,200	3,200	30	34.0	66,000	108,800
CORN								
Jefferson	2.2	1.0	2.1	0.9	21.0	90.0	44	81
Chambers	5.7	*	2.7		49.3		133	
Texas	2,100	1,600	1,900	1,420	124	118	235,600	167,560

* Less than 1,000 acres planted

Source: Texas Agricultural Statistical Service, “2001 Texas Agricultural Statistics”, Austin Texas.

Table 3-30
Cattle and Calf Inventory, 2001 and 2002, Jefferson and Chambers Counties

County	All Cattle and Calves		Beef Cows	
	2001	2002	2001	2002
Jefferson	43,000	42,000	38,000	36,000
Chambers	23,000	24,000	44,934	40,733

Source: Texas Agricultural Statistical Service, "2001 Texas Agricultural Statistics", Austin Texas.

2. Livestock

Cow-calf operations are also a significant agricultural use in Jefferson and Chambers counties. According the 1997 Agricultural Census, cattle and calf sales in Chambers County accounted for 87 percent of all livestock sales and 31 percent of all agriculture sales in 1997. For Jefferson County, cattle and calf sales accounted for 89 percent of all livestock sales and 37 of all agricultural sales. The latest cattle and calf inventory for each county was obtained from the Texas Agricultural Statistics for 2000 and 2001 as summarized in Table 3-30.

3. Agricultural Production in the Primary Study Area

In many ways agriculture production within the primary study area mimics operations throughout the two-county study area. In this smaller sub-area, agricultural production is dominated by grazing operations and rice production. However, rice production is not as common in the primary study area as throughout the northern parts of the counties. For Jefferson County, most rice production occurs north of Highway 73. However, a small area south of Highway 73 on the western edge of the county does support rice production. Rice production is not feasible in much of the areas south of Highway 73 due to high percentage of marsh habitat (e.g. fresh, brackish and salt). Therefore, most of the acreage south of Highway 73 is used for grazing operations. While there is also grazing in the northern part of the county, most of the large ranches are located within the primary study area and support a significant percentage of the beef production activities for the county. Rangelands in this area generally support both bahia and bermuda grass varieties.

The patterns vary slightly in Chambers County with more of the rice acreage extending down in the primary study area. Soils maps reveal that rice production is viable in areas farther south in Chambers County and extend all the way to the marsh areas. Grazing is also quite common in the southern portions of the county and consists of cow-calf operations.

4. Oil and Gas Production and Refineries

Texas remains a leader in the oil and gas industry in terms of production, refining and petrochemicals. Of the top 16 states that extract oil and natural gas, Texas has over 39.5 percent of all mining establishments, 41 percent of annual payroll, and 32 percent of the value of shipments and receipts. Texas also leads the nation in the number of establishments dedicated to petroleum refining and to the total annual payroll and value of shipments within the oil refining industry.

Chambers and Jefferson counties are no exception to the Texas Coast reliance on petroleum and natural gas exploration and production and petroleum based refining. This began with the discovery of the Spindle Top Gushers in Jefferson County and continues today. Of the 100,000 individuals employed in private industry in Jefferson County, ten percent are employed in the petroleum or petrochemical industry with an annual payroll that represents 20 percent of

Table 3-31
Oil and Gas Well Counts, Jefferson and Chambers Counties

Well Type	**Chambers**	**Jefferson**
Gas Wells		
Regular Producing	96	98
Temporary Abandoned and Not Eligible	58	33
Shut-In	16	3
Shut-In 14 (B)(2)*	192	96
Injection	8	8
Total	370	238
Oil Wells		
Regular Producing	218	149
Shut-In	353	215
Shut-In 14 (B)(2)*	267	152
Injection	50	47
Total	888	563

Source: Railroad Commission of Texas, February, 2003.
* Inactive well with valid 14 (B)(2) extension.

the total private sector payroll in 2000.[3] The petroleum and chemical manufacturing industries in Chambers County accounted for thirty-seven percent of total private industry employment and 60 percent of total private industry annual payroll.

Table 3-32
Annual Oil and Gas Production, Jefferson and Chambers Counties, 1997-2001

Year	Natural Gas (MCF)	Crude Oil (BBls)	Condensate (BBLs)	Casing head Gas (MCF)
Chambers				
2001	34,729,281	810,796	691,698	1,990,306
2000	39,814,093	982,597	685,490	3,648,056
1999	38,077,964	1,311,830	575,143	4,516,316
1998	58,787,071	1,310,381	657,766	4,884,325
1997	50,971,963	1,441,684	480,229	4,304,746
Jefferson				
2001	42,405,339	1,286,402	1,133,112	1,616,419
2000	49,776,615	1,345,231	1,534,404	2,042,383
1999	38,839,085	1,071,852	1,123,017	2,022,323
1998	43,363,760	1,125,608	1,799,103	1,495,981
1997	50,038,436	1,498,410	2,757,224	1,678,499

Source: Railroad Commission of Texas, February, 2003.

Information on oil and gas production activities within both Jefferson and Chambers counties was obtained from the Railroad Commission of Texas and is summarized in Tables 3-31 and 3-32. Table 3-31 shows the number and type of wells in both counties as of February 2003. This includes over 300 actively producing wells in Chambers County and nearly 250 producing wells in Jefferson County.

5. Oil and Gas Activities on the Refuge Complex

As discussed in earlier sections, active oil and gas activities are supported in many areas within the Refuge Complex. This includes exploration and development as well as infrastructure that support offshore activities. Since 1996, several new oil and gas wells have been drilled within the Refuge Complex. This includes one well on the McFaddin NWR, four wells on Anahuac NWR, and two wells on the Moody NWR. Of these, three of the wells drilled within the Anahuac NWR were successful. In addition, a total of eight 3-D seismic surveys have occurred since 1995 on Anahuac (4), McFaddin (3), and Texas Point NWRs (1).

Both Anahuac and McFaddin NWRs have active oil and gas operations. Two operators hold active leases in the Roberts-Mueller Oil and Gas Field within Anahuac NWR. This includes two or three producing wells and several shut-ins wells that are being operated under the 14(B) state exemptions. Facilities within the refuge include separators and tank batteries, flowlines, and roads. Natural gas from these operations is piped off-site while oil is transported off the refuge by tanker truck. In addition, Kerr-McGee Oil and Gas Onshore, LP operates three active wells on the northeast portion of the refuge. Condensate from these wells is piped to an off-site separator/storage facility. Natural gas is then piped back through refuge to Centana pipeline.

Currently one operator holds lease in the Clam Lake Oil and Gas Field within the McFaddin NWR. The lease covers several small producing wells in addition to shut-ins wells operated under 14(B) exemptions. Facilities include separators and tank batteries, flowlines, office and storage buildings, roads, etc. Oil is removed from refuge primarily by off-loading from tank battery to barges in Gulf Intracoastal Waterway. Natural gas is piped off-site.

There are also several pipelines that cross the Refuge Complex and support oil and gas activities offshore and onshore. Most of these pipelines were preexisting to the establishment of the wildlife refuges. This includes two pipelines that cross the Anahuac NWR from offshore and support gas production. A tributary line, which also crosses Anahuac, supports gas production on neighboring private property. Three permitted and active pipelines that support production offshore currently cross the

3 U.S. Census Bureau, 2000 County Business Patterns,(NAICAS), http://censtats.census.gov/cgi-bin/cbpnaic/cbpsel.pl

McFaddin NWR. An additional pipeline that crosses this refuge is used by U.S. Department of Energy for the transport of brine from the Big Hill Strategic Petroleum Reserve facility for disposal in the Gulf of Mexico. Several other pipelines that cross McFaddin have been abandoned in recent years. Texas Point NWR has two permitted and active pipelines that cross within its boundaries.

6. Recreation

Recreational activity has important economic value both in terms of the satisfaction it provides local residents and the economic activity it generates for the regional economy. In terms of economic activity, recreation generates additional spending in the local economy that supports jobs and income. Economic stimulus occurs as non-residents to the area spend money in the local economy that generates additional spending by local residents. This assumes that if local residents were not participating in recreation they probably would have spent their money on something else in the region's economy. Thus, expenditures by local residents are seen as a shifting of dollars from one sector to another within the local economy and not a net gain to the region. Outdoor recreation in general is important to the region both in terms of satisfaction to residents and economic stimulus for the regional economy.

7. Refuge Complex Operations

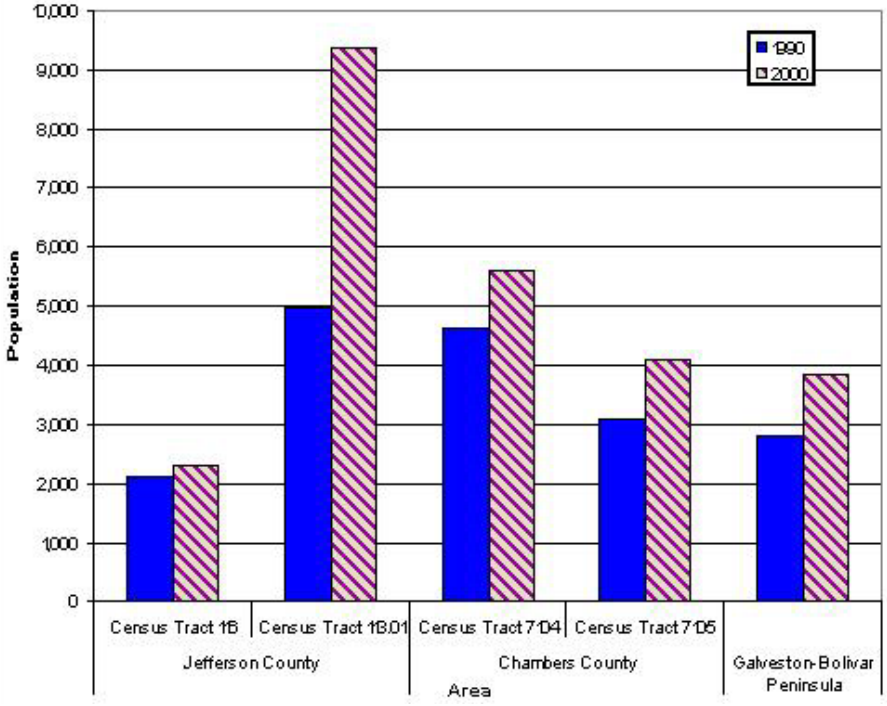
The administration and operation of the four national wildlife refuges within Jefferson and Chambers counties also provide economic stimulus to the local area. This is due to the fact that funds from outside the region (e.g. Federal Government) are used to support various activities at the Refuge Complex. This includes salaries for local USFWS employees, operation and maintenance of the refuges as well as rental and purchase of equipment and supplies.

D. Demographics

1. Population Trends

a. Secondary Study Area

Figure 3.5
Primary Study Area Population Trends



Overall, population increased by 4.1 percent in the secondary study area over the last two decades with an annual average population increase of 0.2 percent. During the 1980s, the area experienced a population decline of 2.9 percent with an annual average population decrease of 0.3 percent. During the 1990s, however, the population rose by 7.2 percent with a 0.7 percent annual average increase. The largest annual increase in the secondary study area population was experienced more recently at 4.8 percent in 2000 (4.4 percent in Jefferson County and 8.5 percent in Chambers County).

b. Primary Study Area

Compared to overall county trends, population increased more significantly in the primary study area. For instance, population increased by 43.3 percent in the primary study area over the last decade. Census Tract 113.01 in Jefferson County primarily skewed the average with an estimated 89.3 percent increase in the last decade, where the population in Block Group 1 (located near Beaumont and Port Arthur) quadrupled from 1,277 in 1990 to 5,012 in 2000. Population on the Galveston-Bolivar Peninsula (Census Tract 7239) rose by 37.3 percent in the last decade; the two Census Tracts in Chambers County, 7104 and 7015, increased by 21.2 and 32.3 percent, respectively; and Census Tract 116 in Jefferson County increased by a mere 8.3 percent in comparison. Figure 3.5 displays these trends (source - US Census Bureau).

2. Migration Patterns

The components of population change provide additional insights in factors affecting the population. The change in population for the secondary study area is mostly attributed to natural changes experiencing more births than deaths, while net migration continued to draw individuals away from the area. On the contrary, natural changes and net migration have greatly contributed to the population changes statewide. During the 1980s, both Jefferson and Chambers Counties experienced decreases in population due to net migration resulting in a net population decline of 10.2 percent. During the 1990s, the secondary study area increased in population by 2 percent, primarily attributed to the natural changes (4.2 percent in Jefferson County and 5.6 percent in Chambers County). However, during the 1990s, Chambers County experienced a 14 percent increase in net migration, while Jefferson County experienced a 3.1 percent decrease in net migration.

Figure 3.6
Age Distribution Within the Secondary Study Area (2000)
Source: US Census Bureau

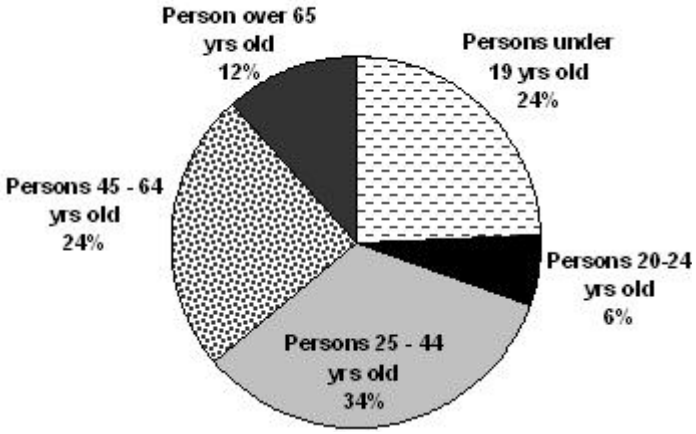
3. Population Characteristics

a. Age

As shown in Figure 3.6, the secondary study area is primarily composed of people less than 19 years of age and between 25 and 44 years of age. Approximately 29.2 percent of the people are less than 19 years of age and 29.4 percent are between 25 and 44 years of age, people between 45 and 64 closely follow at 21.4 percent.

The primary study area corresponds closely with the composition of the secondary study area, where distributions between age groups are very similar (Figure 3.7). Approximately 33.4 percent are between 25 and 44 years of age and 24.5 percent of the people are less than 19 years of age, people between 45 and 64 closely follow at 24.4 percent.

Figure 3.7
Age Distribution Within the Primary Study Area (2000)
Source: US Census Bureau



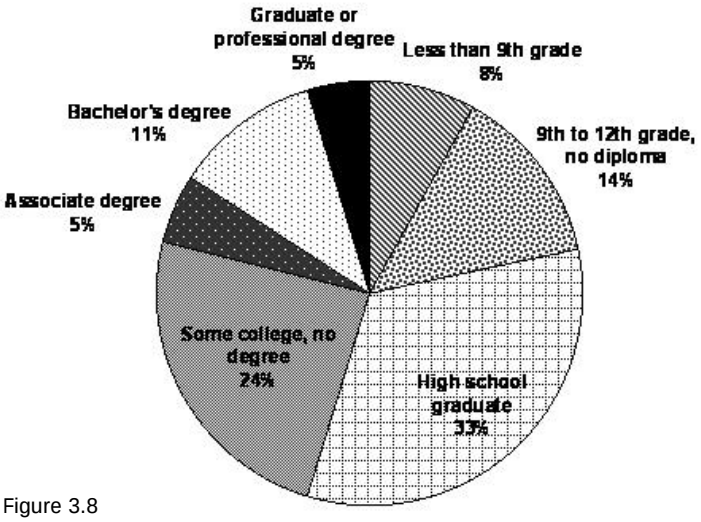


Figure 3.8
Educational Attainment Within the Secondary Study Area (2000)
Source: US Census Bureau

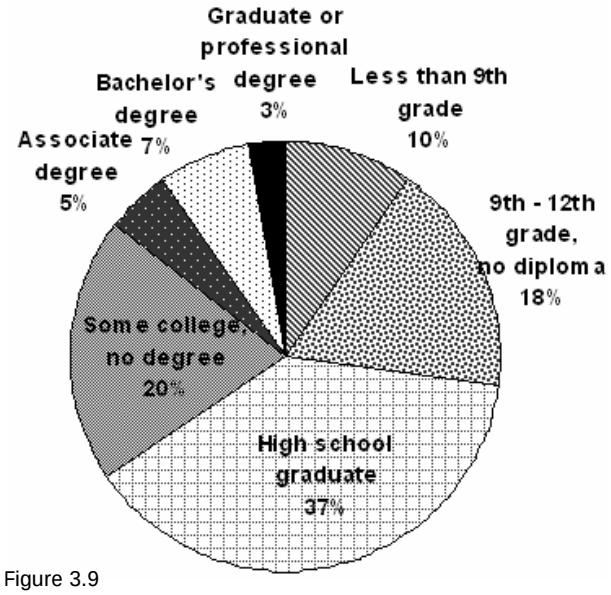


Figure 3.9
Educational Attainment Within the Primary Study Area (2000)

b. Education

A majority of persons over 25 years of age within the secondary study area either have graduated high school or attended college but did not receive a degree (Figure 3.8). Approximately 33.1 percent of persons over 25 years of age have graduated high school, 24.1 percent have attended college but did not receive a degree, and 13.7 percent have attended high school but did not receive a diploma.

The primary study closely corresponds to this trend (Figure 3.9). Approximately 37 percent of persons over 25 years of age have graduated high school, 20 percent have attended college but did not receive a degree, and 18 percent have attended high school but did not receive a diploma.

4. Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

The environmental justice assessment encompasses several aspects of demographics. Early in the process, minority and low-income populations should be identified within the potentially affected area. If minority and/or low-income populations are present in the study area, the environmental impacts likely to fall disproportionately on these populations should be examined in the analysis.

Minority populations are defined as members of the following population groups: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; African American or Black, not of Hispanic origin; or Hispanic or Latino. Community members who are some other race or two or more races are also considered in the minority population. Based on CEQ guidance, minority populations should be identified where either: (a) the minority population of the area exceeds 50 percent, or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-income populations are defined as those below the federal poverty thresholds. Low-income populations are identified using statistical poverty thresholds from the Bureau of Census of $17,463 for a family of four (the 1990 poverty guideline was $13,254). While rigid guidance is provided to determine the composition of a minority population for an analysis, best judgment is the only recommended tool for low-

income populations. EPA identifies a low-income community as an area with a significantly greater population of low-income families than a statistical reference area.[4] A good statistical reference area for this project is the secondary study area, which has a 14.2 percent poverty rate; poverty rates ten percentage points above the secondary study area would be significantly higher. For the purposes of this analysis, low-income populations will be defined as an area where the low-income population exceeds 25 percent poverty or if isolated pockets of large low-income populations are present.

Minority and low-income population designations are based on U.S. Bureau of the Census data for 2000, and environmental justice guidance prepared by the Environmental Protection Agency (EPA) and Council on Environmental Quality (CEQ). The following sections present the demographic profiles of the potentially affected environment that are related to environmental justice.

a. Minority Populations

The economic study area is ethnically diverse, with primarily Black or African American and Hispanic or Latino races leading the minority representation. The economic study area closely corresponds to minority representation statewide (Figure 3.10). Total minority population for the secondary study area is 46.1 percent, compared to 28.9 percent for the primary study area. The secondary study area is very comparable to the statewide minority representation of 46.2 percent, while there is a 17.3 percent difference between Texas and the primary study area.

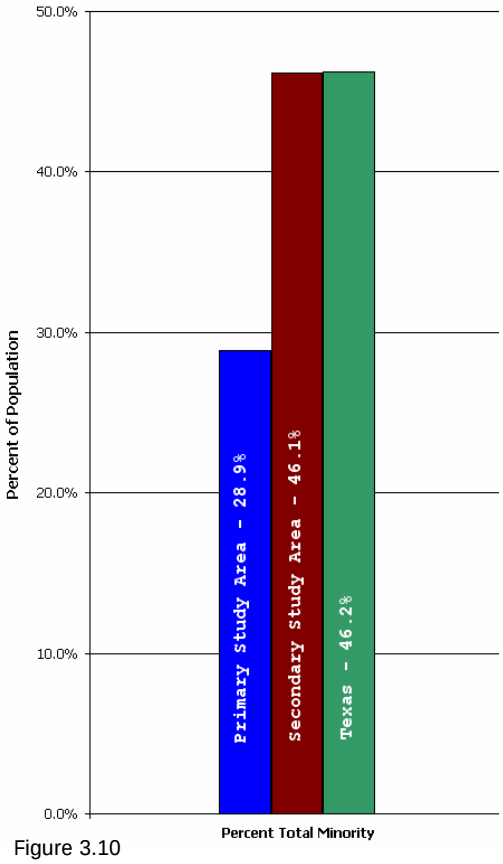


Figure 3.10
Ethnicity for the Economic Study Area (2000)
Source: US Census Bureau

Table 3-33, on the following page, displays percent minority by census tract and block group. Only one block group within the primary study area exceeds the standard 50 percent guideline on minority presence at 64.8 percent minority, Census Tract 7105 Block Group 3 in Chambers County. Census Tract 7105 Block Group 3 is a large area that comprises a small population of 1,175 people and encompasses the Anahuac and Moody NWRs. The minority groups contributing to the elevated overall percentage include 28.7 percent Hispanic or Latino, 20.6 percent in Some Other Race, and 13.5 percent Black or African American. Since the block group encompasses such a large area, more analysis is needed to determine how the minority populations are dispersed within this area.

Two other block groups within the economic study area are just below the standard 50 percent guideline on minority presence: Census Tract 113.01 Block Group 1 in Jefferson County and Census Tract 7104 Block Group 3 in Chambers County. Census Tract 113.01 Block Group 1 in Jefferson County is composed of 46.8 percent minority, which includes 25.7 percent Hispanic or Latino and 19.5 percent Black or African American. Census Tract 7104 Block Group 3 in Chambers County is composed of 45.9 percent minority, which includes 28 percent Black or African American, 9.4 percent Hispanic or Latino, and 7.1 percent in Some Other Race.

4 Environmental Protection Agency, Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analysis, 1998.

Table 3-33
Poverty and Ethnicity Composition of the Economic Study Area (2000) Source: US Census Bureau

	Percent Poverty	Percent Minority							Percent Total Minority
	1999	Black or African American	American Indian or Native Alaskan	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Two or more races	Hispanic or Latino (of any race)	
Jefferson County	**17.4%**	30.5%	0.3%	2.6%	-	3.9%	1.4%	9.5%	**48.2%**
Census Tract 116	**8.5%**	1.3%	0.2%	0.4%	0.1%	2.8%	1.6%	6.1%	**12.6%**
Block Group 1	**4.1%**	3.7%	-	1.5%	-	-	-	6.7%	**11.9%**
Block Group 2	**11.5%**	1.5%	-	1.9%	-	-	0.5%	5.7%	**9.6%**
Census Tract 113.01	**7.2%**	12.8%	0.3%	0.5%	0.1%	0.9%	0.8%	17.4%	**32.8%**
Block Group 1	**6.5%**	19.5%	0.3%	0.4%	0.1%	0.1%	0.7%	25.7%	**46.8%**
Block Group 2	**9.8%**	0.5%	0.1%	-	0.2%	1.6%	0.7%	5.4%	**8.6%**
Block Group 3	**6.0%**	4.4%	0.3%	1.1%	-	2.3%	1.1%	5.3%	**14.5%**
Chambers County	**11.0%**	8.8%	0.4%	0.6%	-	5.4%	1.1%	9.7%	**26.1%**
Census Tract 7104	**14.4%**	10.9%	0.6%	0.2%	-	5.5%	0.8%	8.9%	**26.8%**
Block Group 1	**18.8%**	5.3%	0.6%	0.5%	-	4.8%	1.0%	9.6%	**21.7%**
Block Group 2	**9.7%**	4.4%	0.7%	-	-	5.3%	0.6%	8.8%	**19.9%**
Block Group 3	**18.8%**	28.0%	0.6%	-	-	7.1%	0.7%	9.4%	**45.9%**
Block Group 4	**8.5%**	2.4%	0.6%	0.4%	-	4.2%	0.8%	7.1%	**15.5%**
Block Group 5	**-**	-	-	-	-	-	-	-	**-**
Census Tract 7105	**17.5%**	8.0%	0.5%	2.3%	-	13.2%	1.4%	18.4%	**43.8%**
Block Group 1	**12.3%**	7.6%	0.1%	0.4%	-	8.8%	1.7%	11.7%	**30.2%**
Block Group 2	**20.0%**	2.5%	1.4%	6.8%	-	10.7%	0.7%	15.4%	**37.5%**
Block Group 3	**22.0%**	13.5%	0.1%	0.1%	-	20.6%	1.8%	28.7%	**64.8%**
Galveston County-Bolivar Peninsula									
Census Tract 7239	**11.7%**	0.4%	0.8%	0.5%	-	2.6%	1.6%	6.5%	**12.4%**
Block Group 1	**15.6%**	0.1%	0.9%	0.5%	-	0.1%	1.1%	2.8%	**5.6%**
Block Group 2	**10.0%**	0.5%	0.9%	0.7%	-	1.4%	1.1%	3.8%	**8.3%**
Block Group 3	**11.7%**	1.0%	0.5%	0.2%	-	7.8%	2.7%	16.9%	**29.1%**
Block Group 4	**10.9%**	-	0.6%	0.5%	-	2.3%	1.8%	4.8%	**9.9%**
Primary Study Area	**11.9%**	8.9%	0.5%	0.8%	-	4.4%	1.1%	13.3%	**28.9%**
Secondary Study Area	**14.2%**	28.5%	0.3%	2.4%	-	4.0%	1.3%	9.5%	**46.1%**
Texas	**15.4%**	8.7%	0.4%	2.0%	0.1%	8.9%	1.9%	24.2%	**46.2%**

b. Household Income Levels

The median household income for the secondary study area is $41,335 and $39,064 in the primary study area, which is comparable to the statewide median income of $39,927. Incomes within the study area are dispersed from less than $10,000 to more than $100,000, within incomes concentrated near the middle to lower end of the scale. An estimated 22.1 percent of households in the secondary study area, 17.9 percent of the households in the primary study area, and 17 percent of the households in Texas have incomes less than $15,000. Whereas, 31.5 percent of the households in the secondary study area, 36.2 percent of the households in the primary study area, and 30.6 percent of the households in Texas have incomes less than $25,000.

(1). Low-income Populations

Shown in Figure 3.11, low-income populations are present in the economic study area, but poverty rates have declined in the past decade. The primary study area displays the biggest change in poverty rates declining from 17.8 percent in 1989 to 11.9 percent in 1999. The secondary study area displayed a slight decrease in poverty declining from 15.9 percent to 14.2 percent. Statewide poverty rates have decreased in the past decade as well, from 18.1 percent in 1989 to 15.4 percent in 1999.

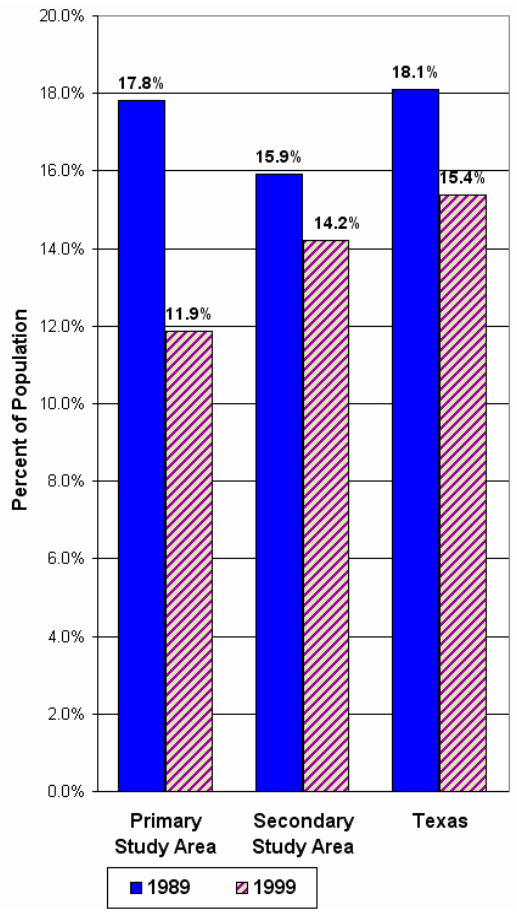


Figure 3.11
Poverty for the Economic Study Area (1999 vs. 1989) Source: US Census Bureau

Table 3-33 displays percent poverty by census tract and block group. None of the areas are above 25 percent poverty, however, two block groups are slightly above 20 percent poverty and two block groups are just below 20 percent, all are within Chambers County. Census Tract 7105 Block Groups 2 and 3 in Chambers County both exceed 20 percent poverty at 20 and 22 percent, respectively. Census Tract 7105 Block Group 3 is a large area that comprises a small population of 1,175 people, of which 64.8 percent are minority, and encompasses the Anahuac and Moody National Wildlife Refuges. Census Tract 7105 Block Group 2 encompasses the outskirts of Anahuac and has a population of 1,304 people, of which 37.5 percent are minority.

Two block groups are just below 20 percent with poverty rates both at 18.8 percent, Census Tract 7104 Block Groups 1 and 3 in Chambers County. Census Tract 7104 Block Group 1 encompasses the western part of Winnie and has a population of 1,408 people. Census Tract 7104 Block Group 3 encompasses the Stowell area and has a population of 1,572 people.

(2). Housing

The economic study area has experienced increases in housing units over the last decade. The secondary study area experienced a 2.8 percent increase in housing units and the primary study area experienced a 15 percent increase in housing units. Statewide, housing units increased by 16.4 percent. Chambers County experienced the largest increase countywide with a 28.2 percent increase over the last decade. Within the primary study area, Census Tract 7239 Block Group 4 in Galveston County, which encompasses the northern half of the Bolivar Peninsula, experienced the largest increase at 33.9 percent from 660 units to 884 units. Census Tract 7104 in Chambers County,

which encompasses Winnie and Stowell extending down towards the Gulf, experienced the second largest increase at 20.6 percent.

The secondary study area has a 9.2 percent vacancy rate, which is comparable to the state vacancy rate of 9.4 percent. In comparison, the primary study area has a high vacancy rate of 35.7 percent. The high vacancy rate is primarily attributed to Census Tract 7239 on the Bolivar Peninsula in Galveston County, which has a vacancy rate of 66.8 percent due to the large amount of vacation homes on the Peninsula.

Housing units in the economic study area are mostly owner-occupied. An estimated 32.4 percent of the occupied units are rented in the secondary study area, while 17.7 percent of the units in the primary study area are rented. The secondary study area has a median home value of $72,200 and a median rent value of $482. The primary study area has a median home value of $61,140 and a median rent value of $499. Both study areas are below the statewide average of an $82,500 median home value and $574 median rent value.

E. Governmental Infrastructure / Services

1. Chambers County

Chambers County is surrounded by industrial cities, including Beaumont, Port Arthur, and the eastern portion of the Houston Metropolitan Area. The County has barge access to the Houston Ship Channel, is in close proximity to the Houston Port Authority, and commercial air service facilities are available at William P. Hobby Airport and George Bush Intercontinental Airport in Houston. Anahuac, Winnie, and Smith Point are the major cities/towns within the primary study area in Chambers County.

a. Utilities

Utilities are provided by several major carriers including Entergy-Texas and Reliant Energy HL&P for electricity needs. Trinity Bay Conservation District and the cities of Anahuac and Mont Belvieu provide water and sewer. Reliant Energy Entex, as well as the cities and privately owned gas distribution companies, provide natural gas, propane, and butane. Verizon provides telecommunications service to the west side of Chambers County, while Texas Alltel services the central and eastern sections of the County with fiber optics.

b. Transportation

Interstate Highway 10 (I-10) extends across the County in an east-west direction. Four major State Highways also serve the County. State Highway (SH) 146 connects Mont Belvieu with US 90 to the north and Baytown to the south. SH 61 connects Anahuac to I-10 on the north and proceeds to US 90. SH 65 extends east and west from Anahuac to SH 124 in Stowell. At that point, SH 124 then connects the Winnie-Stowell area with I-10 and SH 73 to the north and proceeds south to SH 87, which provides access to the Bolivar Peninsula and Galveston Island.

Major connections to the County include the Grand Parkway project and the Fred Hartman Bridge. The Grand Parkway project is a planned 155-mile freeway that will encircle the Houston area and extend through the western portion of Chambers County. The Fred Hartman Bridge is an eight-lane suspension bridge that connects Baytown and LaPorte.

Union Pacific and Southern Pacific Railroads serve the western portion of Chambers County. These railways provide links to the Missouri Pacific Railway in Liberty County and offers service to industrial tracts in that area.

Chambers County has one private airport and two county airports for light planes. The Tom Jenkins Memorial Airport in Winnie has a 3,600-foot lighted runway with fueling stations and hangars. The Oscar

F. Nelson, Jr. Memorial Airport in Anahuac has 3,003 feet of lighted runway (a 3,700 extension is planned) with a pilot's lounge, fueling stations, and hangars.

The west side of Chambers County has two major airports located within 30 miles of the area. The George Bush Intercontinental Airport in north Houston and William P. Hobby Airport in south Houston provide passenger and cargo services throughout the United States and to 29 foreign markets. The Jefferson County Airport in Beaumont is approximately 30 miles from the eastern portion of the county and also provides passenger and cargo service. In addition, Houston and Beaumont are served by every major overnight delivery service in the United States.

The nearest navigable waterway (40 feet) is the Intracoastal Waterway, located 11 miles south of Winnie on State Highway 124. Kiva Construction and Galveston Bay Construction/Thornton Marine in Oak Island provide public barge docks on Double Bayou. The Houston Ship Channel, operated by the Houston Port Authority, and the Port of Beaumont are both located approximately 35 minutes from the west and east sides of the County. In addition to these public ports, there are many privately owned shipping terminals in the Houston-Galveston and Beaumont-Port Arthur areas.

c. School Districts

Chambers County has three school districts (Table 3-34): Anahuac Independent School District in Anahuac, Barbers Hill Independent School District in Mont Belvieu, and East Chambers Independent School District in Winnie.

Table 3-34
Chambers County School Districts

School District	Location	Students	Teachers
Anahuac Independent School District	Anahuac, TX	1,427	101
Barbers Hill Independent School District	Mont Belvieu, TX	2,703	183
East Chambers Independent School District	Winnie, TX	1,128	82

Source: Chambers County website, http://co.chambers.tx.us/schools.pdf.

d. Emergency Services

The Cities of Anahuac, Beach City, and Cove provide volunteer emergency and fire departments. The communities of Hankamer, Mont Belvieu, Oak Island/Double Bayou, Old River-Winfree, Smith Point, Winnie, and Wallisville also have volunteer emergency and fire departments. [5]

e. City of Anahuac

The City of Anahuac is located primarily in the middle of Chambers County near Lake Anahuac, northeast of the Trinity Bay, at the eastern terminus of State Highway 61.

(1). Utilities

Utilities are provided by Entergy-Texas for electricity needs. The City of Anahuac provides water and sewer. Reliant Energy Entex, as well as the cities and privately owned gas distribution companies provide natural gas, propane, and butane. Texas Alltel services the eastern sections of the County with telephone and fiber optics.

5 (http://co.chambers.tx.us/emsfire.html).

(2). Transportation

Interstate 10 is located six miles north of the city limits and many other state and local highways, such as State Highway 61, Farm Road 562, Farm Road 563, Farm Road 1724, and Jenkins Road, link the area. The Chambers-Liberty Counties Navigation District maintains the Port of Anahuac along the Trinity River at the foot of Miller Street and Bolivar Avenue in Anahuac. The Anahuac Ship Channel connects the port to the Houston Ship Channel via a passage approximately eight feet deep and 120 feet wide. The nearest public barge dock is at Anahuac Towing and Shell Company, with the two deep-water ports, one 32 miles away at the Port of Beaumont, and the other 45 miles to the west at the Port of Houston. Kiva Construction and Galveston Bay Construction/Thornton Marine in Double Bayou also provides use of their loading docks for a fee.

The nearest air service is the Oscar F. Nelson Airport at Anahuac with 5,000 feet of runway. Commercial service is available 35 miles away at Jefferson County Airport and 60 miles at Bush Intercontinental and Hobby Airports. A private airport facility is located on the west side of Chambers County, approximately 20 miles from Anahuac.

(3). School District

The Anahuac Independent School District services this area with three schools, an elementary school, middle school, and high school.

(4). Emergency Services

Anahuac Emergency Corps provides volunteer emergency services and there is one volunteer fire department located within the town boundaries. The County Sheriff's office provides police protection. One hospital is also within the City limits, Bayside Memorial Hospital.

f. Winnie

Winnie is an unincorporated area located off of Interstate 10, exit 829, between Houston and Beaumont. Winnie and Stowell are neighborly communities among rice fields and abundant pasture. Because of its location, the Winnie-Stowell Area has justly earned its motto as the "Crossroad of Southeast Texas".

(1). Utilities

Entergy provides electricity for the Winnie Area, while Entex Gas Company provides natural gas, fuel oil and LP gas are available locally, and the Trinity Bay Conservation District provides water. The Winnie Area has a capacity of 1,080,000 gallons per day (GPD), with an average daily consumption of 581,000 GPD, a peak consumption of 818,000 GPD, and storage capacity of 495,000 gallons. Sanitary sewerage is via the Trinity Bay and landfill is the method for garbage disposal.

(2). Transportation

Interstate 10 and Highways 73 and 124 link the Winnie-Stowell Area to the more urban centers of Beaumont, Port Arthur, Galveston, and Houston.

The nearest navigable waterway is the 40-foot Intracoastal Waterway, located 15 miles south of the Winnie-Stowell area. The area is also surrounded with the deepwater ports of Houston, Port Arthur, and the closest, the Port of Beaumont, 27 miles away. In addition to the deepwater ports, the Anahuac Towing and Shell Company, Galveston Bay Construction/Thornton Marine and Kiva Construction Co. have barge dock available to the public. Anahuac Towing and Shell Company is located 22 miles from Winnie in Anahuac, and Galveston Bay Construction/Thornton Marine and Kiva Construction is located approximately 30 miles from Winnie in Oak Island.

The nearest air service is the Tom Jenkins Airport, which has 3,600 feet of lighted runway. Commercial Air Service is available 30 miles east of Winnie at the Jefferson County Airport, and 65 miles west at either Houston Intercontinental or William F. Hobby Airports.

(3). School District

There is one elementary school in the Winnie Area serving pre-kindergarten through fifth grade with 35 teachers and 509 pupils and one middle school serving grades 6 through 8 had 17 teachers and 237 pupils. One high school serves 9th through 12th grades with 24 teachers and 328 pupils. There are also two vocational technical private schools within 35 miles, one college within 40 miles, and one university within 30 miles. Three libraries are also within the community).[6]

(4). Emergency Services

The community of Winnie has Volunteer Services for fire and EMS. The County Sheriff's Department services unincorporated areas.

g. Smith Point

Smith (Smith's) Point is an unincorporated area that overlooks East Bay and Trinity Bay on Farm Road 562, twenty miles from Galveston in southern Chambers County.[7]

(1). Utilities

Trinity Bay Conservation District provides water to Smith's Point. Sewer service is not provided and the area relies on septic systems. Entergy provides electricity to the east portion of the County and Alltel provides telephone service. Gas is not distributed to this area; rather propane systems with private company servicing are the main supply of gas.

(2). Transportation

Farm Road 562 is the primary method of travel to or from this area. The County Airport, located near Anahuac, is the closest airport.

(3). School District

The Anahuac Independent School District services this area and provides bus services to the schools in Anahuac.

(4). Emergency Services

The community of Smith Point has Volunteer Services for fire and EMS. The County Sheriff's Department provides services to unincorporated areas.

2. Jefferson County

Jefferson County is located on Interstate Highway 10 in the Coastal Plain or Gulf Prairie region of extreme southeastern Texas. A series of lakes extends across the southern part of the county, and beaches overlook the Gulf. Geologically, the county is noted for its Beaumont Clay formation and the Spindletop and Big Hill salt domes, which contain sulfur and petroleum. The county seat, Beaumont, an important shipping point, petrochemical producer, and hospital and nursing home center, is located on the Neches River at the county's approximate midpoint. Incorporated towns include Beaumont, Bevil Oaks,

6 http://winnietexas.com/
7 The Texas State Historical Association, The Handbook of Texas Online, www.tsha.utexas.edu/handbook/online.

China, Groves, Nederland, Nome, Port Arthur, and Port Neches. Sabine Pass is the only major city/town within the primary study area in Jefferson County.

a. Utilities

Utilities throughout the county are provided by the following entities. Entergy provides electricity throughout the county while Mercado Gas Services, Reliant Energy/Entes and Southern Union Gas provide natural gas. Water and sewer service is provided by the cities of Nederland, Beaumont and Port Arthur and the West Jefferson County Municipal Water District in other areas of the county. Southwestern Bell, Birtch, AT&T, MCI Worldcom and others provide telecommunications throughout the county.

b. Transportation

The Gulf Intracoastal Waterway crosses the southern part of the County. The Port Arthur ship canal, on the western shore of Sabine Lake, connects with the Neches and Sabine rivers to provide deepwater ports at Beaumont, Port Arthur, Nederland, and Port Neches.

The Jefferson County Airport in Beaumont is approximately 30 miles from the eastern portion of the county and also provides passenger and cargo service. In addition, Beaumont is served by every major overnight delivery service in the United States.

c. School Districts

Jefferson County has four school districts (Table 3-35): Beaumont Independent School District, Nederland Independent School District, Port Arthur Independent School District, and Port Neches-Groves Independent School District. There is also a university, Lamar University in Beaumont and Port Arthur, and one private high school, Monsignor Kelly Catholic High School in Beaumont.

Table 3-35
Jefferson County School Districts

School District	Elementary Schools	Middle Schools	High Schools	Alternative Education
Beaumont ISD	21	5	3	3
Nederland ISD	4	2	1	1
Port Arthur ISD	9	3	1	2
Port Neches-Groves ISD	6	2	1	2
Sabine Pass ISD (1 all level school)	1	1	1	1
Hamshire- Fannett	2	1	1	1

Source: Jefferson County website, http://co.jefferson.tx.us/links/areaed.htm.

d. Emergency Services

A county jail, a state prison (the Mark Stiles Unit), and a unit of the federal prison system reside in the area. The Jefferson County Sheriff's Department as well as Beaumont, Port Arthur and other cities, provides police and emergency services. Several hospitals and health facilities are located throughout the county including Christus St. Elizabeth, Mid-Jefferson, Christus St. Mary's, Baptist Memorial Hermann Hospital, Park Place, Health South and Doctor's Hospital.

e. Sabine Pass

Sabine Pass is a former town incorporated into Port Arthur. It is located on State Highway 87 at Sabine Pass, thirty miles southeast of Beaumont in extreme southeastern Jefferson County.[8] Information was provided by the Public Works Department in Port Arthur, unless otherwise noted.

8 The Texas State Historical Association, *The Handbook of Texas Online*, www.tsha.utexas.edu/handbook/online.

(1). Utilities

Entergy provides electricity and Southern Union Gas provides gas service. Water and sewer service is provided by the City of Port Arthur.

(2). Transportation

State Highway 87 is the primary means to and from Sabine Pass. Travel on SH 87 north of the area leads to Port Arthur, at which point SH 73 can be accessed to travel west. Potential future improvements to SH 87 west of Sabine Pass would provide an alternate means to access the area and directly link it to the Bolivar Peninsula. The closest airport is located in Beaumont, which is 10 to 12 miles north of the area.

(3). School District

Sabine Pass ISD includes a high school, middle school, and elementary school.

(4). Emergency Services

The Jefferson County Sheriff's Department and City of Port Arthur provide police protection for Sabine Pass. The City of Port Arthur also provides fire service. There are no hospitals within the town boundaries. However, there are several hospitals and outpatient care center located within 20 miles of Sabine Pass. St. Mary Hospital, Port Arthur Day Surgery Center, and Park Place Medical Center are located in nearby Port Arthur. Doctors Hospital is located in Groves and St. Elizabeth Physicians Hospital and Mid-Jefferson Hospital are located in Nederland.

3. Galveston County

The Bolivar Chamber of Commerce provided most information, unless otherwise noted.

Only a small portion of far eastern Bolivar Peninsula in Galveston County is included in the study areas. High Island is the only city/town within the primary or secondary study areas in Galveston County.

a. High Island

High Island is on a tall salt dome on Bolivar Peninsula at the extreme eastern end of Galveston County. Its thirty-eight-foot rise above sea level makes High Island the highest point on the Gulf of Mexico between Mobile, Alabama, and the Yucatán Peninsula (Handbook of Texas Online).

(1). Utilities

Entergy, located in Beaumont, provides electricity and Bolivar Peninsula Water provides water. Sewer service is not available, and homes rely on septic tank systems. Gas service is not available, but private companies provide propane service.

(2). Transportation

State Highway 87 provides access to and across the Bolivar Peninsula. When leaving High Island, travel must detour from SH 87 to I-24 towards Winnie, which connects with I-10 from that point. Ferry service to Bolivar Peninsula is available from Galveston. Future transportation projects may include reconstruction/relocation of SH 87, a bridge to Pelican Island, and an elevated highway that connects to I-45.

The nearest navigable waterway (40 feet) is the Intracoastal Waterway. Kiva Construction and Galveston Bay Construction/Thornton Marine in Oak Island provide public barge docks on Double Bayou. The Houston Ship Channel, operated by the Houston Port Authority, and the Port of Beaumont are both

located approximately 35 minutes from the west and east sides of the County. In addition to these public ports, there are many privately owned shipping terminals in the Houston-Galveston area.

(3). School District
High Island Independent School District houses a high school, middle school, and elementary school with approximately 300 students in grades Kindergarten through 12th grade.

(4). Emergency Services

There are no hospitals in the town. Volunteer fire and emergency services are provided in the area and "911" service is also available. The Galveston County Annex houses a Sheriff's outpost and jail in Crystal Beach.

F. Fiscal Conditions of Local Governments

Lands acquired by the USFWS in fee are removed from the tax rolls, because as an agency of the United States Government, the USFWS, like city, township, county and state governments, is exempt from taxation. Therefore, it is necessary to have an understanding of what entities would be impacted by acquisition of acreage by the USFWS. This section summarizes the potential impacted districts in the study areas.

1. Taxing Districts in Jefferson County

Jefferson and Chambers counties are local government entities that levy taxes and distribute revenues to other county governmental units. Jefferson County distributes revenues to six school districts, four cities, three ports, three drainage districts, and eight other public service entities such as rural fire and emergency service districts. To date, nine taxing districts have been identified as being potentially impacted by land acquisition activities. This includes Jefferson County, Sabine Pass and Hamshire-Fannett Independent School Districts, Drainage District #3 and #6, Port of Port Arthur and the Port of Sabine Pass, Jefferson County Waterways and Navigation District, and Trinity Bay Conservation District. Information was obtained from the Jefferson County Appraisal District on assessed values and tax levies for these districts and is summarized in Tables 3-36 through 3-44.

Table 3-36. Appraised Property Values and Tax Levy, Jefferson County, Texas - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$4,220,923,925	$286,836,655	$10,469,546	23.6%
Commercial/Industrial	$10,620,613,407	$8,822,292,693	$32,201,397	72.5%
Mineral	$142,139,140	$142,139,140	$518,809	1.2%
Other	$413,333,285	$343,346,196	$1,253,215	2.8%
Total	$14,657,208,677	$12,175,397,037	$44,440,239	100.0%

Table 3-37
Appraised Values and Tax Levy, Hampshire-Fannett ISD – 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$136,122,770	$104,787,890	$1,718,521	27.1%
Commercial/Industrial	$166,731,009	$280,253,184	$4,596,152	39.1%
Mineral	$142,139,140	$142,139,140	$518,809	19.1%
Other	$12,012,812	$10,906,900	$178,873	14.7%
Total	$425,986,226	$386,769,506	$6,343,020	100.0%
	$457,005,730	$538,087,114	$7,012,355	

Table 3-38
Appraised Property Values and Tax Levy, Sabine Pass ISD - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$5,718,520	$3,177,554	$53,669	0.8%
Commercial/Industrial	$397,743,339	$280,253,184	$4,596,152	93.4%
Mineral	$14,774,250	$14,774,250	$249,537	3.6%
Other	$12,012,812	$10,906,900	$178,873	2.2%
Total	$425,986,226	$386,769,506	$6,343,020	100.0%

Table 3-39
Appraised Values and Tax Levy, Port of Port Arthur - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$695,349,749	$445,144,665	$584,373	16.3%
Commercial/Industrial	$2,609,680,005	$2,246,578,797	$2,949,240	82.3%
Mineral	$2,386,320	$2,386,320	$3,132	0.1%
Other	$37,370,060	$36,777,048	$48,278	1.3%
Total	$3,344,786,134	$2,730,886,830	$3,585,023	100.0%

Table 3-40
Appraised Values and Tax Levy, Port of Sabine Pass - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$9,044,683	$7,388,035	$21,806	8.8%
Commercial/Industrial	$55,764,680	$55,744,300	$164,529	66.6%
Mineral	$14,773,720	$14,773,720	$43,604	17.7%
Other	$6,227,360	$5,779,624	$17,058	6.9%
Total	$85,810,443	$83,685,679	$246,997	100.0%

Table 3-41
Appraised Values and Tax Levy, Drainage District #3 - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$27,869,840	$18,965,176	$58,362	12.8%
Commercial/Industrial	$67,049,040	$67,049,040	$206,318	45.2%
Mineral	$45,806,970	$45,806,970	$140,965	30.9%
Other	$20,503,866	$16,422,552	$50,537	11.1%
Total	$161,229,716	$148,243,738	$456,182	100.0%

Table 3-42
Appraised Values and Tax Levy, Drainage District #6 - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$2,612,113,491	$1,891,239,192	$3,783,211	37.8%
Commercial/Industrial	$3,004,883,274	$2,925,260,192	$5,851,655	58.4%
Mineral	$64,851,680	$64,851,680	$129,727	1.3%
Other	$142,233,850	$125,642,062	$251,328	2.5%
Total	$5,824,082,295	$5,006,993,126	$10,015,921	100.0%

Table 3-43
Appraised Values and Tax Levy, Jefferson County Waterways and Navigation District - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$4,600,218,102	$3,223,412,333	$1,064,139	26.8%
Commercial/Industrial	$9,569,876,099	$8,466,836,419	$2,796,003	70.3%
Mineral	$141,845,080	$141,845,080	$46,841	1.2%
Other	$786,866,735	$210,791,517	$69,606	1.8%
Total	$15,098,806,016	$12,042,885,349	$3,976,589	100.0%

Table 3-44
Appraised Values and Tax Levy, Trinity Bay Conservation District - 2002

Property Type	Appraised Value	Taxable Value	Tax Levy	Percentage of Total Tax Levy
Residential	$129,690	$129,690	$606	2.6%
Commercial/Industrial	$558,990	$558,990	$2,616	11.2%
Mineral	$877,400	$877,400	$4,108	17.6%
Other	$3,428,620	$3,428,620	$16,055	68.7%
Total	$4,994,700	$4,994,700	$23,385	100.0%

Table 3-45
2002 Tax Rates for Potential Impact Districts in Jefferson County

Code	Tax District	Tax Rate Per $100/Value
01	Jefferson County	0.365
03	Hamshire-Fannett ISD	1.64
13	Sabine Pass ISD	1.689
35	Port of Port Arthur	0.131277
37	Port of Sabine Pass	0.295151
47	Drainage District #3	0.307738
49	Drainage District #6	0.200039
55	Jefferson County Navigational District	0.033023
79	Trinity Bay Conservation District	0.4827

Source: Jefferson County Appraisal District, www.jcad.org

Examination of this data reveals that the districts vary greatly in their dependence on different property classes for tax revenues. For instance, several of the districts are much more dependent on commercial and industrial properties and others such as Hamshire-Fannett ISD and Trinity Bay Conservation District are more dependent on other types of properties for their tax base. This dependence affects potential impacts of land acquisition by the USFWS, and these impacts are evaluated in detail in Chapter 4.

Tax levies for each of these districts is summarized in Table 3-45.

2. Jefferson County

Expenditures incurred by the County are described in Jefferson County's Comprehensive Annual Financial Report (FY 2000). Governmental funds account for the majority of the County's general activities including the collection and disbursement of restricted monies (special revenue funds), the acquisition or construction of general fixed assets (capital project funds), the servicing of general long-term debt (debt service funds), and all activities not accounted for in any other fund (general fund). During fiscal year 2000, revenues totaled $151.2 million compared to total expenditures of $99.5 million. The largest sources of revenue for Jefferson County are bond proceeds at 35.6 percent and property taxes at 28.2 percent as shown in Figure 3.12 on the following page. Most expenditures are attributable to judicial and law enforcement at 49.8 percent, while general government is the second largest expenditure at 11.7 percent (Figure 3.13).

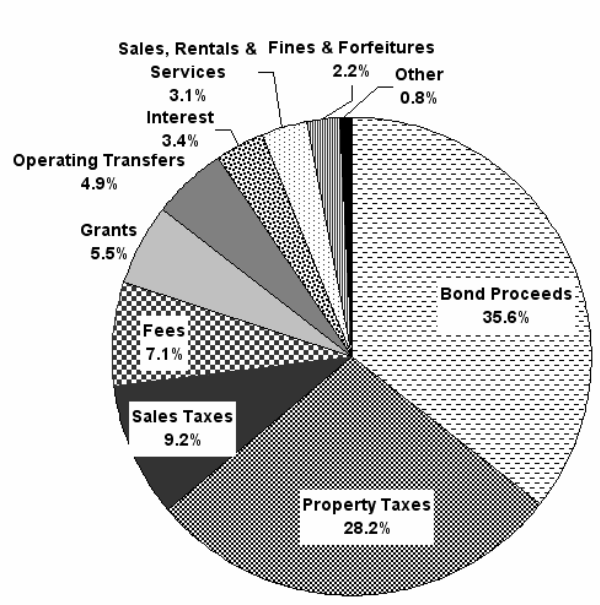


Figure 3.12
Jefferson County Revenues by Source (FY 2000)*

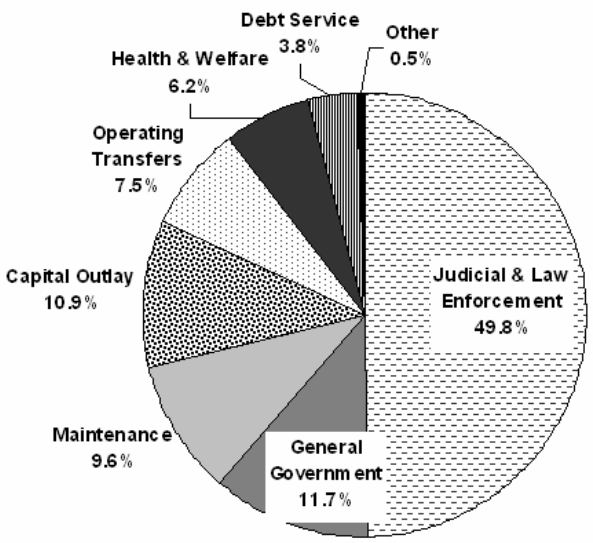


Figure 3.13
Jefferson County Expenditures by Function (FY 2000)*

*Source: Jefferson County, TX Comprehensive Annual Financial Report, 2000.

a. Hampshire-Fannett ISD

The Hampshire-Fannett ISD is located in west-central Jefferson County and includes two elementary schools, one middle school and one high school. The district is also responsible for a juvenile justice alternative education school. Current estimated enrollment is 1,892. Information on District financing was obtained from the Texas Education Agency and is summarized in Table 3-46 for 1996-1997 through 2000-2001.

Table 3-46
Financial Overview - Hamshire-Fannett ISD, Hamshire, Texas

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Revenues					
Property Taxes	$8,655,942	$9,719,299	$9,378,299	$10,133,454	$10,634,887
Other Sources	$104,337	$1,138,889	$3,404	$120,901	$2,300
Total Revenue	$8,760,279	$10,858,188	$9,381,703	$10,254,355	$10,637,187
Expenditures					
Instruction	$5,735,703	$6,110,011	$6,219,615	$6,874,080	$7,163,314
Operations & Other	$3,328,745	$4,407,284	$3,126,183	$3,570,663	$3,818,653
Total Expenditures	$9,064,448	$10,517,295	$9,345,798	$10,444,743	$10,981,967
Balance	-$304,169	$340,893	$35,905	-$190,388	-$344,780

Source: Texas Education Agency, Resource Connection, http:\\lucas.tea.state.tx.us/pai

b. Sabine Pass ISD

The Sabine-Pass ISD is located in southeastern Jefferson County and includes one all level school and one juvenile justice alternative education school. Current estimated enrollment is 155. Information on District financing is summarized in Table 3-47 for 1996-1997 through 2000-2001.

Table 3-47
Financial Overview - Sabine Pass ISD, Sabine Pass, Texas

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Revenues					
Property Taxes	$3,150,012	$4,383,203	$7,707,582	$8,651,960	$7,239,197
"Robin Hood" - Redistribution	-$1,102,006	-$1,818,069	-$4,333,005	-$3,435,570	-$4,620,966
Other Sources	$0	$0	$0	$0	$318,431
Total Revenue	$2,048,006	$2,565,134	$3,374,577	$5,216,390	$2,936,662
Expenditures					
Instruction	$1,230,460	$1,262,695	$1,296,401	$1,166,479	$1,243,481
Operations & Other	$711,593	$729,586	$904,601	$875,227	$1,340,947
Total Expenditures	$1,942,053	$1,992,281	$2,201,002	$2,041,706	$2,584,428
Balance	$105,953	$572,853	$1,173,575	$3,174,684	$352,234

Source: Texas Education Agency, Resource Connection, http:\\lucas.tea.state.tx.us/pai

2. Taxing Districts in Chambers County

Chambers County is responsible for collecting and distributing revenues to four school districts, six cities, and five other public service entities such as Chambers County Hospital, Trinity Bay Conservation District, and Lee College. To date six tax districts have been identified as being potentially impacted by a land acquisition program. This includes Chamber County, Anahuac ISD, East Chambers Consolidated ISD, Chambers County Hospital District, Trinity Bay Conservation District and Chambers-Liberty Navigational District. Information on assessed property values was obtained from the Chamber County Appraisal District and is summarized for each of the potentially impact districts in Tables 3-48 on the following page. Tax levies for each of these districts is summarized in Table 3-49.

Table 3-48
Total Assessed Values for Taxing Districts in Chambers County, Texas - Tax Year 2000

Category	CCPHa	TBCBb	CLNDc	East Chambers ISD	Anahuac ISD	Chambers County
Land - Homestead	$11,627,620	$15,108,110	$50,413,210	$6,985,980	$11,627,620	$82,118,060
Land - Non Homestead	$40,641,470	$57,856,110	$62,338,480	$20,924,020	$42,348,680	$245,820,310
Land - Productive Value	$72,400,080	$104,286,290	$41,983,460	$32,690,740	$72,190,540	$135,206,460
Total Land Market Value	$124,669,170	$177,250,510	$154,735,150	$60,600,740	$126,166,840	$463,144,830
Total Improvements	$150,531,980	$226,994,590	$359,506,600	$130,465,730	$150,521,170	$782,968,380
Total Personal Property	$8,396,290	$20,422,100	$10,735,980	$15,108,100	$7,980,130	$40,439,290
Mineral Value	$0	$0	$0	$0	$0	$0
Total Market Value	$283,597,440	$424,667,200	$524,977,730	$206,174,570	$284,668,140	$1,286,552,500
Productivity Losses (Ag. Lands)	$56,910,390	$80,603,080	$36,168,360	$24,475,150	$56,803,890	$107,779,200
Exemptions	$57,046,000	$57,030,540	$80,387,640	$22,298,960	$58,712,310	$184,742,490
Reimbursable Exemptions	$39,936,570	$60,743,820	$89,451,940	$38,270,920	$55,569,310	$178,452,180
Total Assessed Values – Res., Ag. and Commercial	$129,704,480	$226,289,760	$318,969,790	$112,730,650	$110,340,860	$815,578,630
Total Net Taxable Values - Minerals	$82,221,900	$108,096,570	$85,360,630	$26,336,180	$81,756,140	$140,664,600
Total Net Taxable Values – Industrial	$46,522,670	$70,041,160	$81,361,220	$29,027,860	$45,144,940	$2,735,607,590
Total Net Taxable Values – All Property	$258,449,050	$404,427,490	$485,691,640	$168,094,690	$237,241,940	$3,691,850,820

Source: Chambers County Appraisal District

a. Chambers County Public Hospital District b. Trinity Bay Conservation District c. Chambers Liberty Navigation District

Table 3-49 2002 Tax Rates for Potential Impact Districts in Chambers County

Code	Tax District	Tax Rate Per $100/Value
01	Chambers County	0.528645
33	East Chambers Cons. ISD	1.65
30	Anahuac ISD	1.500
60	Chambers-Liberty Nav. District	0.02850
49	Drainage District #6	0.200039
65	Hospital District	0.75000
79	Trinity Bay Conservation District	0.4827

Source: Chambers County Appraisal District, www.chambersad.org

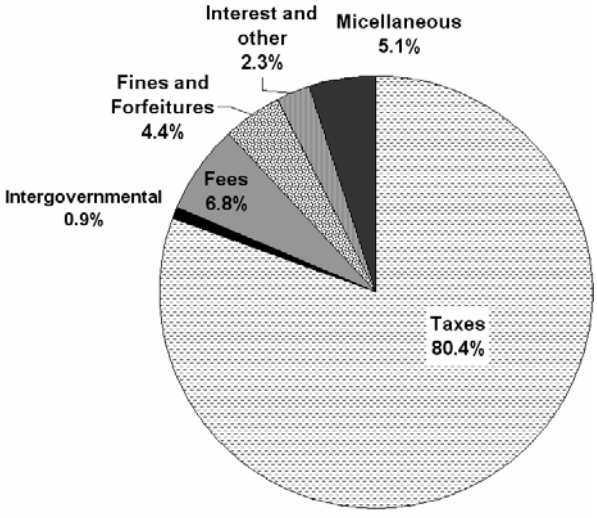


Figure 3.14
Chambers County Revenues by Source (FY 2001)
Source: Chambers County, Texas Comprehensive Annual Financial Report, 2001.

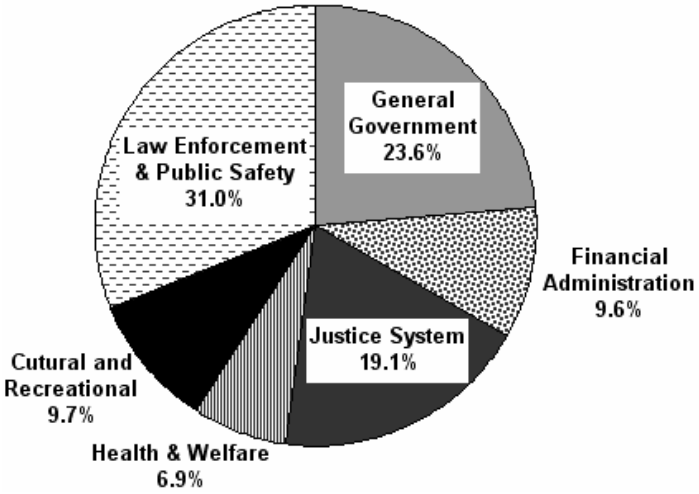


Figure 3.15
Chambers County Expenditures by Function (FY 2001)
Source: Chambers County, Texas Comprehensive Annual Financial Report, 2001.

The current fiscal condition of Chambers County is described in Chamber County's Comprehensive Annual Financial Report (FY 2001). The general fund is used to account for expenditures of traditional governmental services as well as financial resources other than those required and accounted for in other funds. Total county revenues totaled $14,043, 803 in 2001, 80.4% of which is funded by property taxes (Figure 3.14). Major expenditures include law enforcement and public safety at 31 percent, 23.6 percent for general government, and 19.1 percent for the justice system (Figure 3.15).

a. Anahuac ISD

The Anahuac ISD is located in western section of Chambers County and includes one elementary school, one middle school, one high school and one all level school. In addition the district supports one alternative school and two disciplinary alternative educational schools. Current estimated enrollment is 1,427. Information on District financing is summarized in Table 3-50 for 1996-1997 through 2000-2001.

Table 3-50
Financial Overview – Anahuac ISD, Anahuac, Texas

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Revenues					
Property Taxes	$7,850,728	$8,933,511	$8,322,941	$9,636,820	$9,372,143
"Robin Hood" - Redistribution	$0	$0	$0	$0	-$133,704
Other Sources	$0	$0	$0	$0	$0
Total Revenue	$7,850,728	$8,933,511	$8,322,941	$9,636,820	$9,238,439
Expenditures					
Instruction	$5,070,125	$5,330,530	$6,142,559	$6,730,956	$5,774,210
Operations & Other	$2,467,204	$2,572,775	$2,514,605	$2,816,874	$2,914,241
Total Expenditures	$7,537,329	$7,903,305	$8,657,164	$9,547,830	$8,688,451
Balance	$313,399	$1,030,206	-$334,223	$88,990	$549,988

Source: Texas Education Agency, Resource Connection, http:\\lucas.tea.state.tx.us/pai

b. East Chambers ISD, Winnie, Texas

The East Chambers ISD is located in eastern section of Chambers County and includes one elementary school, two middle schools, and one high school. In addition the district supports one alternative school and one disciplinary alternative educational school. Current estimated enrollment is 1,128. Information on district financing is summarized in Table 3-51 for 1996-1997 through 2000-2001.

Table 3-51
Financial Overview - East Chambers ISD - Winnie, Texas

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Revenues					
Property Taxes	$6,313,965	$6,228,551	$6,390,535	$7,398,861	$7,415,220
Other Sources	$24,000	$0	$0	$144,191	$20,997
Total Revenue	$6,337,965	$6,228,551	$6,390,535	$7,543,052	$7,436,217
Expenditures					
Instruction	$3,792,192	$4,189,908	$3,965,471	$4,493,498	$4,497,195
Operations & Other	$2,061,995	$2,760,595	$2,964,073	$3,081,351	$4,189,850
Total Expenditures	$5,854,187	$6,950,503	$6,929,544	$7,574,849	$8,687,045
Balance	$483,778	-$721,952	-$539,009	-$31,797	-$1,250,828

Source: Texas Education Agency, Resource Connection, http:\\lucas.tea.state.tx.us/pai

3. Taxing Districts in Galveston County

The large majority of the property tax base in Galveston County is located on Galveston Island or on the adjoining mainland south of Houston. The value of taxable real estate in Galveston County exceeds $15,000,000,000 and generates tax revenues of around $90 million per year. However, land acquisition would involve only a small portion of the far eastern end of Bolivar Peninsula and consists of low-elevation, lower-valued agricultural lands. The acquired lands would be an extremely small percentage of the total tax base in Galveston County and generate little fiscal impact on local government entities.

Land acquisition activities would potentially impact only three taxing districts: Galveston County, High Island ISD, and Galveston County Road and Flood. The property tax rates for these three taxing districts are summarized in Table 3-52.

Table 3-52
2002 Tax Rates for Potential Impact Districts in Galveston County

Code	Tax District	Tax Rate Per $100/Value
GGA	Galveston County	0.5939
S13	High Island ISD	1.5
RFI	Galveston Co. Road and Flood	0.0124

Source: Galveston County

4. Refuge Revenue Sharing Payments

Lands acquired by the USFWS in fee are removed from the tax rolls, because as an agency of the United States Government, the USFWS, like city, township, county and state governments, is exempt from taxation. Those lands in which the USFWS only acquires a conservation easement remain on the tax rolls and the tax obligation remains with the private landowner. The Refuge Revenue Sharing Act (the Act of June 15, 1935, as amended in 1978 by Public Law 95-469) or (16 U.S.C. 715s) authorizes the USFWS to make payments to the county or other local unit of government to offset the tax losses for lands administered solely or primarily by the USFWS.

The net income the USFWS receives from the sale of products or privileges on refuges (like timber sales, grazing fees, right-of-way permit fees, etc.) is deposited in the National Wildlife Refuge Fund for revenue sharing payments. Originally, 25% of the net receipts collected from the sale of various products or privileges from refuge lands were paid to the counties in which they were located. However, if no revenue was generated from the refuge lands the county received no payment. The Refuge Revenue Sharing Act

was amended in 1964 to allow a payment of either 1) 25% of the net receipts, 2) ¾ of 1% of the adjusted purchase price of refuge land, or 3) 75 cents per acre, whichever was greater, on acquired lands. Payments still had to be made out of refuge receipts in the National Wildlife Refuge Fund. Beginning in Fiscal Year 1976, the refuge receipts were not sufficient to make the county payments and the payments were reduced accordingly. Partly because of this, the Refuge Revenue Sharing Act was again amended in 1978. This amendment allowed Congress to appropriate funds to make up any shortfall in the revenue sharing fund. It also approved use of the payments for any governmental purpose; whereas, before, the payments could only be used for roads and schools.

Because refuge receipts have not kept up with the general increase in property values, the ¾ of 1% of market value of refuge lands has effectively become the largest amount of refuge revenue sharing payment allowable under the Act since 1976. Initially, Congress appropriated the additional funds necessary to make the largest payment, but only through Fiscal Year 1980. Since that time, Congress has not appropriated sufficient additional funds to make the largest payment allowed by law. If the amount Congress appropriates is not enough to match the largest payment allowable, the units of local government receive a pro-rata share. Even without the full supplemental appropriations, the dollar amount of Refuge Revenue Sharing payments is substantial and significantly offsets the local tax losses. In some instances, largely for lands subject to the agricultural exemption, the Refuge Revenue Sharing payments have been equal to or even greater than the amount paid in taxes while in private ownership. The USFWS supports full Congressional appropriations to achieve the maximum Refuge Revenue Sharing payments.

Table 3-53
Annual Refuge Revenue Sharing Payments to Chambers, Jefferson and Galveston Counties, Texas

	Refuge (County)	Acreage	Payment
1995	Anahuac (Cham.)	30,515 acres	$44,966
	McFaddin (Jeff.)	46,642 acres	$50,837
	Texas Point (Jeff.)	8,952 acres	$9,488
1996	Anahuac (Cham.)	31,796 acres	$51,786
	McFaddin (Jeff.)	47,145 acres	$56,919
	Texas Point (Jeff.)	8,952 acres	$10,462
1997	Anahuac (Cham.)	31,796 acres	$47,276
	McFaddin (Jeff.)	47,145 acres	$51,963
	Texas Point (Jeff.)	8,952 acres	$9,551
1998	Anahuac (Cham.)	31,796 acres	$44,492
	McFaddin (Jeff.)	47,145 acres	$48,902
	Texas Point (Jeff.)	8,952 acres	$8,988
1999	Anahuac (Cham.)	34,066 acres	$48,235
	Anahuac (Galv.)	167 acres	$236
	McFaddin (Cham.)	1,281 acres	$557
	McFaddin (Jeff.)	47,150 acres	$49,199
	Texas Point (Jeff.)	8,952 acres	$9,346
2000	Anahuac (Cham.)	34,066 acres	$42,313
	Anahuac (Galv.)	167 acres	$207
	McFaddin (Cham.)	1,281 acres	$1,546
	McFaddin (Jeff.)	47,150 acres	$43,159
	Texas Point (Jeff.)	8,952 acres	$8,199
2001	Anahuac (Cham.)	34,066 acres	$43,188
	Anahuac (Galv.)	167 acres	$211
	McFaddin (Cham.)	1,281 acres	$1,578
	McFaddin (Jeff.)	47,150 acres	$44,052
	Texas Point (Jeff.)	8,952 acres	$8,369
2002	Anahuac (Cham.)	34,066 acres	$35,922
	Anahuac (Galv.)	167 acres	$176
	McFaddin (Cham.)	1,281 acres	$932
	McFaddin (Jeff.)	47,150 acres	$34,289
	Texas Point (Jeff.)	8,952 acres	$7,323
2003	Anahuac (Cham.)	34,066 acres	$34,526
	Anahuac (Galv.)	167 acres	$169
	McFaddin (Cham.)	1,281 acres	$895
	McFaddin (Jeff.)	47,150 acres	$32,957
	Texas Point (Jeff.)	8,952 acres	$7,039
2004	Anahuac (Cham.)	34,066 acres	$30,538
	Anahuac (Galv.)	167 acres	$150
	McFaddin (Cham.)	1,281 acres	$792
	McFaddin (Jeff.)	47,150 acres	$29,150
	Texas Point (Jeff.)	8,952 acres	$6,226

Table 3-53 represents a recent ten-year history (1995-2004) of refuge revenue sharing payments for the Refuge Complex. The table breaks down the payments by refuge, county, and acreage for each year. All lands acquired in the future or lands donated in the future to the refuges would be included in the calculation and payment of Refuge Revenue Sharing payments. The market value for newly acquired lands is initially the purchase price; however, the USFWS reappraises the market value of all the lands in a refuge once every 5 years to keep the market value of the lands updated for refuge revenue sharing purposes. The Refuge Revenue Sharing payments are usually made during the first quarter of each calendar year. By law the USFWS make the payments to the unit of local government that levies and collects general purpose real property taxes, which in Texas, is the county government.

G. Social Conditions

1. Social Conditions / Structures

The two major institutional entities (Chambers and Jefferson counties) within the secondary study area have different social conditions and structures. The factors contributing to these differing social conditions/structures include:

- Geography
- Economic activity
- Population density
- Lifestyles

Physically, Chambers County is divided by the Trinity River, Trinity Bay, and the consequences of these two features. This division is evident in the fact that local residents refer to that part of the County on the Baytown side of the river as “west Chambers County”, while the rest of the County is known as “Mid and East Chambers County”. The geographic separators between the two parts of the County limit the amount of interaction between these two areas. Further, the social separation in Chambers County appears in the location and type of economic activity in the area. Manufacturing, petroleum refining and industrial support activities can be found in the western part of the county. The eastern portion is not industrialized, with most of its employment focused on agriculture, mineral extraction services, small businesses, and government.

In contrast to Chambers County, Jefferson County presents a more compact and cohesive social and economic structure. The population lives primarily in urbanized areas (Beaumont and Port Arthur) and the base economy of the county is oriented to petroleum refining and petrochemical processing. There are no natural barriers to interchange between cities or other areas, and to some extent natural geographic features have benefited economic growth through access to the Sabine River and the port facilities in Beaumont and Port Arthur.

The Bolivar Peninsula region within the primary study area is in Galveston County. Similar to Chambers County, this area is geographically separated from the remainder of Galveston County by Galveston Bay. The portion of Galveston County not within the primary study area (e.g., west of Galveston Bay) is a heavily populated and industrial area tied closely to the Houston metroplex. The population living within the Bolivar Peninsula area (e.g., east of Galveston Bay) is very isolated from the social fabric of the remainder of Galveston County. From a social perspective, persons living within the Bolivar Peninsula area would be more closely aligned to Chambers County.

Much of the history and social culture in the secondary and primary study areas includes use of natural areas, such as those managed by the USFWS on the Refuge Complex, for hunting and fishing as both a recreational opportunity and as a lifestyle. Past public comment has provided a perspective that access to Gulf Coast areas for hunting and fishing is important to a vocal constituency within the two counties. Since these recreational opportunities may not have large economic implications, impacts of USFWS activities on hunting and fishing are likely to be more from the social perspective than from the economic perspective. Beyond recreation, USFWS activities have had, and will likely continue to have, effects on other established lifestyles in the area such as agriculture. In general, individual control of one’s land is also an important social and cultural consideration in the area, which may be inconsistent with the USFWS activities and goals. Other stakeholders may be affected in different ways by USFWS activities.

2. Stakeholder Categories

Stakeholders are those persons and/or groups within existing social structures that have an identified interest in some activity or process. Within the study area for this evaluation, several stakeholder categories have been identified as having potential interest in the existing and future management of the Texas Chenier Plain Refuge Complex:

- Residents and/or employees within the study area
- Land owners within the study area
- Recreationalists, including all of those who visit the Refuge Complex
- Governmental or quasi-governmental agencies, including representatives of these organizations
- Businesspersons and/or business owners
- Conservationists or environmental protection advocates

Stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. The general relationships between the USFWS and Stakeholder Groups are described below:

Residents and / or Employees – Those persons who live and/or work in the study area are likely to be linked to the Refuge Complex by direct and/or indirect means. Direct relationships could include visitation to the refuges, participation in volunteer programs, or simply driving by the refuges. Indirect relationships could include awareness of the refuge activities (e.g., but not direct participation), and an associated opinion or perspective on USFWS activities and management.

Land Owners – Land owners within the study area may or may not have a relationship with the USFWS. Any direct relationship would depend on proximity to Refuge Complex land holdings, and/or the opportunity to sell lands to the USFWS as part of the efforts to acquire additional land. A landowners' choice of land use could be directly or indirectly affected by USFWS activities, depending on circumstances.

Recreationalists – In addition to usage by local residents, visitors to the Refuge Complex come from other areas as well including regionally, nationally, and internationally. For example, the Refuge Complex is within an hour's drive for over five million people in the Houston Metroplex and Golden Triangle regions, ensuring a continual and growing demand for public use opportunities. Ecotourism is expanding rapidly in Texas (as it is in most regions of the country and internationally), and has become one of the state's leading industries. The USFWS seeks to provide quality opportunities for compatible wildlife-oriented recreation including waterfowl hunting, recreational fishing, wildlife observation and photography and environmental education and interpretation.

Governmental or Quasi-Governmental Agencies - Governmental agencies and representatives of these agencies are in some cases responsible for direct interaction, communication, and coordination with the USFWS. With the Refuge Complex extensive land holdings in Chambers and Jefferson counties, county government officials are generally very aware of USFWS activities and relationships to government and citizens alike. Primary relationships of the Refuge Complex to government agencies in the study area include fiscal links (revenues and expenditures) and provision of services. Governmental agencies would have a substantial interest in understanding the effects of potential land acquisitions by the USFWS and how management activities within the Refuge Complex could affect the governmental jurisdictions and residents of these jurisdictions.

Businesspersons and / or Business Owners – The study area includes businesspersons and/or business owners who have direct and indirect relationships with the Refuge Complex. Direct relationships could include opportunities to do business with the USFWS. Indirect relationships could include the indirect benefits of USFWS activities on the local and regional economies.

Conservation or Environmental Protection Advocates – Lands held by the USFWS and associated management activities on these lands represent a conservation and environmental protection advocacy to some persons. Those individuals supporting conservation or environmental protection advocacy are not necessarily local study area residents and are not necessarily visitors to the Refuge Complex.