

# CHAPTER 4: ENVIRONMENTAL IMPACT ANALYSIS

## Introduction

This Chapter analyzes the environmental impacts from the actions proposed in the alternatives presented in Chapter 2 of this document. This Chapter is organized in the same way as Chapter 2 with a separate section addressing the impacts relating to each of the two separate, but related, sets of alternatives for 1) Refuge Management and 2) Refuge Boundary Expansion. The terms impacts, consequences, and affecting / effects all mean the same thing in the context of this chapter. An action affects the physical environment if it changes the physical environment; and, effects on the human environment from changes in the physical environment are addressed as the socio-economic effects.

The National Environmental Policy Act (NEPA) requires that all of the significant environmental effects must be addressed within an Environmental Impact Statement (EIS). This includes the beneficial as well as the negative effects and the direct as well as the indirect effects. A direct effect is caused by the agency action and occurs at the same time and place. An indirect effect is also caused by the agency action but occurs later in time or is further removed in distance than a direct effect; however, the indirect effect must be reasonably foreseeable to be included in the EIS. The cumulative effects must also be considered in an EIS. A cumulative effect results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless whether undertaken by Federal agency, non-Federal agency or private individuals. This Chapter provides a reasonably thorough discussion of the significant aspects of the probable environmental consequences of the proposed actions.

**This Chapter has three (3) parts:**

- 1. Part A - Impact Analysis for the Five Refuge Management Alternatives**
- 2. Part B - Impact Analysis for the Four Refuge Boundary Expansion Alternatives**
- 3. Part C - Combined and Cumulative Impacts Analysis**

Part A consists of the discussion of the probable environmental consequences associated with the five Refuge Management Alternatives proposed in Chapter 2, including the “No Action Alternative” of continuing current management activities. Part B consists of the discussion of the probable environmental consequences associated with the four Refuge Boundary Expansion Alternatives proposed in Chapter 2, including the “No Action Alternative” of not expanding any of the refuge boundaries. Part C consists of a discussion of the probable environmental consequences associated with combining the two Preferred Alternatives, one from each of the two separate but related sets of alternatives. Part C also includes a discussion of the cumulative impacts associated with the two combined Preferred Alternatives.

## **PART A: IMPACT ANALYSIS FOR THE FIVE REFUGE MANAGEMENT ALTERNATIVES**

### **Summary of Refuge Management Alternatives**

The five Refuge Management Alternatives (A - E) are listed below with a short summary for each.

#### *Refuge Management Alternative A: (NEPA No Action Alternative) Continuation of Current Management*

Under this Alternative, current management programs on the Refuge Complex would continue unchanged. Management of wetland habitats including coastal marsh and prairie wetlands to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory birds would continue at current levels and intensities using prescribed burning, grazing, water level and salinity management, rice farming, moist soil management, and mowing and haying. Restoration and protection of native habitats including wetlands, prairie and woodlands would proceed at current annual acreage rates and using existing techniques. The Refuge Complex would continue to provide opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation through the use of existing programs and facilities.

#### *Refuge Management Alternative B: Emphasis on Intensifying Management of Wetland Habitats for Waterfowl, Shorebirds, Wading Birds, and Other Wetland-Dependent Migratory Birds*

Under this Alternative, the Refuge Complex would focus its management efforts on active management of wetland and upland habitats to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory and resident birds. In marsh habitats, grazing intensity, annual prescribed burn acreage and the frequency of burning would be increased to substantially increase the amount of marsh habitat in early successional plant communities. Two new marsh semi-impoundments totaling 7,500 acres would be constructed and water management capabilities enhanced in existing impoundments through installation of new control structures and levees. The cooperative rice farming program, moist soil management, and haying and mowing programs on Anahuac NWR would be expanded to enhance shallow fresh water wetland habitats and adjacent upland prairies for resident Mottled Ducks, and for wintering and migrating waterfowl shorebirds and wading birds. The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses, with an emphasis on providing more public hunting opportunities.

#### *Refuge Management Alternative C: Emphasis on Native Habitat Restoration and Addressing Major Threats to the Ecosystem*

Under this Alternative, the Refuge Complex would focus its management efforts on restoring wetlands, native prairie and woodlots, and on reversing trends of loss and degradation of these native habitats by increasing efforts to address coastal erosion, saltwater intrusion, and loss of freshwater and sediment inflows. Restoration of native prairie and prairie wetlands would occur on all suitable upland sites. A portion of the historic fresh and intermediate component of the Refuge Complex's coastal marshes would be restored and ongoing interior marsh loss addressed by working with agencies and other stakeholders on major hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion across watersheds, and through refuge-specific projects. Efforts to address coastal wetland loss resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW would be intensified by increasing coordination among agencies and other stakeholders to develop and implement major projects aimed at stabilizing shorelines, and by implementing smaller scale projects on the Refuge Complex. The Refuge Complex would continue to provide the current level of opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses.

*Refuge Management Alternative D: (Preferred Alternative) Emphasis on an Integrated Management Approach Combining: 1) Expanded Habitat Management and Restoration Programs, 2) New Research and Wildlife Population Monitoring, and 3) Increased Efforts to Address Major Threats to the Ecosystem*

Under this Alternative, the Refuge Complex would continue and expand current habitat management and native habitat restoration programs, with increased monitoring and research to assess management actions and facilitate an adaptive management approach. Wetland habitat management activities for waterfowl, shorebirds and other wetland-dependent migratory birds including prescribed burning, controlled grazing, management of marsh semi-impoundments, and moist soil management would be refined and expanded through development of new infrastructure. Concurrently, additional restoration of native habitats including wetlands, prairie and woodlots would be undertaken to benefit a variety of native fauna, with a focus on priority species identified as in need of conservation actions through national and international conservation initiatives.

Additional shoreline protection and hydrologic restoration projects would be implemented on the Refuge Complex and coordination with other agencies would be expanded to address shoreline erosion and interior marsh loss on a landscape scale. Implementation of major projects that protect, restore and enhance coastal marshes by restoring freshwater inflows, providing sediments through the beneficial use of dredge materials, restricting saltwater intrusion, and protecting shorelines would be the goal of this interagency coordination and cooperation. Through new partnerships with universities and other agencies, additional research and monitoring would be conducted to assess the impacts of relative sea level rise and to gather baseline data on fish and wildlife populations and habitat use with an emphasis on documenting the status of several sensitive or declining species. The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. The Refuge Complex would seek to improve the quality of visitor services and of the visitor experience.

*Refuge Management Alternative E: Emphasis on a Passive Management Approach*

Under this Alternative, the Refuge Complex would change its management focus from active habitat management and restoration to a more passive management approach, in which plant communities and wildlife populations are influenced primarily by natural events such as lightning-caused fires, herbivory by native wildlife, and tidal or stream flooding. Active habitat management and restoration activities including prescribed burning, controlled cattle grazing, rice farming and moist soil management would be discontinued. Management of water levels and salinities through active manipulation of water control structures would be discontinued. Efforts to address threats to ecosystem health would focus on monitoring rather than active restoration or protection. The Refuge Complex would continue to provide opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation, but administrative oversight and management would occur at reduced levels.

## **USFWS Habitat Management and Restoration**

The primary focus of USFWS land management activities on the Refuge Complex is to fulfill the purpose for which the Refuge Complex was established, i.e., for the conservation and management of migratory birds and their habitats. A complete description of USFWS management activities and programs on the Refuge Complex is found in Chapter 3, Affected Environment.

The major habitat management and restoration activities implemented on the Refuge Complex by the USFWS can be grouped into three major categories:

- Wetland Specific Management and Restoration
  - Water level and salinity management in coastal marshes

- Wetland restoration
- Moist soil management
- Cropland management – cooperative rice farming program
- Upland Specific Management and Restoration
  - Native prairie restoration
  - Woodlot restoration and protection
- General Habitat Management and Restoration Activities
  - Fire Management –Wildland Fire Suppression and Prescribed Burning
  - Controlled Livestock Grazing
  - Exotic / Invasive Species Management
  - Shoreline Protection and Restoration
  - Mowing and Haying

The management of fish, wildlife and plant populations on the Refuge Complex involves an active Biological Program with ongoing field surveys, monitoring and research studies. Management of American alligator populations on the Refuge Complex includes a commercial harvest program on the McFaddin and Anahuac NWRs.

Implementation of a management action under the Refuge Complex' habitat or biological programs is intended to have a beneficial effect on a specific resource, or resolve an existing or potential environmental or natural resource problem. Therefore, management actions are intended and generally cause positive environmental impacts. However, not all results of management actions are positive, or entirely eliminate or resolve the targeted environmental problems and concerns. In addition, with most management activities on the Refuge Complex, actions that directly affect one resource have links to other resource areas (e.g., hydrology, vegetation and habitats, and fish and wildlife).

In addition to habitat and fish and wildlife management activities, the Refuge Complex administers all six of the National Wildlife Refuge System's priority public uses: hunting, fishing, wildlife observation and photography, and environmental interpretation and education. Recreational uses of the Gulf of Mexico beaches on and adjacent to the McFaddin NWR also occur. Public recreational and educational programs on the Refuge Complex provide societal benefits and promote an increased awareness of and support for conservation of natural resources among the general public, but these uses also have direct impacts to fish and wildlife and habitats and other resources. The Refuge Complex law enforcement program is a critical aspect of management to ensure public safety and protection of natural resources.

The USFWS acquired lands for establishment of all four refuges in the Refuge Complex subject to reserved and outstanding mineral interests. The mineral estates underlying the refuges are privately owned, and the USFWS must allow reasonable use of the surface of the refuges for exploration and development of underlying oil and gas reserves. Management of existing and new oil and gas exploration and development activities is important for protecting habitats and fish and wildlife resources on the Refuge Complex. New activities are managed through the issuance of Special Use Permits, which contain stipulations aimed at protecting these resources.

The USFWS also works with private landowners, primarily to facilitate implementation of wetland habitat restoration and enhancement projects. Refuge staff provides technical assistance to private landowners, and works with landowners and the USFWS Division of Ecological Services to develop projects under the USFWS Partners for Fish and Wildlife Program. Community outreach efforts also include establishment of partnerships with conservation organizations, local governments, and industry to further natural resource conservation in the region. Two non-profit groups, the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, actively support a variety of refuge management programs and activities. Volunteers contribute approximately 10,000 hours annually on the Refuge Complex.

## **Impacts to Cultural Resources**

The impacts to cultural resources on the Refuge Complex from the actions proposed in the Refuge Management alternatives are discussed in a separate section at the end of Part A of this Chapter. The impacts for all of the alternatives are grouped together in one discussion because the impacts are very similar and not substantial.

# I. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE A (NEPA NO ACTION) – CONTINUATION OF CURRENT MANAGEMENT

## *Overview*

Under this Alternative, current management programs on the Refuge Complex would continue unchanged. Management of wetland habitats including coastal marsh and freshwater prairie wetlands to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory birds would continue at current levels and intensities using prescribed burning, controlled grazing, water level and salinity management, rice farming, and moist soil management. Restoration and protection of native habitats including wetlands, prairie and woodlands would proceed at current annual acreage rates and using existing techniques. The Refuge Complex would continue to provide opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation through the use of existing programs and facilities.

## **A. Natural Resources Section**

### **1. Impacts to Air Quality**

The USFWS fire management program on the Refuge Complex includes both the suppression of unplanned wildland fires and prescribed burning. Under Refuge Management Alternative A, suppression of wildland fires would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under Refuge Management Alternative A, the USFWS would also continue its current prescribed burning program on the Refuge Complex with generally the same frequency and magnitude. Most burning would be conducted in emergent marsh habitats (during fall and early winter) on the Refuge Complex, with some burning in upland grassland habitats during spring, and with an overall annual burning objective of 12,000 - 15,000 acres. Prescribed burning is defined by Texas's Outdoor Burning Rule as "the controlled application of fire to naturally occurring vegetative fuels under specified environmental conditions and confined to a predetermined area, following appropriate planning and precautionary measures (Therriault 2001)."

The USFWS fire management program has the greatest potential of all refuge management activities to impact the region's air quality. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities. Smoke is made up primarily of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organics, nitrogen oxides, and trace minerals. The composition of smoke varies with fuel type. In general, particulate matter is the major pollutant of concern from wildland fire and prescribed fire smoke. Particulate matter is a general term for a mixture of solid particles and liquid droplets found in the air. Particulate matter from smoke tends to be very small (less than one micron in diameter) and, as a result, is more of a health concern than the coarser particles that typically make up road dust. Because of their size range, particulates scatter light effectively and therefore, reduce visibility easily.

The human health effects from smoke run from irritation of the eyes and respiratory tract to more serious disorders including asthma, bronchitis, reduced lung function, and premature death. Particulate matter is the main source of health effects, but carbon dioxide and toxic air pollutants from wildfires can also cause health concerns (Therriault 2001).

The atmospheric conditions that affect the movement and dispersal of smoke include the following: wind direction, wind speed, mixing height (the elevation in the atmosphere that the smoke mixes and disperses), transport wind speed and direction (the direction and speed of upper level winds responsible for moving the smoke from the immediate area), and Category day / dispersion (a combination of mixing height and transport wind speed to give an over all indicator of smoke dispersion potential). The Category Day 1, 2, 3, 4 or 5 equates to poor, fair, good, very good and excellent smoke dispersal (USFWS 2003).

The USFWS uses prescribed burning on the Refuge Complex to reduce accumulations of hazardous vegetative fuels and to maintain and improve habitat for wintering and migrating waterfowl and other migratory birds. Although prescribed burning under Refuge Management Alternative A would continue to be beneficial to the Refuge Complex's habitats and wildlife (as discussed under *Section II.A.4 Vegetation and Habitats* and *Section 4.A.5 Wildlife below*), prescribed burning has the potential to negatively impact local air quality through the production of smoke. Because prescribed burning is conducted on the Refuge Complex under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality from the USFWS fire management program are minimal. Prescription parameters which must be met prior to ignition and for the predicted duration of a prescribed burn specifically aimed at preventing smoke impacts include surface and transport wind direction and speed, mixing height, ambient air temperature and humidity, and fuel moisture. Both current and predicted climatic conditions are considered when deciding whether to proceed with a burn, and are regularly monitored for the duration of the burn as a further safeguard. Reducing smoke impacts to surrounding communities is also an important consideration in planning and implementing suppression actions on all wildland fires occurring on the Refuge Complex.

Prescribed burning on the Refuge Complex also reduces the potential for smoke impacts to air quality from unplanned wildland fires by effectively managing vegetative fuels. Most lightning-ignited wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires are less likely to start in areas with reduced fuel loads because of prescribed burning, and fires that do start burn with less intensity, produce less smoke, and are easier to suppress than in unburned areas with excessive accumulations of hazardous fuels.

## **2. Impacts to Geology and Soils**

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

Under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss. Under this Alternative, management and restoration activities would continue with generally the same frequency and magnitude, but could expand as additional partnerships are developed and cooperative projects implemented.

On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline. In 2001, 1,700 linear feet of dunes were restored on the eastern portion of McFaddin NWR, adjacent to Sea Rim State Park. On Texas Point NWR, dredge material from the Sabine-Neches Ship Channel was beneficially used to augment sediment supply and restore marsh along the Gulf shoreline. Structural erosion abatement projects have also been implemented. Over 1.5 miles of rock water breakwaters have been constructed along the GIWW on McFaddin NWR in recent years. These breakwaters have trapped up to 18 inches of sediment and created conditions that allowed for the natural creation of new marsh. Smooth cordgrass plantings along over three miles of the GIWW in the past seven years has established vegetated shorelines that trap sediments, build elevation and new

wetlands, and temporarily slow erosion. Shoreline restoration / stabilization efforts on Anahuac NWR have been ongoing for the last 25 years. Several shoreline stabilization studies were conducted on the Anahuac NWR to develop shoreline protection techniques, which involved locating the most suitable native plant species capable of stabilizing the shoreline (Webb 1974, Webb and Dodd 1976). Stabilization of the eroding shoreline on Anahuac NWR has involved the placement of barriers of shell and stone on the eroding shoreline, restoring vegetation along Galveston Bay, and the construction of offshore breakwaters and springing smooth cordgrass transplants between the shoreline and the breakwaters.

The historic barrier beach / dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (2004) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. 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 habitat, 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 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 (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Shoreline erosion and retreat is resulting in loss of coastal habitats throughout the Refuge Complex. The shore of East Galveston Bay on the Anahuac NWR is eroding at 1.2 meters annually (Carrol 1974). Paine and Morton (1986) determined the East Bay shoreline of Anahuac NWR consistently eroded at a rate of 3 feet / year between 1850 and 1982. The erosion threatens approximately 6,000 acres of inland brackish and intermediate marshes with saltwater intrusion. Erosion along the some sections of the GIWW is occurring at rates between 5 to 10 feet annually. This is resulting in current or pending loss of intermediate and brackish marsh habitats on Anahuac and McFaddin NWRs, further threatening these habitats with saltwater intrusion.

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of channels have led to erosional loss of organic marsh soils and conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Land subsidence occurs naturally as 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, Morton *et al.* 2001). In some areas, rapid land subsidence caused by underground fluid withdrawals has been correlated with submergence of wetlands and conversion of vegetated marshes to open water (White and Tremblay 1995). Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). It is likely that conversion of vegetated marshes to open water has been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Dune restoration and the use of dredged material on McFaddin and Texas Point NWRs are contributing to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). Restoring the Gulf barrier beach / dune system to historic elevations is also protecting inland marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring on the Refuge Complex also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines reduces land loss and increase sedimentation and vertical accretion within vegetation stands.

In addition to ongoing impacts, relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 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](http://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. Increased saltwater intrusion and loss of freshwater and sediment / nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

The relatively small scale of ongoing shoreline restoration projects under Refuge Management Alternative A is not likely to be sufficient to counter the effects of relative sea level rise and altered hydrological regimes on coastal land loss, and accelerated rates of shoreline retreat and land loss will likely continue under this Alternative. For example, restoration of the historic barrier beach and dunes on McFaddin NWR would require a large-scale project affecting an additional 16 miles of Gulf shoreline. Under this Alternative, increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes on McFaddin and Texas Point NWRs will continue to negatively impact soil formation and vertical accretion by causing direct mortality of some plant species and an overall reduction in above and below-ground plant productivity.

Other USFWS management activities under Refuge Management Alternative A would also impact soils and soil formation. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). (Water management in coastal marshes on the Refuge Complex is fully detailed below in *Section 4.a. Impacts to Vegetation and Habitats from Habitat Management / Restoration Activities*). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana. USFWS water management activities in fresh to brackish coastal marshes on the Refuge Complex typically reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. In meeting these objectives, these management activities should also benefit soil formation and vertical accretion in marshes by increasing plant productivity and preventing oxidation of marsh soils.

Flood waters from hurricanes and winter storms have been found to be sources of mineral sediment deposition for coastal marshes (Rejmanek *et al.* 1988, Reed 1989 and Nyman *et al.* 1995). A potential problem with structural marsh management is that high levees prevent sediment-laden flood waters from entering impounded marshes (Bryant and Chabreck 1998). Chabreck (1994) recommended using low levees in structural marsh management to provide access for storm driven sediment. The low levees that enclose most of the structurally managed marshes on the Refuge Complex do not prevent inundation during hurricanes or tropical storms. In many cases, salt prairie ridges form part of the high ground enclosing the structurally managed unit. These ridges are relatively low and tropical disturbances regularly overtop them, flooding interior marshes. These flood events typically result in blackwater conditions and reduced habitat quality and plant vigor, but may provide sediment subsidies for the marsh. Accretion monitoring plots not subjected to structural marsh management on McFaddin NWR detected no sediment deposition following the passage of Hurricane Rita in September of 2005 (USGS unpublished data), indicating that the relationship between storm-driven flood water and sediment deposition is not yet well understood and likely varies between storms and locations. While structurally managed marshes impede sediment-laden flood waters to some degree (Bryant and Chabreck 1998), excessive flooding and saltwater intrusion stresses plant communities (DeLaune *et al.* 1994) and can impede vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003).

Vegetation management activities such as prescribed burning can also affect soils and vertical accretion in marshes. Insufficient data exists to fully evaluate the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). In most situations, root and peat fires are avoided by carefully monitoring water levels and soil moisture. Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood.

### **3. Impacts to Hydrology and Water Quality**

#### **a. Hydrology**

The Chenier Plain region's coastal marshes were historically influenced by high annual precipitation and substantial freshwater riverine inflows, creating a continuum of coastal estuarine marsh types associated with a natural salinity gradient, from fresh to saline. Fresh and intermediate marshes formed a substantial component of this continuum. The natural hydrologic regimes of the coastal marshes in the region, and on the Refuge Complex, have been greatly modified by the construction of major navigation channels including the GIWW and the Houston and Sabine-Neches Ship Channels, dams and reservoirs upstream of estuaries, numerous smaller canals and ditches, roads, levees and impoundments, and by the deepening and channeling of most natural waterways and other inland drainage improvements. The hydrological consequences of these activities include saltwater intrusion, reduced or restricted freshwater and nutrient / sediment inflows, and altered hydroperiods (wetting and drying cycles). Hydrological changes in turn have impacted natural biological diversity and in some cases contributed to a net loss of estuarine wetlands (Moulton *et al.* 1997).

Under Refuge Management Alternative A, the USFWS would continue wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. These include structural marsh management, marsh restoration using dredge material, moist soil management, cooperative rice farming, and shoreline protection and restoration.

Water management activities in marsh habitats on the Refuge Complex include water level and salinity management and establishment of freshwater inflows. An extensive management infrastructure comprised of water control structures, levees, and water delivery systems (including pumps, ditches and canals) is used to manage and manipulate water and soil salinities and water levels within structurally-managed marsh units on the Refuge Complex. Similar water management infrastructure is used to intensively manage moist soil units and rice fields. Recovery of tail waters from moist soil and rice farming activities also contribute freshwater inflows to marshes on the Anahuac NWR. Shoreline restoration and protection activities under this Alternative include maintenance of existing projects and coordination with partners towards implementing additional small scale projects along the Gulf, GIWW and Galveston Bay shorelines. Under this Alternative, the USFWS would continue to coordinate with the U.S. Army Corps of Engineers and other agencies to evaluate opportunities to beneficially use dredge material to restore marshes which have converted to open water. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass.

Conversion of vegetated marshes to open water has occurred throughout the Chenier Plain region in areas where increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels has caused erosional loss of organic marsh soils.

As discussed in *Section I.A.2* above, salt water intrusion and soil waterlogging has been associated with peat collapse and subsequent conversion of coastal marsh to open water (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Work conducted by Nyman *et al.* (1995b) indicate that marshhay cordgrass has higher root production at lower salinity levels. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993). Excessive flooding, salt water intrusion, and sulfide stress can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Loss of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as 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, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water has been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 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](http://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. Increased saltwater intrusion and loss of freshwater and sediment / nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

The wetland management and restoration activities implemented by the USFWS under Refuge Management Alternative A would continue to help maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats would continue to support a natural diversity of native plant, fish and animal communities. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and

drying cycles) in coastal marshes on the Refuge Complex also will help to prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain (accretion).

The relatively small-scale hydrologic and shoreline restoration projects to be maintained and implemented in the future on the Refuge Complex under Refuge Management Alternative A are not likely to be sufficient to counter the effects of relative sea level rise and altered hydrological regimes on coastal land loss. If this is the case, current rates of shoreline retreat and conversion of vegetated marshes to open water will likely continue, and may accelerate. For example, restoration of the historic barrier beach and dunes on McFaddin NWR would require a large-scale project affecting an additional 16 miles of Gulf shoreline. Under this Alternative, increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes on McFaddin and Texas Point NWRs will continue to negatively impact soil formation and vertical accretion by causing direct mortality of some plant species and an overall reduction in above and below-ground plant productivity. Under this scenario, these marshes will become increasingly susceptible to submergence and conversion to open water.

## **b. Water Quality**

Potential sources of contaminants affecting water quality include accidental releases from oil and gas exploration and production activities on and adjacent to the Refuge Complex, including spills and leaks from wells, production facilities, and pipelines. In addition, a high volume of petrochemicals is transported through the Refuge Complex on a daily basis via the GIWW. Municipal development and agricultural practices may also impact water quality in the Refuge Complex. Non-point pollution sources, such as storm drain run-off from local cities and towns, are a major source of pollution that enters the Galveston Bay estuarine ecosystem (Galveston Bay Estuary Program 1995). Point source pollution from upstream facilities such as landfills is also of concern. Rice cultivation contributes important freshwater inflows to the Galveston Bay and Sabine Lake estuarine ecosystems, but agricultural practices as a whole may also contribute excess nutrients and toxins to surface waters within these coastal watersheds. Herbicide application is used on rice, soybeans, sorghum, and hay throughout the region. Concentrations of herbicides are greatest during May, June and July, with the lowest concentrations occurring in the fall and winter. Nitrates from nutrient loading are common in agricultural areas where fertilizer application enters into streams, creeks, and bayous during storm events.

Under Refuge Management Alternative A, the USFWS would continue to periodically monitor water quality on the Refuge Complex through its Environmental Contaminants program, and continue to work with local, state and federal agencies to address water quality issues. Oil and gas exploration and production activities would continue to be managed, including enforcing conditions of Special Use Permits aimed at preventing pollution from accidental releases. The USFWS would continue to coordinate with State and Federal spill response agencies to maintain preparedness and to effectively respond to accidental spills affecting water quality (and fish, wildlife and habitats) on the Refuge Complex. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills to water quality and fish, wildlife and plant resources.

## **4. Impacts to Vegetation / Habitats**

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative A include habitat management and restoration activities in wetland and upland habitats. These include structural water management in coastal marshes, marsh restoration, rice farming, moist soil management, native prairie restoration, and coastal woodlot restoration and protection. Habitat management and restoration activities with impacts to vegetation in both wetland and upland habitats include prescribed burning, controlled grazing, exotic / invasive plant and animal control, shoreline restoration and protection and mowing / haying.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation, have direct and indirect impacts on vegetation and habitats.

Systematic monitoring of vegetation and habitats under the Refuge Complex Biological Program allows ongoing assessment of management activities.

Management of oil and gas activities on the Refuge Complex through issuance of Special Use Permits is aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

## **a. Impacts to Vegetation and Habitats from Habitat Management / Restoration Activities**

### **(1). Wetland Specific Management and Restoration**

As discussed under *Sections I.A.2. and I.A.2.*, wetlands management and restoration activities on the Refuge Complex impact geology, soils and hydrologic regimes. Such activities also strongly influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

#### **(a). Water Management in Coastal Marshes**

Coastal marshes provide important food resources and cover to a diversity of wetland-dependent resident and migratory fish and wildlife species. These marshes also provide buffering of tidal storm surge, reduce flooding, and filter excessive nutrients and other contaminants. Threats to the Chenier Plain region's coastal marshes include altered hydrology resulting in increased saltwater intrusion and loss of freshwater and sediment inflows, rising sea levels and land subsidence, and waterborne and airborne contaminants (discussed in *Sections I.A.2. and I.A.3.* above). These processes are resulting in coastal land loss as shorelines are eroded and recede and as inland vegetated wetlands convert to open water, which in turn is decreasing habitat quantity and quality for native fish and wildlife.

Under Refuge Management Alternative A, structural water management to control salinities and water levels within marsh habitats on the Refuge Complex would continue. The following water management activities in marsh habitats would continue Complex-wide:

- Approximately 12,000 acres of marsh habitats on the Anahuac NWR would continue to be managed via large water control structures on Oyster Bayou, Onion Bayou, East Bay Bayou, Jackson Ditch, and Oil Field Ditch and their associated levees and canal / ditch systems. Such water management infrastructure includes more than 100 small 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.
- Approximately 18,000 acres of the McFaddin NWR's structurally managed marshes would continue to be managed via large water control structures on Willow Slough, Wild Cow Bayou, 5-Mile Cut and the GIWW, and their associated levees and canal / ditch systems.
- Water management on Texas Point NWR would continue to be conducted in a passive manner. 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 constructed ditches, were installed 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 culverted water crossings.

Managed marsh units within the Refuge Complex are under varying degrees of structural control, and may best be described as marsh semi-impoundments. A few units are entirely or almost entirely behind man-made levees and water control structures, and are intensively managed through manipulation of the water control structures and water delivery systems including ditches and canals. Most are managed less intensively, relying to some degree on natural topography and drainage to control hydrologic regimes.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization (Hess *et al.* 1989). This restoration project caused both emergent and submergent vegetation to flourish. Monitoring efforts on and around McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exacerbate flooding, further reducing plant vigor.

Structural marsh management on the Refuge Complex helps to maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes and the native plant, fish and animal communities that depend on these habitats. USFWS water management activities in fresh to brackish coastal marshes on the Refuge Complex reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying, therefore benefiting soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils. Ultimately, restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater and sediment inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes on the Refuge Complex may help to prevent the conversion of vegetated marsh to open water.

The above notwithstanding, periodic climatic events such as flooding during periods of high rainfall or due to tidal storm surge and prolonged drought influence and sometimes are the dominant factors controlling hydrologic regimes and the response of vegetative communities in the Refuge Complex' coastal marshes.

#### **(b). Marsh Restoration**

Under the Refuge Management Alternative A, the level and scope of wetlands restoration activities, as well as their benefits to the Refuge Complex, would generally continue. For example, in the year 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 project implemented under Section 206 of the Water Resources Development Act. This COE Continuing Authorities Program is entitled Ecosystem Restoration through the beneficial use of dredged material. 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 dredged material from the Sabine-Neches Ship Channel were used to increase elevation in a subsided marsh which had been converted to open water allowing reestablishment of emergent vegetation, and restored additional emergent marsh which had which had eroded into the Gulf.

Under Refuge Management Alternative A, the following marsh restoration efforts would continue.

- Additional strategies and projects to restore and enhance wetlands through the beneficial use of dredged materials would be developed through coordination with the U.S. Army Corps of Engineers, Texas General Land Office, Texas Parks and Wildlife Department, Texas Department of Transportation and others.
- Coordination would continue with the Texas Parks and Wildlife Department and other agencies on a proposed hydrological restoration project at the Keith Lake Fish Pass, aimed at curtailing emergent marsh loss on J.D. Murphree WMA, Sea Rim State Park, and private lands in the eastern portion of the Salt Bayou watershed in Jefferson County.

Marsh restoration efforts under Refuge Management Alternative A would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife. This practice also increases net sediment supply to marshes which provides nutrients and increases plant productivity (Chabreck 1976, 1994).

### **(c). Moist Soil Management**

Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). Like coastal marshes, shallow freshwater prairie wetlands provide important food resources and cover to a diversity of wetland-dependent resident and migratory birds and wildlife.

Under Refuge Management Alternative A, 500 acres of moist soil units would continue to be managed annually on Anahuac NWR to provide and enhance shallow freshwater wetland habitat for migratory birds 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.

The purposes of moist-soil management are to increase wetland productivity and waterfowl use on migrating and wintering grounds (Fredrickson and Taylor 1982). Moist soil management is the process of exposing soils by lowering water levels or mechanically manipulating vegetation or soils to create a seedbed for native wetland plants to germinate, grow and reproduce. Flooding provides foraging habitat and cover for diverse communities of migrating and wintering waterfowl and other waterbirds (Fredrickson and Taylor 1982). The seeds, tubers, rhizomes and vegetative portions of moist soil plants provide important foods for waterfowl and other migratory birds.

Moist soil management contributes to increasing and maintaining the biological diversity of an area. Moist-soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Over 80 percent more species have been found to occur in moist-soil impoundments than in adjacent row crops and include invertebrates, herpetofauna (amphibians and reptiles), prairie and marsh passerines (small- to medium-sized perching birds), shorebirds, wading birds, waterfowl, gallinaceous birds (e.g., pheasants, wild turkeys), raptors, and mammals (Fredrickson and Taylor 1982).

Water management and mechanical soil manipulations in moist soil units on the Refuge Complex are timed to promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Approximately 150 acres of the Anahuac's NWR's moist soil units are flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. The management regime favors the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

#### **(d). Cooperative Rice Farming Program**

Under the Refuge Management Alternative A, the USFWS would continue to implement a cooperative rice farming program to provide shallow freshwater wetland habitat, primarily for wintering and migrating migratory birds. Anahuac NWR is the only refuge on the Refuge Complex with a cooperative farming program. Farming on the Refuge is accomplished through cooperative agreements with local farmers.

The USFWS has agreements with three local farmers who farm rice on approximately 500 to 700 acres annually on a three-year rotation, leaving approximately 1,000 to 1,200 acres of the Refuge farm as “maintenance” acreage. The farmers are required to disc, spray, or mow noxious weeds on all maintenance acres each year according to the USDA farm program. Cooperators are allowed to take the first rice crop and are required to maintain levees and flood fields after harvest. Generally rice is harvested in September or October. Several farmers have produced 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.

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. Other changes in rice cultivation practices may also have deleterious effects on waterbird populations. Abandoned rice fields and pasturelands are susceptible to invasion by Chinese tallow, Eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality and will require extensive restoration efforts.

Continuation of the cooperative rice farming program on Anahuac NWR under Refuge Management Alternative A would provide shallow freshwater wetland habitat and serve several management outcomes for migratory bird management on the Refuge Complex: creating forage for migrating and wintering waterfowl, habitat for migrating shorebirds, and fresh water habitat for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also left for wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest rice fields that were cultivated and at least partially flooded (Czech and Parsons 2002). Managed rice fields on the Refuge Complex 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. Mottled Ducks also heavily use habitats adjacent to rice fields for nesting (Stutzenbaker 1988). Rice farming also helps to offset waterfowl consumption of crops on adjacent privately-owned croplands.

### **(2). Upland Specific Management and Restoration Activities**

#### **(a). Native Prairie Restoration and Management**

Over 9 million acres of native tallgrass 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, respectively, 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).

Approximately 4,420 acres of upland non-saline grasslands (not including acres cultivated through the cooperative farming program) occur on the Anahuac NWR. Of this total, approximately 2,914 acres are

permanently fallowed former agricultural fields which have naturally revegetated over time and currently contain native and non-native grasses, forbs and woody vegetation. Sites within these habitats have been enhanced by transplanting, sprigging and seeding of native grasses and forbs. On the East Unit, approximately 441 acres of permanently fallowed cropland has been restored to native prairie through an intensive restoration process. This involves control of 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 plant seed mixtures. 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. 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.

Under Refuge Management Alternative A, the following prairie habitat restoration and management activities would continue to be used in an integrated approach on non-saline grassland habitats on the Refuge Complex: 1) restore an additional 245 acres of permanently fallowed cropland on Anahuac NWR to native prairie; 2) increase native plant diversity in grassland habitats by seeding and sprigging native grasses and forbs; 3) conduct a rotational prescribed burning and controlled livestock grazing on upland grassland habitats; 4) utilize an integrated pest management program, consisting of herbicide application, mechanical removal, burning and controlled livestock grazing to manage exotic / invasive plant species such as Chinese tallow and deep-rooted sedge which are negatively impacting upland habitats; and 5) mow or hay approximately 100 acres annually on Anahuac NWR to control weed and woody species infestations and increase diversity and productivity of native prairie grasses and forbs.

Together, the native prairie management and restoration activities undertaken under Refuge Management Alternative A would continue to protect and enhance the 5,744 acres of non-saline grassland habitats (fallowed croplands, prairie remnants, and previously restored sites) on the Refuge Complex. Under this Alternative, 245 acres of former cropland would be restored to native prairie on Anahuac NWR, and other existing grassland habitats would be enhanced by seeding and sprigging of native plants. Impacts of burning, grazing, exotic / invasive species management and mowing / haying to vegetation and habitats are discussed below. Overall, prairie restoration and management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity. Management and restoration of native prairie habitat on the Refuge Complex would help conserve an increasingly rare component of the western Gulf Coast ecosystem by restoring and maintaining native prairie plant associations including little bluestem / brownseed paspalum and eastern gamma grass / switchgrass prairie plant communities.

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. Native prairie conservation efforts on the Refuge Complex under Refuge Management Alternative A would help maintain a small but potentially important source of native prairie seed.

#### **(b). Woodlot Restoration and Protection**

Although comprising less than 1 percent (approximately 127 acres) of the Refuge Complex acreage, 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).

Under the Refuge Management Alternative A, the following USFWS management actions would continue to have beneficial impacts on the existing 127 acres of coastal woodlots: 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.

The primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially Lepidopteron larvae. A study examining arthropod communities found lower total diversity in Chinese tallow compared to native ecosystems (Hartley *et al.* 2004). Chinese tallow woodlots may thus be an “ecological trap” that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001). In addition, activities by feral hogs can also damage understory vegetation and soils, as a result of their rooting habits, and may also cause a shift in plant succession. Such activities can also create disturbed areas that enable easier establishment of some exotic species. Feral hogs may also directly compete with several species of native wildlife for certain foods.

Overall, USFWS management activities under Refuge Management Alternative A would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

### **(3). General Habitat Management Activities**

The USFWS uses fire management, controlled livestock grazing and exotic / invasive species management and mowing / haying to enhance habitats for migratory birds and other native fish and wildlife species. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Shoreline restoration and protection activities are being implemented on the Refuge Complex to counter ongoing coastal land loss caused by relative sea level rise, altered hydrological regimes and loss of coarse sediment supply. These management and restoration activities are used to conserve, enhance and restore both wetland and upland habitats on the Refuge Complex.

#### **(a). Fire Management - Prescribed Burning / Wildland Fire Suppression**

Natural fire and herbivory by native species likely occur less frequently or at reduced levels than historically in the Chenier Plain region, primarily due to human influences on this coastal ecosystem. This has reduced diversity and productivity of native wetland and upland habitats. For example, in brackish and intermediate marsh habitats, reduced disturbance generally allows marshhay cordgrass, considered a climax plant community, to become the dominant emergent plant. Dense, homogeneous stands of marshhay cordgrass are less biologically diverse and productive than marsh habitats in which burning and herbivory create a mosaic of plant communities with greater plant species composition and greater structural diversity (attributes such as stem densities, height, and erect vs. decumbent growth habits). In upland coastal prairie habitats, encroachment by native and exotic woody species, such as Eastern baccharis and Chinese tallow, occurs in areas where fire is excluded, also resulting in loss of native habitat diversity and productivity.

Under Refuge Management Alternative A, the current fire management program would continue to be implemented on the Refuge Complex. Suppression of unplanned wildland fires and prescribed burning

would continue as under current conditions. Approximately 12,000 to 15,000 acres per year would be burned under prescription. Areas would be burned on a three-year rotation; however, the actual condition of vegetation and fuel loading would dictate the need for a burn (USFWS 2001). The majority of the prescribed burning would be conducted from October through January in marsh habitats. Prescribed burning of upland grassland units would occur primarily in late winter and early spring (USFWS 2001). Prescribed burning during these periods avoids nesting seasons for migratory birds, alligators, and other wildlife.

In wetland habitats on the Refuge Complex, prescribed burning is implemented in combination with controlled livestock grazing and water level and salinity management with a primary goal of providing a diversity of high-quality wintering habitats for waterfowl, shorebirds and other marsh and waterbirds. In upland habitats, burning and grazing are used to control encroachment by woody species and to enhance germination and growth of native prairie grasses and forbs, benefiting many grassland avian species. USFWS fire management practices in non-saline coastal prairies on the Refuge Complex reflect the idea that burning prior to green-up of the warm season grasses promotes these species. This is the most common type of prescribed burn currently conducted on remnant native prairies and restored coastal prairie sites on the Refuge Complex. Burning is conducted on upland non-saline grasslands when target warm-season grass species have less than 10cm of green foliage, prior to the grasses' growth points becoming elevated. This strategy of prescribed burning is considered a restoration phase in the management of non-saline uplands on the Refuge Complex.

Fire has long had a role in the ecology of the Texas Chenier Plain marshes. 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). 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. *jamaicense*), maidencain (*Panicum hemitomom*), 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.

Once a burn has been completed, many factors can affect post-fire conditions. If excessive rainfall causes water to cover the vegetation stubble for prolonged periods of time, the vegetation can die off (Hoffpauer 1968). Soils are particularly susceptible to erosion until the vegetation recovers. Excessive high tides, particularly storm driven tides, can push salt water over the burn area and cause plant mortality. For this reason many managers delay prescribed fire until the end of the hurricane season and until the fall equinox tide has passed (USFWS 2001).

Under Refuge Management Alternative A, the impacts of prescribed burning in wetland habitats (in combination with controlled grazing and water level and salinity management) would include: 1) increasing plant species diversity, 2) maintaining and enhancing desirable emergent marsh plant communities such as Olney bulrush and leafy three-square bulrush, 3) creating openings in otherwise dense stands of emergent marsh vegetation, and 4) helping to control exotic and / or invasive plants. Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several "early successional" target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato.

Burning makes vegetation more desirable to herbivores and will increase grazing pressure. Post-fire herbivory, whether by geese or cattle, prolongs early successional marshes and creates habitat for other wildlife. Post-fire herbivory will slow the recovery of climax vegetation and prolong early serial stages and open marsh conditions favorable to waterfowl (USFWS 1994). Livestock turn the soil through hoof action and further set back succession (Chabreck 1968, Stutzenbaker and Weller 1989).

Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.), increases after a fire, particularly when followed by grazing and suitable hydrology. Burning opens up dense vegetation and allows waterfowl access to seeds and other plant parts (Lynch 1941). Fire can remove plant cover and create open water conditions conducive to Mottled Duck brood-rearing habitat (Stutzenbaker 1988). Generally speaking, burning creates open marsh conditions and sets back succession if timed properly, particularly when followed by herbivory. Burning is an effective tool to manipulate vegetation composition and create a habitat mosaic (Fredrickson and Laubhan 1996).

The impacts of prescribed burning in upland grassland habitats would include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control exotic and / or invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased.

One of the primary objectives of burning non-saline upland grasslands on the Refuge Complex is the control of Chinese tallow. Tallow is generally non-flammable and in heavily infested situations suppresses herbaceous plants and fine fuel loading, limiting the potential for fire (Grace *et al.* 2001). Thus, the invasion of Chinese tallow converts a fire-adapted grassland site to a non-flammable, near monotypic woodland. Work has been conducted on Brazoria NWR in the Texas Mid-Coast region on the relationship between fire and Chinese tallow. Preliminary results indicate that while total control was not realized with one treatment, some mortality was achieved (Grace 1998). Further, sites with fuel characteristics more typical of coastal prairies (high fuel loading, species composition, and continuity of fuels) achieved better control of Chinese tallow using fire than did abandoned agricultural fields.

In summary, the current USFWS fire management program on the Refuge Complex is conducted to achieve the following benefits (USFWS 2001). These beneficial impacts would continue under Refuge Management Alternative A.

- Hazardous fuels are reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning lessens the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds is restored, maintained, or improved by maintaining early successional plant communities in marsh habitats, by increasing production and nutritional quality of these foods, and enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation. For example, prescribed burning encourages tuber producing plants such as Olney and leafy bulrush preferred by waterfowl. Snow geese heavily use recent marsh burns because they can readily access roots, tubers, and young green shoots of these plant species. Both geese and ducks use burned areas as roosts or loafing areas.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, is suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife. Management of exotic and invasive species such as Chinese tallow, deep-rooted sedge and Eastern baccharis using an integrated pest management approach enhances germination, growth and reproduction of native prairie grasses and forbs. The mechanical removal of undesirable woody and weed plant species reduces competition with native plant species, and enhances germination, growth and reproduction of native prairie grasses and forbs.

While fire, whether planned or unplanned, can have positive ecological effects, detrimental impacts to vegetation and habitats ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water can also occur. For example, fire under excessively dry conditions can result in plant mortality and / or consume organic matter and decrease marsh soil elevation, either of which could result in permanent conversion to open water. Excessively hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Proper timing of prescribed burns under appropriate environmental and climatic conditions is essential to minimize potential negative impacts to habitats. Implementation of the USFWS fire management program on the Refuge Complex (both wildland fire suppression and prescribed burning) considers factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive wetland and upland habitats.

### **(b). Controlled Livestock Grazing**

Controlled grazing is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats on the Refuge Complex.

Under Refuge Management Alternative A, grazing intensity, duration, location, and timing of use would continue unchanged, as would overall impacts to vegetation and habitats on approximately 41,000 acres on the Refuge Complex. Grazing strategies currently 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. Anahuac NWR implements cool season and summer cattle grazing on various marsh and upland units. Permittees graze only during the cool season, generally from November 1 through May 1 on the McFaddin and Texas Point NWRs.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relationship of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Studies conducted on Sabine National Wildlife Refuge in Cameron Parish, Louisiana (Valentine 1961) determined that increased grazing can change tall climax marshhay cordgrass stands to a more diverse community such as seashore paspalum, *Setaria*, and longtom (*Paspalum lividum*), that are more beneficial to certain types of wildlife. Depending on site conditions (elevation, soil, and hydrology) annual grasses and forbs (including millets, fall Panicum (*Panicum dichotomiflorum*), sprangletop, and *Setaria*) can be produced through proper grazing.

Pate (2001) found that grazed marshes remained in a sub-climax state, while habitat within grazing exclosures reverted to marshhay cordgrass. At the onset of the study *Spartina* spp. made up 20% of the plant community, while seashore paspalum comprised 80%. By the end of the study, communities within grazing exclosures changed to 65% *Spartina* spp. and 25% seashore paspalum. In contrast, the grazed area maintained high cover of seashore paspalum throughout the study. Shallowly-flooded seashore paspalum provides habitat for many species of waterfowl, wading birds and shorebirds, while marshhay cordgrass largely precludes use by these species.

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Moderate grazing following burns in marshes also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Grazing also helps provide optimal physical structure of vegetation for waterfowl utilization in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with

ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Specifically, the beneficial effects of grazing in wetland habitats include:

- Reduces rank vegetation which enables migratory birds to access roots and tubers of mature plants and shoots of new plants.
- Reduces competing growth of marshhay cordgrass and other dominant climax plant communities, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Creates open water which provide loafing spots for birds and allow them to access aquatic invertebrates.
- Compliments marsh burning by prolonging the time that browse is available for goose use.
- Improves plant vigor, increases plant productivity, speeds nutrient recycling, and prevents excessive build-up of residual plant material.
- Reduces the amount of hazardous fuel loading, reducing the amount and intensity of wildfires.
- Breaks up capped soils through hoof action, which assists in seedling establishment.
- Maintains regrowth of vegetation in recently burned areas in more palatable stages for wintering waterfowl.
- Provides a reliable disturbance tool that is not as dependent on favorable weather and fuel conditions as prescribed fire.

Carefully managed grazing in coastal prairie habitats increases plant vigor of native prairie grasses and increases overall plant species composition and structural diversity.

Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1992). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing intensity, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative A, the USFWS would continue to monitor grazing programs and adjust grazing strategies so as to minimize detrimental impacts.

### **(c). Exotic / Invasive Species Management**

Under Refuge Management Alternative A, the level and scope of exotic and invasive species management activities, as well as their impacts to native vegetation and habitats on the Refuge Complex, would generally continue as described below. The USFWS would continue to control exotic and invasive

plant species to conserve biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program is currently used to control the following exotic and invasive plant species (USFWS 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies

The IPM program for invasive plant management on the Refuge Complex includes using herbicide application, mechanical control, prescribed burning, controlled grazing and water level and salinity management, usually in some combination of strategies. Combinations of treatments often are most successful and provide more long lasting results. In general, mowing and burning are used on upland grassland habitats to control upland exotic and plant invasive species. Burning and controlled grazing are the primary tools used in marsh habitats. Discing or roller chopping are used in rice fields and moist soil units to manage invasive species. Spot treatments with herbicides are typically used in wetland and upland habitats when target stands are small enough to treat by hand. Aerial herbicide application has been required to initiate control on large mature stands of Chinese tallow. The long-range goal of the USFWS IPM program on the Refuge Complex is to reduce the dependence on and use of chemical herbicides to control and manage invasive plant species.

In wetland habitats, these activities include and result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

The control of Chinese tallow and deeprooted sedge in prairie and woodlots results in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001). Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants.

Under Refuge Management Alternative A, the USFWS would also continue to control exotic animal species on the Refuge Complex to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral pigs are the primary species currently impacting habitats on the Refuge Complex. Rooting and wallowing by feral pigs cause 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 prolific and are able to exploit wetland and upland habitats. Under Alternative A, the USFWS would continue to control feral hog activities on the Refuge Complex by using State animal damage control agency personnel to capture and remove hogs or kill them on-site. In addition, Refuge Complex law enforcement personnel would continue to conduct periodic lethal control activities. Although nutria have not reached population levels capable of damaging habitats in recent years on the Refuge Complex, this exotic animal has been highly destructive in coastal wetlands in neighboring Louisiana and other coastal states. Control activities for nutria which could be implemented under Refuge Management Alternative A include trapping and removal by State animal damage control agents, Refuge staff or qualified individuals under Special Use Permit for nuisance animal control.

#### **(d). Shoreline Protection and Restoration**

Under Refuge Management Alternative A, the following USFWS management actions would continue to have beneficial impacts on beach / dune and other shoreline habitats, and to inland wetland habitats which they protect:

- McFaddin and Texas Point NWRs: (1) maintain existing dune restoration project and explore opportunities for additional dune restoration along the Gulf of Mexico on McFaddin NWR; (2) maintain existing shoreline protection and seek opportunities for additional protection along the GIWW shoreline; and (3) implement additional projects to beneficially use dredged materials from the Sabine-Neches Ship Channel to reduce land loss by restoring sediment supply to the Gulf shoreline on and adjacent to Texas Point NWR.
- Anahuac NWR: Maintain existing offshore rock breakwaters and continue efforts to construct additional breakwaters and restore emergent marsh by planting smooth cordgrass along the East Galveston Bay shoreline.
- Complex-wide: (1) coordinate with the U.S. Army Corps of Engineers on their ongoing Section 227 National Shoreline Erosion Demonstration Project in Jefferson County and their Shoreline Erosion Feasibility Study for Galveston and Jefferson counties; and (2) coordinate with the U.S. Army Corps of Engineers, Texas General Land Office, Texas Parks and Wildlife Department, Texas Department of Transportation and others to develop strategies to restore and enhance wetlands through the beneficial use of dredged materials.

Altered hydrological regimes and relative sea level rise resulting in erosion and land loss along the Gulf and Bay shorelines are major threats to wetland and upland habitats on the Refuge Complex. Barrier beaches and dunes along the Gulf of Mexico provide habitat for a variety of plant and animal species, protect and stabilize the coastline and help protect landward wetland habitats. Shoreline erosion threatens Gulf of Mexico beach and dune habitats throughout the Chenier Plain region. Although shoreline erosion during storms is a natural process, a severe sediment deficit in the Gulf's littoral system resulting from construction of navigation channels, jetties and upstream dams on rivers has greatly accelerated rates of shoreline retreat. Rising sea levels and land subsidence are also causative factors in the accelerated loss of coastal habitats.

Virtually all of the historical low barrier beach / dune system on the McFaddin and Texas Point NWRs has been lost as the Gulf shoreline has eroded and retreated. In addition to direct loss of habitat, loss of elevation along the Gulf shoreline has increased saltwater intrusion from tidal flooding from the Gulf into inland marshes. Tidal overwash of the low remaining beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity in Refuge marshes. On Anahuac NWR, shoreline erosion along Galveston Bay is resulting in loss of salty prairie habitat and threatens interior marshes with saltwater intrusion. Erosion of the GIWW banks on both refuges poses a significant threat of saltwater intrusion. Breaching of the channel's banks would directly connect interior marshes with the GIWW.

Under Refuge Management Alternative A, shoreline protection and restoration activities would continue to positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier beaches and dunes along the Gulf of Mexico protects interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events, as well as restoring an upland native habitat type which has been almost completely lost. Use of dredged material along existing shorelines protects existing marshes by reducing shoreline retreat and direct loss of these habitats, and provides a substrate for reestablishment of marsh vegetation. Breakwaters enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines restores vegetated wetlands that have

converted to open water. The stands of smooth cordgrass also provides habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

The relatively small scale of ongoing shoreline restoration projects under Refuge Management Alternative A on the Refuge Complex is not likely to effectively counter the future effects of relative sea level rise and altered hydrological regimes, and accelerated rates of shoreline retreat and land loss will likely continue to occur. For example, total restoration of the barrier beach / dunes on McFaddin NWR would require work along an additional 16 miles of Gulf shoreline. Increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes will continue to negatively impact vegetation and habitats on McFaddin and Texas Point NWRs by causing direct mortality of some plant species and an overall reduction in plant productivity.

#### **(e). Mowing and Haying**

Mowing and haying consists of the mechanical removal of vegetation in situations where grazing, burning, or herbicide applications are impractical, undesirable, or ineffective methods of vegetation management. Under Refuge Management Alternative A, approximately 100 acres per year of upland grassland habitats would continue to be mowed or hayed on the Refuge Complex.

Mowing and haying stimulates growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants. Reduction of this herbaceous cover often results in the “release” of native prairie plants. Mowing and haying is often used where the vegetation to be controlled is undesirable to livestock, or where the terrain or soil conditions are difficult to graze without excessive environmental damage. Mowing and haying facilitates more control over the amount and locations of vegetation management, however, costs per acre are much higher than for controlled grazing or prescribed burning.

#### **b. Impacts from Public Use Programs**

The greatest potential for impacts to vegetation resources and habitats associated with public use on the Refuge Complex likely comes from motorized boating. Many Refuge Complex hunt areas and fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, and environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

Under current levels of use and current USFWS administration and management of these uses on the Refuge Complex, impacts to vegetation are generally localized and not substantial. This would continue under Refuge Management Alternative A. Regulations, including horsepower restrictions and area closures to motorized boating are used to protect wetland habitats and public safety. Permanent sanctuary areas are maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses is restricted to established trails, boardwalks, and observation platforms. Fishing piers have been constructed in many heavily used shoreline fishing areas, reducing trailing impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats

(dunes and / or the overwash terrace) inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative A, the USFWS would continue routine patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative A. Continued habitat and vegetation monitoring activities and research studies on the Refuge Complex support an adaptive management approach, by providing information which helps refine and improve existing management practices.

### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative A, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and / or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex is a reduction of impacts to vegetation and habitats from these activities.

### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative A, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project. 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.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships currently support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative A would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

## **5. Impacts to Fish and Wildlife Resources**

Under Refuge Management Alternative A, habitat management and restoration and biological program activities on the Refuge Complex are focused on conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating

- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS also administers the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

The USFWS manages of oil and gas exploration and development activities on the Refuge Complex so as to ensure maximum protection of habitats and fish and wildlife resources.

USFWS community outreach and partnership programs support natural resource conservation initiatives on the Refuge Complex and throughout the project area, and contribute greatly to achieving fish and wildlife conservation objectives.

#### **a. Impacts from Habitat Management and Restoration Activities**

##### **(1). Impacts to Migrating and Wintering Waterfowl**

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on landscape scale has increased the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.<sup>9</sup> Many wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Declines in habitat quality caused by regular tidal overwash are adversely affecting migratory waterfowl use, especially on McFaddin and Texas Point NWRs. As beach ridges and the banks of the GIWW erode they are less effective barriers to tidal inundation and salt water intrusion during storm and other high tidal events. Overwash events create sudden and drastic spikes in salinities, often killing submerged aquatic vegetation and seed producing annual plants. Inundation of the marshes with sea water provides the sulphates which are reduced to hydrogen sulfide under conditions of high water temperatures. Hydrogen sulfide toxicity and low dissolved oxygen cause large scale die-offs of plants and animals, including many

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<sup>9</sup> During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

invertebrates which provide an important food source for waterfowl and other migratory birds. Survey data indicate that waterfowl numbers have dropped to below five birds per thousand acres in affected areas following overwash events, and below one bird per thousand acres after severe events (USFWS unpublished data). Areas impacted by overwash events now encompass nearly 15,000 acres on McFaddin NWR and 1,500 acres on Texas Point NWR.

Under the Refuge Management Alternative A, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations on the Refuge Complex:

**(a). Wetlands Management and Restoration**

Under Refuge Management Alternative A, approximately 30,000 acres of marsh habitats would be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. For example, structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

On Anahuac NWR, 500 acres of moist soil units would continue to be managed to provide habitat for wintering and migrating waterfowl. Moist soil management provides 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.

On Anahuac NWR, the cooperative rice farming program would continue to provide food resources for wintering and migrating waterfowl on 500-700 acres annually. Management of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Marsh and wetland restoration activities would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

**(b). General Habitat Management and Restoration Activities**

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex promotes optimum habitat conditions for wintering waterfowl and many additional migratory bird species. Prescribed burning and grazing promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Waterfowl habitat on the Refuge Complex is also enhanced through the control of undesirable invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* must also be controlled to restore and maintain open water habitats. Maintaining an interspersed of open water and vegetated emergent wetlands provides the

habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats increases the production of submerged and floating aquatic plants, an important food source. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields also enhances waterfowl habitat.

Overall, continuing current wetland management and restoration on the Refuge Complex under Refuge Management Alternative A can be expected to maintain wintering and migrating waterfowl populations at levels similar to those documented over the past 20 years. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and / or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

Continuation of shoreline protection and restoration activities under Refuge Management Alternative A would enhance waterfowl habitat on the Refuge Complex by decreasing saltwater intrusion into inland marshes and addressing threats of additional saltwater intrusion. However, the scope and extent of these activities under Refuge Management Alternative A will likely not counteract the ongoing and future impacts of relative sea level rise, loss of coarse sediment supply, and altered hydrological regimes, especially on McFaddin and Texas Point NWRs. Declines in habitat quality caused by regular tidal overwash are adversely affecting migratory waterfowl use on these refuges. As beach ridges and the banks of the GIWW erode they are less effective barriers to tidal inundation and salt water intrusion during storm and other high tidal events. Overwash events create sudden and drastic spikes in salinities, often killing submerged aquatic vegetation and seed producing annual plants. Inundation of the marshes with sea water provides the sulphates which are reduced to hydrogen sulfide under conditions of high water temperatures. Hydrogen sulfide toxicity and low dissolved oxygen cause large scale die-offs of plants and animals, including many invertebrates which provide an important food source for waterfowl and other migratory birds. Survey data indicate that waterfowl numbers have dropped to below five birds per thousand acres in affected areas following overwash events, and below one bird per thousand acres after severe events (USFWS, unpublished data). Areas that can be heavily impacted by overwash events now encompass nearly 15,000 acres on McFaddin NWR and near 1,500 acres on Texas Point NWR.

Increased saltwater intrusion from frequent tidal overwash from the Gulf into inland marshes on these refuges will continue to negatively impact habitat quality for waterfowl, other migratory birds, and other native fish and wildlife species. Declining habitat conditions due to increased saltwater inundation could result in further significant declines in wintering waterfowl use on McFaddin and Texas Point NWRs.

## **(2). Impacts to Resident Waterfowl - Mottled Ducks**

Mottled ducks are year-round residents of the Chenier Plain region. This species prefers fresh to slightly brackish marshes (Gosselink *et al.* 1979), although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled Ducks on the Refuge Complex are part of the western Gulf Coast (WGC) population of Mottled Ducks. Banding studies have indicated that WGC Mottled Ducks do move between Mexico, Texas, Louisiana and Mississippi and Alabama, but no interchange occurs between this population and the Florida population of Mottled Ducks.

Mottled Duck numbers on the Refuge Complex (and other national wildlife refuges on the Texas Coast) have declined precipitously during the last 20 years, as indexed by annual breeding pair surveys and monthly aerial counts conducted September through March (USFWS, Division of Migratory Birds, unpublished reports). Stutzenbaker (1988) reported that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include conversion of native habitats for agricultural and urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988, Morton and Paine 1990), as well as increased pollutants (Cain 1988). Saltwater intrusion into wetlands that range from fresh to moderately brackish probably affects

growth and survival of ducklings (Moorman *et al.* 1991). Encroachment of Chinese tallow into nesting habitat probably leads to abandonment of nesting areas (Stutzenbaker 1988). Other potential factors influencing Mottled Duck populations include declines in rice agriculture, extended periods of drought, mortality from predation due to increasing populations of alligators and possible increases in mammalian predators, a continued high incidence of lead pellet ingestion, and harvest (USFWS Division of Migratory Birds, unpublished reports).

Under Refuge Management Alternative A, the following habitat management and restoration activities would continue to be the primary management activities impacting Mottled Ducks on the Refuge Complex. All would be expected to have positive impacts on this species, although the landscape level issues described above are likely to control population dynamics of the Western Gulf Coast Mottled Duck population.

#### **(a). Wetlands Management and Restoration**

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative A would provide and enhance habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Managing water levels and salinities in managed coastal marsh units would maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. Marsh management also would enhance diversity and productivity of submerged aquatic vegetation which provides important year-round food sources for Mottled Ducks. Moist soil management and the cooperative rice farming program on Anahuac NWR would continue to provide critical shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. Approximately 100-150 acres of moist soil units would continue to be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

#### **(b). Uplands Management and Restoration**

Native prairie restoration and management activities under Refuge Management Alternative A would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The integrated application of prescribed burning, controlled livestock grazing, herbicide application and mowing / haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies (and on levees and along fence lines) would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks 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 "sennabeen ponds," as valuable brood rearing habitat. Protecting extant coastal prairie and restoring adjacent prairie and wetland habitats under Refuge Management Alternative A on the Refuge Complex will increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

#### **(c). General Habitat Management Activities**

Current levels of prescribed burning, grazing, and exotic / invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative A. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex which promotes optimum habitat conditions for wintering and migrating waterfowl also enhances wetland and upland habitats used by Mottled Ducks during all life history phases: pair formation, breeding, nesting, brood-rearing, molting and

wintering. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex. These cordgrass ridges are dominated by gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania* spp.) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks.

Improper application of these habitat management practices has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988).

Marsh habitats being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRS overwash events provide important Mottled Duck production and brood rearing habitat. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. If erosion problems persist and result in increased frequency of events and water volumes entering marshes, Mottled Duck production can be expected to further decrease on the Refuge Complex.

### **(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds**

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally-listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migratory, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat

types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Refuge Management Alternative A would continue to positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative A, actively managing water levels and salinities (e.g., by utilizing water control structures, levees, water delivery systems) would allow for continued protection of managed marsh units, which includes a wide variety of vegetation and habitat types used by many avian species in this group. In general, shorebirds and wading birds would continue to benefit from moist soil management and rice farming activities that result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields would influence the type of and intensity of use by such birds (Huner *et al.* 2002).

Under Refuge Management Alternative A, the cooperative rice farming program on Anahuac NWR would continue to provide from 500-700 acres of shallow freshwater wetland habitat, benefiting many avian species in this group. In addition, approximately 100-150 acres of the Anahuac NWR's moist soil units would continue to be managed specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species include Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. An additional 250-300 acres of moist soil units would provide wetland habitat for shorebirds, wading birds, and other marsh and waterbirds over the winter months. Wading and marsh bird species using moist soil habitats on the Refuge Complex include 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.

#### **(b). Uplands Management and Restoration**

Under Refuge Management Alternative A, restoration and enhancement of native prairie habitats on the Refuge Complex would benefit some avian species in this category primarily by providing improved habitat for migrating and wintering birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

#### **(c). General Habitat Management Activities**

Current prescribed burning, grazing, and exotic / invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative A. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex which promotes optimum habitat conditions for wintering and migrating waterfowl also enhances wetland and upland habitats used by many shorebird, wading bird and marsh bird species. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species. Prescribed burning and controlled livestock grazing help create optimal physical structure of vegetation for shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for these species. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird

species that utilize open water habitats. Shoreline restoration activities including dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative A, the USFWS would also maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*), (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS uses these techniques in prescribed burning operations on the Refuge Complex.

Some management activities under Refuge Management Alternative A could negatively impact some species of shorebirds, wading birds, and marsh and waterbirds. For example, some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. Other habitat management activities could negatively impact some species of shorebirds, wading birds, marsh and waterbirds, especially if improperly implemented or timed. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979).

Most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. Under Refuge Management Alternative A, the USFWS strategy of management to maintain a mosaic of available habitats on the Refuge Complex should provide an adequate range of habitats for this group of avian species.

#### **(4). Impacts to Landbirds**

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.*

1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative A would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative A, the following wetland management and restoration activities would continue to have positive impacts on several landbird species including managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and cooperative rice farming program. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

#### **(b). Uplands Management and Restoration**

##### *Prairie Restoration and Management*

Together, the native prairie management and restoration activities undertaken under Refuge Management Alternative A would continue to protect and enhance the 5,744 acres of non-saline grassland habitats (fallowed croplands, prairie remnants, and previously restored sites) on the Refuge Complex. Under this Alternative, 245 acres of former cropland would be restored to native prairie on Anahuac NWR, and other existing grassland habitats would be enhanced by seeding and sprigging of native plants.

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 landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative A are species that are declining in the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 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, 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 on the Refuge Complex.

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 Sharp-tailed Sparrow, and nesting habitat for species including Dickcissel 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. Landbirds listed as Avian Species of Conservation Concern utilizing prairie grassland habitats and which would benefit from native prairie restoration and management activities on the Refuge Complex under Refuge Management Alternative A include LeConte's Sparrow, Nelson's Sharp-tailed Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk.

### Woodlot Restoration and Management

Under Refuge Management Alternative A, the following USFWS management actions would continue to have beneficial impacts on coastal woodlots: 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.

Although comprising less than 1 percent (approximately 127 acres) of the Refuge Complex acreage, 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' 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).

A primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially *Lepidopteron* larvae. Chinese tallow woodlots may thus be an "ecological trap" that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001). In addition, activities by feral hogs can also damage understory vegetation and soils, as a result of their rooting habits, and may also cause a shift in plant succession. Such activities can also create disturbed areas that enable easier establishment of some exotic species. Feral hogs may also directly compete with several species of native wildlife for certain foods.

Overall, implementation of the USFWS management actions under Refuge Management Alternative A would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler. Since woodlot acreage is small relative to its importance to migrating neotropical migratory birds and other bird species that require trees and / or understory for cover, such positive impacts for each acre protected are proportionately significant.

#### **(c). General Habitat Management Activities**

Current prescribed burning, grazing, and exotic / invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative A. The integrated combination of water level and salinity management, fire management and controlled livestock grazing on the Refuge Complex which promotes optimum habitat conditions for wetland-dependent migratory birds also enhances wetland and upland habitats used by many land bird species. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is

possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post-fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife.

## **(5). Impacts to Fisheries Resources**

### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative A, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, exotic plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands and help maintain wetland habitat diversity and productivity important to a variety of fish and shellfish species.

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Structural marsh management is employed on portions of the Refuge Complex to enhance wetland habitats for migratory birds, to reduce impacts of saltwater intrusion and subsequent marsh loss and to maintain the historic salinity gradient that characterized coastal marshes of the Chenier Plain. Managing water levels and salinities using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Target salinity ranges typical of structurally managed marshes on the Refuge Complex range from fresh to the low end of brackish, being primarily intermediate (0.5-5.0ppt). While these salinity ranges are used by estuarine species, a study of fisheries use along a salinity gradient in Galveston Bay (Zimmerman *et al.* 1990) found estuarine fisheries were not greatly attracted to intermediate (oligohaline) marshes of the Trinity River delta. This study concluded that the oligohaline environment was not favorable for development of preferred foods, primarily epiphytic algae and peracarid crustaceans. Further, while transient species such as juvenile shrimp, crabs, and fishes had ready access to oligohaline marshes in this area, they did not use them extensively. These data indicate that while water control structures may limit ingress / egress of estuarine organisms, the habitat within may not be optimum for these organisms compared to brackish and saline marshes available on the Refuge Complex.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). Ingress / egress slots allow more marine organism passage than fixed crest weirs, with larger openings allowing greater fisheries access (Herke *et al.* 1992). These slots provide a means of allowing movement of estuarine organisms in and out of structurally managed marshes, but assist in maintaining the fresher end of the coastal marsh continuum that so many of the Refuge Complex's priority species depend on.

Periods of peak ingress and egress movements are associated with water level fluctuations and tidal cycles. Highest peak fisheries resource movements are often related to periods of combined lunar cycles and major tidal movements. Manipulating water control structures during the full moon and new moon of the lunar cycle allows opportunity for the maximum ingress potential of fisheries resources. Holding slight levels of excess water for several days prior to these cycles and releasing during peak ingress periods greatly increases access to the unit from fisheries species dependent on coastal estuaries. Many species will move towards fresher water during incoming tides (Guillory 1996). The USFWS uses these techniques on the Refuge Complex to enhance fisheries utilization of managed marsh units. In addition, the continuum of fresh to saline aquatic environments on the Refuge Complex supports highly diverse aquatic vertebrate and invertebrate communities. Disruption of salinity gradients would likely cause adverse impacts on blue crabs (Guillory 1996). Many of the refuge marshes would exceed these thresholds without some type of hydrologic management.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Knieb and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are experiencing rapid subsidence, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, activities which maintain and restore productive wetland habitats and help reduce rates of marsh loss would also benefit fisheries resources in the long-term.

## **(6). Impacts to Threatened and Endangered Species**

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican. Under Refuge Management Alternative A, protection, restoration and management of coastal wetland habitats on the Refuge Complex would continue to benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative A would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

## **(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates**

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative A which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative A which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Habitat conditions which increase the abundance of insects, crustaceans, and other small prey benefit most species of amphibians and reptiles during at least a portion of their lifecycle. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Under Refuge Management Alternative A, some management activities would continue to have negative impacts on some wildlife species. Control of exotic and / or invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize." Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

### **b. Impacts from Public Use Programs**

The following analysis of impacts of public use programs on fish and wildlife resources focuses on the six wildlife-dependent uses which are the priority public uses of the National Wildlife Refuge System: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Impacts of beach recreational uses on McFaddin NWR are discussed under the specific wildlife species or groups of species affected by this use.

## **(1). Impacts to Waterfowl**

### **(a). Waterfowl Hunting**

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Alternative A should not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichhoff, 1973, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required and additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Afton and Sayler in Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and / or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary areas of adequate size, encompassing and / or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998).

Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

Overall, it is expected that the maintenance of sanctuary areas on the Refuge Complex mitigates for disturbance impacts from hunting activities. In years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances, however, it is possible that hunting activities would result in reduced abundance of wintering waterfowl on the Refuge Complex. Maintenance of traditional sanctuary areas would continue under Refuge Management Alternative A.

Maintaining current Refuge-specific hunting regulations under Refuge Management Alternative A would also help mitigate the impacts of hunting activity-related disturbance to waterfowl. Waterfowl hunting in hunt areas is allowed three days per week (with the exception of the 1,500-acre Pace Tract on Anahuac NWR which is open for hunting seven days per week), and all hunting activity is curtailed each day at noon. The non-hunted days and afternoon and evening closures provide undisturbed periods within the hunt areas, facilitating waterfowl utilization of hunt area habitats for foraging and resting. Boat use on the Refuge Complex occurs primarily in bayous, canals and ditches, limiting disturbance impacts to these narrow corridors (exceptions are Star Lake and Clam Lake on McFaddin NWR and Pole Lake on Texas Point NWR). The majority of the hunt areas therefore are not impacted by boating activity, being accessible primarily by foot. In addition, a variety of regulations govern means of access to hunt areas, including boat motor and horsepower restrictions, prohibition of airboat and all-terrain vehicle use, and establishment of areas in which only non-motorized boat access is allowed. While these regulations are in place primarily to protect habitats and public safety, they also reduce overall disturbance impacts to waterfowl and other migratory birds.

#### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation**

Primary means of access to areas on the Refuge Complex use for fishing and wildlife observation and photography include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors use bicycles on public roads and levee trails on all three refuges. An even smaller number ride horses on roads at Anahuac NWR and on the Gulf beach at McFaddin NWR. Motorized vehicles and walking are used to access areas used for environmental education and interpretation on Anahuac NWR.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

Under Refuge Management Alternative A, most of these visitor facilities on the Refuge Complex would continue to be found on the Anahuac NWR, and the primary impacts of these activities on waterfowl would occur on this Refuge.

## **(2). Impacts to other Migratory Birds, Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds**

### **(a). Waterfowl Hunting**

Although the impacts of waterfowl hunting under Refuge Management Alternative A on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole, 1995), as will non-motorized boats, vehicles and walking through the marsh.

### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

Primary means of access to areas on the Refuge Complex for fishing, wildlife observation and photography include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors use bicycles on public roads and levee trails on all three refuges. An even smaller number ride horses on roads at Anahuac and McFaddin NWRs. Motorized vehicles and walking are used to access areas used for environmental education and interpretation on Anahuac NWR.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

On Anahuac NWR, visitors are allowed to access a 10-acre area within the Yellow Rail Prairie Management Unit to attempt to flush and view yellow rails. This is accomplished by walking slowly through the area, and is most successful when groups of people slowly walk parallel to each other dragging a rope in between participants. This activity occurs primarily during the months of March and April, and includes several guided “Yellow Rail Walks” led by refuge staff or trained volunteers. Disturbance of rails flushed during this activity undoubtedly occurs and likely leads to reduced utilization of this area by rails. Suitable undisturbed habitats exist adjacent to this site, and is unlikely that this disturbance results in long-term negative impacts to individual rails or rail populations.

Heaviest use and vehicular traffic of beaches on and adjacent to McFaddin NWR occurs from April through September. Numerous studies have documented impacts of beach recreation on shorebirds. Beach use affects beach-nesting birds directly and indirectly. Beach use may cause direct mortality of

birds through nest and chick destruction, displacement, or reduced reproductive success (Burger 1995). Burger (1984) found that human disturbance accounted for over half of the reproductive failures of least tern colonies in New Jersey. Most of this loss was due to off-road vehicles and people walking through the colonies. The presence of people on the beach decreases foraging time and increases vigilance of piping plovers, potentially having a negative effect on chick survival and adult maintenance (Burger 1991). Flemming *et al.* (1988) suggest that population decline of piping plovers could be caused by human disturbance altering chick behavior, thereby increasing their susceptibility to inclement weather and predators, and consequently increasing mortality. Beach-nesting birds respond to recreationalists based on species' characteristics, habituation to disturbance, exposure, seasonality, and nesting dispersion (Burger and Gochfeld as cited by Knight and Gutzwiller 1995). Beach use may also cause indirect impacts to birds by increasing predators or habitat loss (Burger 1995).

Long-term declines in the abundance of some migratory shorebird species may be associated with increased human disturbance factors on beaches (Pfister *et al.* 1992). This study found that vehicles, pedestrians, and pets displace shorebirds from traditional resting areas, thereby reducing the utility of impacted areas to migrating shorebird populations. Burger and Gochfeld (1991) found that human disturbance from beach use (walking, sunbathing, swimming, and jogging) impacted the time devoted to foraging by wintering sanderlings. An increase in the number of people on the beach was associated with sanderlings spending more time directly running or flying due to disturbance.

Recreational beach uses and associated vehicular traffic have had impacts on shorebirds and other waterbirds on Gulf of Mexico beaches on and adjacent to McFaddin NWR. Species known to nest on the beach, dunes and / or overwash terrace on the Refuge include least tern, Wilson's plover, black skimmer, killdeer, and common nighthawk. Mortality of least tern chicks, and the loss of least tern, killdeer, and common nighthawk nests and eggs has been documented on the Refuge due to illegal motorized vehicle activity on the dunes and overwash terrace inland of the beach. Illegal travel on these habitats occurs primarily when high water or erosion precludes travel on the beach. Beach walkers and unleashed pets have also caused disturbance to least tern colonies located on the overwash terrace. Under Refuge Management Alternative A, the USFWS would continue routine law enforcement patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

### **(3). Impacts to Fisheries**

#### **(a). Fishing**

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term. Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative A should not have any measurable effect on overall populations and the long-term viability of these species' populations.

#### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative A.

#### **(4). Impacts to Threatened and Endangered Species**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

It is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats are subject to the some level of disturbance by public use activities on the Refuge Complex, but these impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Alternative A.

##### **(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

It is likely that mammals and amphibians and reptiles are subject to some level of disturbance from public use activities occurring on the Refuge Complex, but these impacts are expected to be negligible. Vehicles do occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

##### **(b). Commercial Alligator Harvest**

Under Refuge Management Alternative A, an adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Refuge Management Alternative A should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

##### **(c). Control of Muskrat Populations**

Under Refuge Management Alternative A, muskrat populations would be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

##### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

Surveys, monitoring and research activities for waterfowl to continue under Refuge Management Alternative A include the following: 1) monthly aerial surveys of waterfowl (September through March); ) annual Mottled Duck breeding pair surveys; 3) national, regional and local banding studies of waterfowl,

including ongoing banding studies of Mottled Ducks and snow geese; 4) data collection from harvested waterfowl at check stations including body condition indices and lead shot ingestion rates; 5) participation in the annual Audubon Society Christmas Bird Count; and 6) coordination of research studies on Mottled Ducks and other priority waterfowl species through partnerships with the USFWS Division of Migratory Birds, universities and the U.S. Geological Survey Biological Resources Division.

Surveys, monitoring and research for shorebirds, wading birds and other marsh and waterbirds to continue under Refuge Management Alternative A include the following: 1) an annual nesting survey for colonial nesting waterbirds on Gulf shoreline of Texas Point NWR; 2) periodic spring and fall shorebird surveys in various representative wetland habitats; 3) participation in the annual Audubon Society Christmas Bird Count; and 4) research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Surveys, monitoring, and research activities for resident and migratory landbirds to continue under Refuge Management Alternative A include the following: 1) periodic surveys of selected landbirds in marsh, prairie and woodland habitats; 2) participation in the annual Audubon Society Christmas Bird Count; and 3) coordination of research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Surveys and monitoring activities for fisheries resources to continue under Refuge Management Alternative A include the following: 1) coordination with the USFWS Fisheries Program for periodic fisheries monitoring in representative wetland habitats; and 2) coordination with USFWS Division of Ecological Services and other State and Federal agencies to conduct periodic monitoring and studies of contaminant impacts to fisheries.

Surveys and monitoring activities indirectly benefiting T&E species to continue under Alternative A include the following: 1) participation in the annual coast-wide wintering Piping Plover survey; and 2) coordination of research studies on sensitive and / or declining species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Under Refuge Management Alternative A, annual aerial basking surveys and nighttime spotlight surveys to monitor alligator population trends would continue. Data collection from harvested alligators would continue, including data collection on previously marked and released alligators. Coordination and information sharing with the Texas Parks and Wildlife Department on alligator harvest management, population monitoring, and research would continue.

Collection of information on species composition and relative abundance of invertebrates on the Refuge Complex would continue under Refuge Management Alternative A. These data are typically collected through "BioBlitz" events and other surveys conducted in partnership with universities, the U.S. Geological Survey Biological Resources Division, and volunteer naturalists. The North American Butterfly Association's Fourth of July Butterfly Counts would also continue on the Refuge Complex. These monitoring activities are providing baseline information, previously not available, on this important resource. Many species of invertebrates provide a critically important prey base for migratory birds and other native fish and wildlife.

Surveys and monitoring / research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information facilitates implementation of an adaptive management approach which allows continual refinement and improvement of management activities. In some cases, monitoring activities are providing baseline information, previously not available, on this important resource.

#### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative A, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife

resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex is a reduced impact on fish and wildlife resources from these activities.

#### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative A, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project. 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.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative A would result in benefits to fish and wildlife resources as important habitats are restored and enhanced. Projects on private lands such as those implanted to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat. Ongoing partnerships with the Refuge Friends groups, agencies and conservation organizations and volunteers would support a variety of habitat restoration and biological program activities on the Refuge Complex, contributing directly to conservation of fish and wildlife resources.

## **B. Socioeconomic Resources Section**

### **1. Economic Impacts**

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements:

- 1) Direct expenditures made by USFWS to manage operations at the Refuge Complex,
- 2) Value of production from agricultural programs on the Refuge Complex, and
- 3) Expenditures made by recreational visitors to the Refuge Complex.

Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of each management alternative, including the No Action Alternative, were estimated using the data and methods discussed below.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

**a. Direct Economic Impacts**

**(1). Value of Refuge Operations (Direct Expenditures)<sup>10</sup>**

Data on current local USFWS operational expenditures at the Refuge Complex was gathered and is summarized in Table 4-1. Expenditures that support operations from sources outside the region were not considered. This is due to the fact that these expenditures do not have a local economic impact and

Table 4-1 Annual Average Operational Costs for the Refuge Complex (Direct Expenditures)	
Salaries	\$1,736,727
Utilities	\$35,000
Supplies	\$28,000
Travel	\$39,123
Heavy Equip. Rental	\$50,000
Equipment Replacement	\$27,000
Annual Maintenance (Facilities and Equipment)	\$231,000
Deferred Maintenance	\$533,333
Special Programs	\$15,000
<b>Total</b>	<b>\$2,695,184</b>

are thus not a focus of this analysis. The average annual expenditure estimates were based on budgets for the Refuge Complex for Fiscal Years 2001, 2002 and 2003. The largest expenditure associated with the Refuge Complex is for staff salaries, which comprises approximately 65 percent of total budgeted costs. Deferred maintenance projects are the second largest local expenditure and comprise approximately 20 percent of the annual budget. These projects cover the costs of continuing habitat management and restoration at the Refuge Complex. The third highest cost is for annual maintenance of facilities and equipment.

To support these activities, the USFWS purchases a variety of inputs from the local economy. This includes such things as labor (FWS jobs or contract), materials (e.g. equipment, construction materials, office supplies, plants, rock, fuel, chemicals, etc.), and services (e.g. dirt work, water well development, repairs, etc.) It was assumed for the analysis that the costs summarized in Table 4-1 would represent spending patterns under Refuge Management Alternative A (No Action).

**(2). Value of Production from Refuge Agricultural Programs**

This section presents data that is used to estimate the value of agriculture production within the Refuge Complex, specifically grazing operations and rice production.

**(a). Cattle Grazing**

Information from the USFWS and the Texas Agricultural Statistical Service was used to value current grazing operations within the Refuge Complex. First, information concerning the historical grazing use within the Refuge Complex over the last 6 years was accumulated. The annual grazing rate is expressed in Animal Unit Months (AUMs) which is the standard industry measure for cattle grazing. Cattle grazing on the Refuge Complex for the last 6 years is summarized in Table 4-2.

Table 4-2 Annual Grazing AUMs on Refuge Complex			
Year	Anahuac NWR	McFaddin NWR	Texas Point NWR
2001-2002	14,352	10,240	845
2000-2001	10,542	13,979	737
1999-2000	11,459	10,669	1,140
1998-1999	13,171	6,468	1,477
1997-1998	11,418	12,056	0*
1996-1997	12,778	9,689	1,283

\*Grazing did not occur on Texas Point NWR during this year due to a late decision of a permittee not to graze.

<sup>10</sup> The Value of USFWS Operations Table is essentially done for the Refuge Management Alternative A (No Action). Under the remaining Refuge Management Alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

The value of grazing AUMs for cattle was then estimated as summarized in Table 4-3. For cattle AUMS, as shown in columns 2 and 3, data were obtained from the Texas Agricultural Statistical Service and include the value of cattle sold in Texas each year between 1998 to 2002. Total cattle sales were divided by the number of cows that have calved each year, which provided a value per cow sold as summarized in column 4. The value per cow was then divided by an AUM conversion factor, which resulted in an estimated value per AUM per year. This annual value was adjusted for inflation each year as summarized in column 7. The economic analysis for this report used the 5-year average value of AUMs, or \$88.02 / AUM in inflation-adjusted dollars.

Year	Value of Production (1,000\$s)a	Cows that have Calved (1,000 Head)a	Value Per Cow	Conversion to AUMs (AUMs/cow)b	Value of Production Per AUM Nominal \$	Value of Production Per AUM Real (2002\$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	\$7,830,000	5,880	\$1,332	16	\$83.23	\$89.97
1999	\$7,050,000	5,870	\$1,201	16	\$75.06	\$80.10
2000	\$7,784,000	5,780	\$1,347	16	\$84.17	\$88.00
2001	\$8,357,000	5,810	\$1,438	16	\$89.90	\$91.87
2002	\$8,296,000	5,750	\$1,443	16	\$90.17	\$90.17
<b>5-yr Average</b>					<b>\$88.02</b>	

a Texas Agricultural Statistical Service, "Texas Agriculture Statistics, 2001", Austin, Texas.  
b J.P. Workman, Range Economics, 1986, McMillian Publishing, Inc. New York, New York.

Using the value per AUM and the five-year average grazing use, the value of current grazing operations within the Refuge Complex were estimated as shown in Table 4-4.

	Anahuac NWR	McFaddin NWR	Texas Point NWR
Annual Ave.	12,287	10,517	1,096
Value Per AUM	\$88.02	\$88.02	\$88.02
<b>Total Output</b>	<b>\$1,081,532</b>	<b>\$925,743</b>	<b>\$96,510</b>

\*A similar process was used to estimate the value of grazing operations under the other alternatives. This effort included some development assumptions regarding the number of annual AUMs expected to occur under each alternative. For instance, grazing use is expected to increase under Alternative B and D in varying ways due to the change in management while grazing use is expected to decrease under Alternative C. The most dramatic change will occur under Alternative E where the controlled grazing program would be eliminated.

### (b). Rice Production

The USFWS manages a cooperative farming program within the Refuge Complex. The program supports rice farming and occurs solely on Anahuac NWR. The refuge has 1,713 base acres registered with the USDA used currently by four permittees on a three-year rotational basis. Thus, approximately 500 to 700 acres of rice are currently produced on an annual basis and would continue under Refuge Management Alternative A. The USFWS recognizes the benefits of having rice produced on the refuge as a potential food source for migratory birds. Rice operations within the refuge must be compatible with these wildlife goals. In accordance, USFWS requires permittees to meet certain stipulations including: use of only approved herbicides, maintenance schedules, use of certified rice seed and restrictions on second growth harvests. Currently, nearly two-thirds of the total acreage within the cooperative farming program is managed as an organic rice farming operation.

Using information from the Texas Agriculture Extension Service, an estimate of average returns for rice production was prepared. A summary is provided in Table 4-5.

	Quantity (cwt)	\$/cwt (2002\$)	Estimated Value Per Acre
Rice 1st Crop	56.9	\$7.32	\$416

Source: Texas Agriculture Extension Service, Rice, First and Second Crop, Texas Gulf Coast, 2000 Projected Costs and Returns per Acre

Using the estimated value per acre from Table 4-5 and the average number of acres actually farmed each year, an estimate of the value of annual rice production occurring on the Refuge Complex was prepared and is summarized in Table 4-6.

	Average Acres	Value Per Acre	Estimated Value of Production
Rice 1st Crop	600	\$416.45	\$249,867

### (3) Value of Refuge Recreational Programs

Economic impacts occur within the local economy as recreationalists spend money while visiting the Refuge Complex. From a regional economic standpoint, the importance of this spending is dependent on where the funds originate. If funds originate outside the region, it generates additional economic activity. If they originate from inside the region and would have occurred anyway, it does not increase economic activity though it may still be important to local businesses. This analysis focused on the number of visitors that originate from outside the study area (e.g. outside Jefferson and Chambers counties) and travel to the Refuge Complex to enjoy recreational activities.

The value of refuge current recreational programs under Refuge Management Alternative A was estimated using several steps as follows:

- Estimate visitation by activity to the refuges open for recreation (uses considered included hunting, fishing, wildlife observation)
- Determine the number of out-of-area visitors that come to the Refuge Complex
- Estimate the average expenditures per Recreational Visitor Days (RVDs) at the Refuge Complex

First, estimates were generated on the number of visits made to each refuge open to recreational use (e.g. Texas Point, McFaddin and Anahuac NWRs). These estimates are based on currently available data from the USFWS on recreational use and on a series assumptions regarding how management actions will affect recreational uses during the study period. Most of the data used to estimate refuge visitation comes from the Recreation Management Information System (RMIS), which includes data on visitation reported by Refuge Complex staff. Estimated refuge visitation is expressed in RVDs, and the annual estimates of RVDs is used to calculate the logarithmic trend for each activity. The trend is then applied over the 15-year study period to determine projected visitation.

Next, the origin of recreational visitors to the Refuge Complex was determined based on USFWS data and information. This includes visitor origin for fishing and hunting which was estimated from actual licenses or staff observations. The determination also used visitor origin estimates for wildlife observation as published by the USFWS for Laguna Atascosa National Wildlife Refuge in Texas.<sup>11</sup> It was determined that approximately 90% of the visitors participating in wildlife observation were not local, while only about 10% of the visitors participating in hunting or fishing were not local.

11U.S. Fish and Wildlife, "Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge", June 1997, p. 94.

Annual RVDs by activity for non-resident recreationalists was estimated using the above factors and the estimated annual RVDs for the Refuge Complex based on USFWS data. Annual non-resident RVDs for 2003 using this method is provided in Table 4-7. Wildlife observation attracts the greatest percentage of non-resident recreationalists accounting for over 83 percent of annual non-resident visits. Because visitors may spend less than one day at the Refuge, counting brief visits as full RVDs would overstate visitor spending that can be attributed to the Refuge Complex. However, observations by USFWS staff indicated that individuals using the Refuge Complex do spend most of the day on site while recreating. Therefore, no additional adjustments were made to the RVD estimates.

Wildlife Observation	Waterfowl Hunting	Other Hunting	Fishing	Total Non-Resident Visitors
29,099	1,167	0	4,744	35,010

Average daily expenditures made by recreators visiting the Refuge Complex were extracted from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Texas.<sup>12</sup> This survey is administered every five years to recreators throughout the country. Each respondent who indicated participation in an activity were asked about the trips made to a particular state to pursue this activity including trip expenditures. Data published for Texas regarding trip expenditures associated with wildlife observation, migratory bird hunting and fishing were used to estimate an average expenditure per day as summarized in Table 4-8. This data was used to estimate total recreational expenditures that can be attributed to recreational visitors to the Refuge Complex.

Total annual direct expenditures associated with recreation at the Refuge Complex was estimated for fiscal year 2003 by multiplying the non-resident RVDs provide in Table 4-7 by the average daily expenditures provided in Table 4-8. The summary provided in Table 4-9 shows that annual direct recreational expenditures exceeds \$1 million in the secondary study area on an annual basis.

Itemized Expenditures	Fishing	Migratory Bird Hunting	Wildlife Observation and Photography
Food and lodging	\$10.80	\$21.07	\$19.77
Food	\$7.83	\$16.13	\$11.00
Lodging	\$2.97	\$4.94	\$8.76
Transportation	\$7.27	\$12.38	\$8.26
Other trip costs	\$9.55	\$0.00	\$2.84
Privilege and other fees	\$2.77	\$6.13	Na
Boating costs	\$4.09	\$1.31	Na
Bait	\$1.97	\$0.00	Na
Ice	\$0.57	\$0.00	Na
Heating and cooking fuel	\$0.14	\$0.00	Na
<b>Average Daily Costs</b>	<b>\$47.97</b>	<b>\$61.96</b>	<b>\$50.63</b>

\*Estimated with data from the U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

12 U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

Table 4-9  
Annual Direct Expenditures Associated with Recreational Visitors at the Refuge Complex (2003)

Expenditure Type	Total Recreational Expenditures (2003\$)
Food	\$415,563
Lodging	\$284,225
Transportation (Gas)	\$313,534
Other trip costs (Misc.)	\$82,552
Boating costs	\$3,049
Bait	\$0
Ice	\$0
<b>Sum</b>	<b>\$1,098,923</b>

## b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

**Employment:** The annual average estimated employment is measured as Full-Time Equivalent (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

**Labor Income:** Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

**Other Property Type Income:** This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

**Indirect Business Taxes:** Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses

### (1). Refuge Operations

The largest economic contribution results from the direct expenditures made by the USFWS to support operations at the Refuge Complex. These operations currently support approximately 45 FTEs per year. This includes direct employment at the Refuge Complex of approximately 30 FTEs at this time, as well as an additional 15 FTEs supported in the surrounding area. Current operations generate approximately

\$1.2 million in income and nearly \$450,000 in indirect business taxes to local government entities. The economic impacts of refuge operations are summarized in Table 4-10.

Impacts on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)	45	45	45
Labor Income	\$1,066,457	\$1,066,457	\$1,066,457
Other Property Type Income	\$222,664	\$222,664	\$222,664
Indirect Business Taxes	\$493,149	\$493,149	\$493,149

## (2). Refuge Agricultural Program

Current agricultural activities on the Refuge Complex, cattle grazing and rice farming, support approximately 20 FTEs per year, about \$859,000 in annual income and \$87,000 in indirect business taxes. See Table 4-11.

Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)	20	20	20
Labor Income	\$587,382	\$587,382	\$587,382
Other Property Type Income	\$272,759	\$272,759	\$272,759
Indirect Business Taxes	\$87,668	\$87,668	\$87,668

## (3). Refuge Recreational Programs

Recreational activities on the Refuge Complex also generate economic activity in the regional economy by supporting approximately 25 FTEs, and generating \$883,000 in annual income and \$136,000 in indirect business taxes. Under this Alternative there would be a slight increase in employment during the study period which is attributed to expected growth in demand for recreational activities under current management.

Total recreational expenditures by activity were estimated by multiplying average daily expenditures by the number of RVDs that are likely to occur annually each year at the Refuge Complex for each alternative. A series of economic multipliers, estimated with IMPLAN were then applied to the total annual expenditures to estimate the impacts to employment, income and indirect business taxes in the study area that can be attributable to recreation at the Refuge Complex. See Table 4-12.

Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)	25	26	26
Labor Income	\$609,908	\$621,374	\$629,040
Other Property Type Income	\$224,963	\$229,144	\$231,939
Indirect Business Taxes	\$136,816	\$139,559	\$141,394

## 2. Population Impacts

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives

under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under current management is expected to continue to support approximately 90 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

### **3. Fiscal Impacts on Local Governments**

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and / or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under current management or any of the proposed alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers-Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area.

### **4. Social Impacts**

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, ecosystem management actions such as those made by the USFWS within the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

#### **a. Impacts to Social Structures and Lifestyles**

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and / or community cohesiveness and stability)
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there

would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and / or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause / effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

#### **b. Impacts to Relationships between the USFWS and Stakeholder Groups**

General categories of stakeholder groups describe those persons and / or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that 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. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole.

**Residents and / or Employees** – those persons who live and / or work within the area would generally continue their existing relationships with the USFWS. The reactions of those persons to any changed relationship with the USFWS would be individualistic in nature, and could range from very positive to very negative feelings depending on the goals, values and beliefs of those affected.

**Landowners** – existing land management issues such as water management and prescribed fire activities may continue to be controversial for some landowners in the area.

**Recreationalists** – the land and water of the Texas Chenier Plain region have a rich heritage of public and commercial recreational activity. While recreation plays an important part in the economy of the area, outdoor recreation opportunities are also a traditional and substantial part of the social structure and lifestyles of the area. The USFWS is constantly struggling to balance recreational opportunities with its goal of protecting natural resources. Under any of the Refuge Management Alternatives being considered, this struggle would continue, and no matter which Alternative is implemented, there would continue to be major disagreement within the nearby population over the proper amount, locations, and access to recreational resources within the Refuge Complex.

**Governmental or Quasi-Governmental Agencies** – relationships between governmental or quasi-governmental agencies in the area would continue existing trends under any of the Refuge Management Alternatives, with coordination of these agencies with the USFWS sometimes being difficult because of conflicting goals and objectives. The perception of the USFWS being “outsiders” who have a substantial influence on local residents and governments would continue to exist, and associated issues would likely not be resolved easily.

**Business-Persons and / or Business-Owners** – as with current conditions, businesspersons and / or business owners would generally have economic development and growth as major future goals that could conflict with USFWS management actions under any of the Refuge Management Alternatives. Many persons supporting economic growth as a high priority may continue to be frustrated with USFWS

actions that could be perceived as limiting or preventing economic growth. There may be a smaller portion of business persons / business owners who would support USFWS activities in recognition that these activities could bring an expanded visitor base to the area, with the resulting expansion of the ecotourism industry providing economic benefits to at least some portion of local and regional business.

**Conservation or Environmental Protection Advocates** – those supporting conservation of natural resources and environmental protection would generally be supportive of current USFWS management actions under Refuge Management Alternative A. However, there would also continue to be instances where conservationists / environmental protection advocates may believe that the USFWS is not doing enough or taking the correct actions to adequately preserve or protect natural resources within the Refuge Complex.

Overall, USFWS management activities and objectives under all of the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

### **c. Impacts to USFWS Public Outreach Programs and Activities**

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and / or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative A, current USFWS public outreach efforts would continue.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the alternatives for potential management actions:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and / or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved, and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternative A, the No Action Alternative, existing conditions and trends would generally remain the same. The management of the Refuge Complex would not change in substantive ways.

Under the other Refuge Management Alternatives (B through E), management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure / lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

#### **d. Environmental Justice**

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex CCP / EIS is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse effects and some beneficial effects by the continued operation and / or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and / or low-income population components. Overall, the identified minority and / or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

## **II. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE B: EMPHASIS ON INTENSIFYING MANAGEMENT OF WETLAND HABITATS FOR WATERFOWL, SHOREBIRDS, WADING BIRDS, AND OTHER WETLAND-DEPENDENT MIGRATORY BIRDS.**

### *Overview*

Under this Alternative, the Refuge Complex would focus its management efforts on active management of wetland habitats to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory and resident birds. Two new marsh semi-impoundments totaling 6,500 acres would be constructed and water management capabilities enhanced in existing impoundments through installation of new water control structures and levees. The cooperative rice farming program, moist soil management, and haying and mowing programs on Anahuac NWR would be expanded to enhance shallow freshwater wetland habitats and adjacent upland prairies for resident Mottled Ducks and for wintering and migrating waterfowl, shorebirds and wading birds. In marsh habitats, grazing intensity, annual prescribed burn acreage and the frequency of burning would be increased to substantially increase the amount of marsh habitat in early successional plant communities. The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses, with an emphasis on providing more public hunting opportunities.

### **A. Natural Resources Section**

#### **1. Impacts to Air Quality**

The USFWS fire management program on the Refuge Complex has the greatest potential of all refuge management actions to impact the region's air quality. Fire management activities include both the suppression of unplanned wildland fires and prescribed burning. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Under Refuge Management Alternative B, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Reducing smoke impacts to surrounding communities is also an important consideration in planning and implementing suppression actions on all wildland fires occurring on the Refuge Complex.

Under Refuge Management Alternative B, the prescribed burning program would be expanded relative to Refuge Management Alternative A. The USFWS would continue to use prescribed burning on the Refuge Complex primarily to maintain and improve habitat for wintering and migrating waterfowl and other migratory birds and to reduce accumulations of hazardous fuels. Most burning would be conducted in emergent marsh habitats on the Refuge Complex, with an annual burning objective of 35,000 acres (compared to 12,000 – 15,000 acres under Refuge Management Alternative A).

Although prescribed burning under Refuge Management Alternative B would continue to be beneficial to the Refuge Complex's habitats and wildlife (as discussed under *Impacts to Vegetation / Habitats* and *Impacts to Fish and Wildlife Resources* below), this management action could also negatively impact local air quality, primarily through the production of smoke. Because prescribed burning is conducted on the Refuge Complex under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality from the USFWS fire management program would nonetheless remain minimal. The potential for smoke impacts to air quality due to unpredicted climatic events would

increase relative to Refuge Management Alternative A because of increased prescribed burning activities and the additional smoke produced.

Conversely, additional prescribed burning on the Refuge Complex under controlled conditions would reduce the potential for smoke impacts to air quality from unplanned wildland fires by reducing vegetative fuels. Additional prescribed burning activities on the Refuge Complex under Refuge Management Alternative B would result in larger areas with reduced vegetative fuel loads. Most lightning-caused natural fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires are less likely to start in areas with reduced fuel loads because of prescribed burning, and fires that do start burn with less intensity, produce less smoke, and are easier to suppress than in unburned areas with excessive accumulations of hazardous fuels.

## **2. Impacts to Geology and Soils**

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under Refuge Management Alternative B. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Impacts of these activities on soils and geological processes would be similar to those described under Refuge Management Alternative A. As with Alternative A, it is unlikely that the limited scope of these activities under Refuge Management Alternative B would be sufficient to counteract the effects of future relative sea level rise and altered hydrological regimes. Accelerated rates of shoreline retreat and coastal land loss would likely continue.

Both structural marsh management and prescribed burning can affect soil formation and marsh vertical accretion or elevation gain (impacts are fully described under Refuge Management Alternative A). Under Refuge Management Alternative B, the USFWS would increase the acreage of coastal marsh under structural marsh management by approximately 6,500 acres and would increase prescribed burning from 12,000 to 15,000 acres annually to approximately 35,000 acres annually. USFWS water management activities in fresh to brackish coastal marshes typically reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. In meeting these objectives, marsh management should benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils. Fire may have positive or negative impacts on soil formation and marsh accretion. Insufficient information currently exists to fully evaluate these effects.

## **3. Impacts to Hydrology and Water Quality**

### **a. Hydrology**

Under Refuge Management Alternative B, the USFWS would continue wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. The USFWS would expand structural marsh management under this Alternative through construction of 2 additional marsh semi-impoundments totaling approximately 6,500 acres, enhance hydrologic management in several existing marsh units by developing new infrastructure,

and expand cooperative rice farming and moist soil management programs. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass.

The wetland management and restoration activities implemented by the USFWS under Refuge Management Alternative B would help maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats would continue to support a natural diversity of native plant, fish and animal communities. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes on the Refuge Complex also would help to prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain (accretion).

As with Refuge Management Alternative A, the relatively small-scale hydrologic and shoreline restoration projects to be maintained and implemented in the future on the Refuge Complex under Refuge Management Alternative B are not likely to be sufficient to counter the effects of relative sea level rise and altered hydrological regimes on coastal land loss. Current rates of shoreline retreat and conversion of vegetated marshes to open water will likely continue, and may accelerate, under this Alternative. For example, restoration of the historic barrier beach and dunes on McFaddin NWR would require a large-scale project affecting an additional 16 miles of Gulf shoreline. Under this Alternative, increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes on McFaddin and Texas Point NWRs will continue to negatively impact soil formation and vertical accretion by causing plant mortality and an overall reduction in above and below-ground plant productivity. Under this scenario, these marshes will become increasingly susceptible to submergence and conversion to open water.

#### **b. Water Quality**

Under Refuge Management Alternative B, the USFWS would continue activities described under Alternative A. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills to water quality, habitats and fish and wildlife resources.

#### **4. Impacts to Vegetation / Habitats**

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative B would include all of the habitat management and restoration activities in wetland and upland habitats described under Alternative A. Changes from Alternative A would include expanded structural water management in coastal marshes, expanded rice farming and moist soil management programs, and intensified use of prescribed burning and controlled grazing.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation would continue under Refuge Management Alternative B. Additional waterfowl hunting opportunities would be provided and some changes to administration of the hunt programs would occur. Impacts to vegetation and habitats would be similar to those described for these uses under Refuge Management Alternative A.

Current systematic monitoring of vegetation and habitats as part of the Refuge Complex biological program would continue under Refuge Management Alternative B.

Management of oil and gas activities through issuance of Special Use Permits would continue as under Refuge Management Alternative A, and would be aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

The USFWS would also continue to work with private landowners to facilitate implementation of wetland habitat restoration and enhancement projects. Community outreach efforts would include ongoing partnerships with Refuge Friends groups, agencies, volunteers, conservation organizations, community

groups and industry to further natural resource conservation on the Refuge Complex and throughout the project area.

## **a. Impacts to Vegetation and Habitats from Habitat Management / Restoration Activities**

### **(1). Wetland Specific Management and Restoration**

Wetland management and restoration activities under Refuge Management Alternative B would influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

#### **(a). Water Management in Coastal Marshes**

In addition to management activities described under Refuge Management Alternative A, the USFWS would expand structural marsh management through construction of 2 additional marsh semi-impoundments totaling approximately 6,500 acres on McFaddin and Anahuac NWRs, and would enhance management capabilities in several existing managed marsh units by installing new infrastructure including water control structures and levees under Refuge Management Alternative B. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization, allowing both emergent and submergent vegetation to flourish (Hess *et al.* 1989). Monitoring on and adjacent to McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

The additional structural marsh management on the Refuge Complex would maintain or restore approximately 6,500 acres of intermediate marsh in areas which have become brackish due to channelization and saltwater intrusion. Expanded and enhanced hydrologic management and reducing water turbidities through construction of marsh terraces under this Alternative would increase production and diversity of submerged aquatic vegetation open water habitats within managed marsh units. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) would help to prevent the conversion of vegetated marsh in these areas to open water. By promoting plant productivity, this management activity may also contribute to marsh soil formation and surface elevation gain (marsh accretion).

The above notwithstanding, periodic climatic events such as flooding during periods of high rainfall or due to tidal storm surge and prolonged drought would continue to influence and sometimes be the dominant factors controlling hydrologic regimes and the response of vegetative communities in the Refuge Complex coastal marshes.

#### **(b). Marsh Restoration**

Under the Refuge Management Alternative B, the level and scope of marsh restoration using dredge material would continue as described under Alternative A. Marsh restoration efforts under Refuge Management Alternative B would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife.

### **(c). Moist Soil Management**

Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). Like coastal marshes, shallow freshwater prairie wetlands provide important food resources and cover to a diversity of wetland-dependent resident and migratory birds and wildlife.

Under the Refuge Management Alternative B, moist soil management capabilities would be developed on an additional 1,100 acres on the Refuge Complex (900 acres on Anahuac NWR and 200 acres on McFaddin and Texas Point NWRs). This would create additional shallow freshwater wetland habitat for migratory birds and other wetland-dependent wildlife.

Expanded moist soil management would increase biological diversity on the Refuge Complex. Moist-soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Water management and mechanical soil manipulations in new moist soil units would promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Additional moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime would favor the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

Expansion of the moist soil management program under this Alternative would reduce the overall area on the Refuge Complex available for native prairie restoration.

### **(d). Cooperative Rice Farming Program**

Under Refuge Management Alternative B, the USFWS would expand its cooperative rice farming program on Anahuac NWR by farming an additional 300-500 acres annually, from existing levels of 500-700 acres. This expanded program would provide additional shallow freshwater wetland habitat for migrating and wintering waterfowl, shorebirds, wading birds and other wetland-dependent wildlife. Currently, almost 80% of the rice produced on the refuge is organically grown, and the expanded program would give preference to organic producers. Organically produced rice reduces the overall input of herbicides on the refuge.

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. Other changes in rice cultivation practices may also have deleterious effects on waterbird populations. Abandoned rice fields and pasturelands are susceptible to invasion by Chinese tallow, eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality and will require extensive restoration efforts.

Expansion of the cooperative rice farming program on Anahuac NWR under Refuge Management Alternative B would serve several outcomes for migratory bird management: creating forage for migrating and wintering waterfowl, habitat for migrating shorebirds, and fresh water habitat for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also left for wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest ricefields that were cultivated and at least partially flooded (Czech and Parsons 2002).

Expansion of the cooperative rice farming program would reduce the overall area on Anahuac NWR available for native prairie restoration.

## **(2). Upland Specific Management and Restoration Activities**

### **(a). Native Prairie Restoration and Management**

Under Refuge Management Alternative B, upland grassland habitats would continue to be managed using the management tools described in Refuge Management Alternative A. Under this Alternative, no additional native prairie habitat would be restored. Together, the management actions undertaken under Refuge Management Alternative B would continue to protect and enhance the 5,774 acres of non-saline grasslands on the Refuge Complex. Impacts of burning, grazing, exotic / invasive species management and mowing / haying to vegetation and habitats are discussed below. Overall, prairie management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity.

### **(b). Woodlot Restoration and Protection**

Under Refuge Management Alternative B, the USFWS would continue management activities as described under Alternative A on the 127 acres of existing woodlots: 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.

Overall, implementation of the USFWS management actions under this Alternative would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

## **(3). General Habitat Management Activities**

Under Refuge Management Alternative B, the USFWS would expand prescribed burning, controlled livestock grazing and mowing / haying to enhance wetland and upland habitats for migratory birds. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Exotic / invasive species management and shoreline restoration and protection activities would continue as described under Refuge Management Alternative A.

### **(a). Fire Management - Prescribed Burning / Wildland Fire Suppression**

Under Refuge Management Alternative B, the fire management program would continue to involve both suppression of unplanned wildland fires and prescribed burning. Suppression activities would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). The prescribed burning program would be expanded to an annual objective of approximately 35,000 acres (primarily in marsh habitats), and increase of 20,000 acres above current levels. Although most burning would continue to be conducted on a three-year rotation, annual and bi-annual burning in selected fresh and intermediate marsh habitats would be conducted. Most prescribed burning would be conducted from October through January in marsh habitats. Prescribed burning of upland grassland units would occur primarily in late winter and early spring.

Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, and seashore saltgrass. Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.) and forbs such as purple ammenia and Delta duck potato, increases after a fire, particularly when followed by grazing and suitable hydrology.

The impacts of prescribed burning in upland grassland habitats include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control exotic and / or invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased.

In summary, beneficial impacts of an expanded (larger areas burned annually and more frequent burning) prescribed burning program under this Alternative would be similar to but more extensive than those described for burning under Refuge Management Alternative A, and include:

- Hazardous fuels would be reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning over larger areas annually and more frequent burns would further lessen the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds would be enhanced by maintaining a larger proportion of marsh habitats on the Refuge Complex in early successional plant communities which provide important food resources, by increasing production and nutritional quality of these foods, and by enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, would be further suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife.

While fire, whether planned or unplanned, can have positive ecological effects, detrimental impacts to vegetation and habitats ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water can also occur. For example, burning under excessively dry conditions could result in plant mortality and consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Proper timing of prescribed burns under appropriate environmental and climatic conditions is essential to minimize negative impacts. Under Refuge Management Alternative B, the USFWS prescribed burning program would continue to consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive wetland and upland habitats on the Refuge Complex. Potential for some adverse affects to vegetation and habitats to occur would increase under this Alternative because of the additional acreage burned annually and the increased frequency of burning.

#### **(b). Controlled Livestock Grazing**

Controlled grazing on the Refuge Complex is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats. Under Refuge Management Alternative B, grazing intensity and duration would be increased in most fresh and intermediate marsh habitats on the Refuge Complex. Controlled grazing would still be applied on approximately 41,000 acres of the Refuge Complex, but higher stocking rates would be used and grazing periods would be extended in selected refuge units.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relationship of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Studies conducted on Sabine National Wildlife Refuge in Cameron Parish, Louisiana (Valentine 1961) determined that increased grazing can change tall climax marshhay cordgrass stands to a more diverse community such as seashore paspalum, *Setaria*, and longtom (*Paspalum lividum*), that are more beneficial to certain types of wildlife. Depending on site conditions (elevation, soil, and hydrology) annual grasses and forbs (including millets, fall Panicum (*Panicum dichotomiflorum*), sprangletop, and *Setaria*) can be produced through proper grazing.

Pate (2001) found that grazed marshes remained in a sub-climax state, while habitat within grazing exclosures reverted to marshhay cordgrass. At the onset of the study *Spartina* spp. made up 20% of the plant community, while seashore paspalum comprised 80%. By the end of the study, communities within grazing exclosures changed to 65% *Spartina* spp. and 25% seashore paspalum. In contrast, the grazed area maintained high cover of seashore paspalum throughout the study. Shallowly-flooded seashore paspalum provides habitat for many species of waterfowl, wading birds and shorebirds, while dense stands of marshhay cordgrass preclude use by these species.

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Increased grazing intensity and duration in marsh habitats under this Alternative would increase the abundance of target plant species and communities in intermediate and brackish marsh habitats on the Refuge Complex, including Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. The grazing regime under this Alternative would provide additional areas with optimal physical structure of vegetation for waterfowl utilization by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Specifically, the beneficial impacts of grazing in wetland habitats would be similar but more extensive than those described under Refuge Management Alternative A, and include:

- Rank vegetation would be reduced, enabling migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Competing growth of marshhay cordgrass and other dominant climax plant communities would be reduced, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Additional open water habitat would be created, which provides loafing areas for birds and allow them to access aquatic invertebrates.
- Marsh burning would be complemented by prolonging the time that browse is available for goose use.
- Plant vigor and plant productivity would be increased, nutrient recycling enhanced, and excessive build-up of residual plant material prevented.

- Hazardous fuel loading would be reduced, reducing the amount and intensity of wildfires.
- Capped soils would be broken through hoof action, assisting in seedling establishment of many preferred food plants.
- Vegetation in recently burned areas would be maintained in more palatable stages for wintering waterfowl.

Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1992). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged intensive grazing, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative B, the USFWS would continue to monitor grazing programs and adjust grazing strategies so as to avoid detrimental impacts. The potential for some adverse impacts to vegetation and habitats to occur would increase under this Alternative. Upland areas adjacent to marshes but contiguous within an individual grazing unit would be subject to higher grazing intensities and be most susceptible to potential adverse impacts.

### **(c). Exotic / Invasive Species Management**

Under Refuge Management Alternative B, the level and scope of exotic and invasive species management activities, as well as their impacts to native vegetation and habitats on the Refuge Complex, would generally continue as described for Alternative A. The USFWS would continue to control exotic and invasive plant species to conserve native biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program would be implemented to control the following exotic and invasive plant species (USFWS, 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies

In wetland habitats, these activities would result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

Control of Chinese tallow and deep-rooted sedge in prairie and woodlots would result in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub

abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

Under Refuge Management Alternative B, the USFWS would also continue to control exotic animals on the Refuge Complex to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral hog control would be conducted as described under Alternative A. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants. Control activities for nutria under this Alternative would be the same those under Refuge Management Alternative A, and if implemented would decrease damage to wetland habitats.

#### **(d). Shoreline Protection and Restoration**

Under Refuge Management Alternative B, shoreline protection and restoration activities would continue as described under Alternative A. These activities would positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier dunes and beaches along the Gulf of Mexico would protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events, as well as restoring an upland native habitat type which has been almost completely lost. Use of dredged material along existing shorelines would protect existing marshes by slowing erosion and shoreline retreat, providing a substrate for reestablishment of marsh vegetation and restoration, and increasing net sediment supply to marshes which would provide nutrients and increase plant productivity (Chabreck 1976, 1994). Breakwaters would continue to enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have converted to open water. The stands of smooth cordgrass also would provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

The relatively small scale of ongoing shoreline restoration projects under Refuge Management Alternative B on the Refuge Complex is not likely to effectively counter the future effects of relative sea level rise and altered hydrological regimes, however, and accelerated rates of shoreline retreat and land loss would likely continue to occur. For example, total restoration of the barrier beaches and dunes on McFaddin NWR would require work along an additional 16 miles of Gulf shoreline. Increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes would continue to negatively impact vegetation and habitats on McFaddin and Texas Point NWRs by causing direct mortality of some plant species and an overall reduction in plant productivity.

#### **(e). Mowing and Haying**

Under the Refuge Management Alternative B, approximately 400 acres of upland grassland habitats would be mowed or hayed annually on the Refuge Complex, an increase of approximately 300 acres from current levels. Mowing and haying would result in invigorating growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis. Reduction of this herbaceous and woody cover often results in the “release” of native prairie plants.

#### **b. Impacts from Public Use Programs**

Assuming an increase in visitation to the Refuge Complex under Refuge Management Alternative B due to improved and expanded waterfowl hunting opportunities and new hunting programs for doves and snipe, rails and gallinules and to development of new visitor facilities, impacts to vegetation and habitats described below would likely increase over current levels.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and

fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

Although visitation would increase under this Alternative, administration and management of these uses would continue and impacts to vegetation and habitats would be expected to remain localized and not substantial. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts. New facilities would be designed and located in such a manner so as to further reduce these impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative B, the USFWS would continue routine patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative B. Continued habitat and vegetation monitoring activities and research studies on the Refuge Complex would support an adaptive management approach, by providing information which helps refine and improve existing management practices.

### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative B, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and / or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduction of impacts to vegetation and habitats from these activities.

## **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative B, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance wetland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. 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.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative B would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

## **5. Impacts to Fish and Wildlife Resources**

Under Refuge Management Alternative B, habitat management and restoration and biological program activities on the Refuge Complex would be focused on wetlands and migratory birds, with continued consideration of the conservation of the following fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS would continue to administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development and expanded community outreach and partnership programs would contribute to conservation of fish and wildlife resources on the Refuge Complex and throughout the project area.

### **a. Impacts from Habitat Management and Restoration Activities**

#### **(1). Impacts to Migrating and Wintering Waterfowl**

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation

of habitat on landscape scale has increased the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.<sup>13</sup> Many wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Overall and all else being equal, expanding and enhancing wetland management and restoration under Refuge Management Alternative B can be expected to increase wintering and migrating waterfowl populations on the Refuge Complex. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and / or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

Under the Refuge Management Alternative B, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations on the Refuge Complex.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative B, approximately 36,500 acres of marsh habitats would be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems, and management capabilities would be enhanced on several existing managed units. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

Approximately 1,100 additional acres of moist soil units would be developed on the Refuge Complex under Refuge Management Alternative B, specifically to provide additional high quality habitat for wintering and migrating waterfowl. Moist soil management would 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.

On Anahuac NWR, rice production through the cooperative rice farming program would be expanded to approximately 1,000 acres annually under this Alternative to provide additional habitat for wintering and migrating waterfowl. Management of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

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<sup>13</sup> During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

Marsh restoration using dredge material would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

#### **(b). General Habitat Management and Restoration Activities**

Under Refuge Management Alternative B, the USFWS would continue an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex to promote optimal habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, enhanced water management capabilities, expanded prescribed burning and more intensive grazing under Refuge Management Alternative B would provide enhanced habitat conditions for wintering waterfowl on the Refuge Complex. Prescribed burning and grazing would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing would also result in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing also would help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Waterfowl habitat on the Refuge Complex would also be enhanced under Refuge Management Alternative B through the control of undesirable invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would also be controlled to restore and maintain open water habitats. Maintaining an interspersion of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source for migratory birds. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

Continuation of shoreline protection and restoration activities under Refuge Management Alternative B would enhance waterfowl habitat on the Refuge Complex by decreasing saltwater intrusion into inland marshes and addressing threats of additional saltwater intrusion. However, the scope of these activities under Alternative B will likely not counteract the ongoing and future impacts of relative sea level rise, loss of coarse sediment supply, and altered hydrological regimes, especially on McFaddin and Texas Point NWRs. Declines in habitat quality caused by regular tidal overwash are adversely affecting migratory waterfowl use on these refuges. As beach ridges and the banks of the GIWW erode they are less effective barriers to tidal inundation and salt water intrusion during storm and other high tidal events. Overwash events create sudden and drastic spikes in salinities, often killing submerged aquatic vegetation and seed producing annual plants. Inundation of the marshes with sea water provides the sulphates which are reduced to hydrogen sulfide under conditions of high water temperatures. Hydrogen sulfide toxicity and low dissolved oxygen cause large scale die-offs of plants and animals, including many invertebrates which provide an important food source for waterfowl and other migratory birds. Survey data indicate that waterfowl numbers have dropped to below five birds per thousand acres in affected areas following overwash events, and below one bird per thousand acres after severe events (USFWS, unpublished data). Areas that can be heavily impacted by overwash events now encompass nearly 15,000 acres on McFaddin NWR and near 1,500 acres on Texas Point NWR.

Increased saltwater intrusion from frequent tidal overwash from the Gulf into inland marshes on these refuges will continue to negatively impact habitat quality for waterfowl, other migratory birds, and other native fish and wildlife species. If present erosion problems persist, total acreage of impacted marsh could increase to nearly 30,000 acres over the next 5 to 10 years. Declining habitat conditions due to increased saltwater inundation could result in further significant declines in wintering waterfowl use on McFaddin and Texas Point NWRs.

## **(2). Impacts to Resident Waterfowl - Mottled Ducks**

Under Refuge Management Alternative B, many habitat management and restoration activities currently conducted on the Refuge Complex would be continued, and all would be expected to have positive impacts on this species. Several habitat management and restoration activities will be expanded specifically to benefit Mottled Ducks. Management and enhancement of nesting and brood-rearing habitats would be targeted.

### **(a). Wetlands Management and Restoration**

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative B would provide additional enhanced habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Expanded and enhanced structural marsh management would maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. It would enhance diversity and productivity of submerged aquatic vegetation in open water habitats, providing an important year-round food sources for Mottled Ducks. Expanded moist soil management and cooperative rice farming programs would provide additional shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. Rice farming would provide an additional 300-500 acres and moist soil management an additional 1,100 acres of wetland habitat over current levels on the Refuge Complex under this Alternative. Approximately 400 acres of moist soil units would be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

### **(b). Uplands Management and Restoration**

Native prairie management activities under Refuge Management Alternative B would generally remain the same as under Alternative A, and would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The integrated application of prescribed burning, controlled livestock grazing, herbicide application and expanded mowing / haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies (and on levees and along fence lines) would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks 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. Protecting extant coastal prairie and restoring adjacent prairie and wetland habitats under Refuge Management Alternative B on the Refuge Complex would increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

### **(c). General Habitat Management Activities**

Annual prescribed burning would increase under Refuge Management Alternative B, to a target of 35,000 acres. Grazing intensity (higher stocking rates) and duration in fresh and intermediate marshes would be increased. The integrated combination of expanded water level and salinity management, and increased prescribed burning and controlled livestock grazing in wetland habitats on the Refuge Complex under this

Alternative would increase the acreage of optimal wetland habitat for Mottled Ducks. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex. These cordgrass ridges are dominated by Gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania* spp.) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks.

Improper application of these habitat management practices has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988). The potential for some negative impacts to Mottled Duck nesting habitat would increase under Refuge Management Alternative B. Higher cattle stocking rates and grazing durations and more frequent burning in fresh and intermediate marshes could reduce availability of suitable nesting cover in contiguous salty prairies and non-saline grassland habitats under this Alternative.

Marsh habitats being impacted by tidal overwash of the eroding beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck nesting and brood rearing habitat. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50% to 65% over the last 10 years. If erosion problems persist and result in increased frequency of saltwater intrusion events, Mottled Duck use and reproductive success on the Refuge Complex will likely further decline.

### **(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds**

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant,

Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migratory, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Refuge Management Alternative B would continue to positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative B, expanded and enhanced structural marsh management would improve habitat conditions in a wide variety of vegetation and habitat types used by many avian species in this group. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species.

Under Refuge Management Alternative B, the cooperative rice farming and moist soil management programs would be expanded to provide additional shallow freshwater wetland habitat. In total, rice farming would provide approximately 1,000 acres on Anahuac NWR, and Complex-wide moist soil management would provide 1,600 acres under this Alternative. Approximately 300 acres of the Anahuac NWR's moist soil units would be managed specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species would include Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. Under this Alternative, 1,200 acres of moist soil units would provide wetland habitat for shorebirds, wading birds, and other marsh and waterbirds over the winter months. Wading and marsh bird species using moist soil habitats on the Refuge Complex include 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.

In general, shorebirds and wading birds would also benefit from expanded moist soil management and rice farming activities under this Alternative. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields influences the type of and intensity of use by such birds (Huner *et al.* 2002).

#### **(b). Uplands Management and Restoration**

Under Refuge Management Alternative B, restoration and enhancement of native prairie habitats would continue as described under Alternative A. Some avian species in this category would benefit, primarily from improved habitat for migrating and wintering birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

#### **(c). General Habitat Management Activities**

Under Refuge Management Alternative B, the USFWS would continue the integrated combination of water level and salinity management, prescribed burning and controlled livestock grazing in wetland habitats on the Refuge Complex. The USFWS would expand prescribed burning and controlled livestock grazing programs under this Alternative. These management activities promote optimum habitat conditions for wintering and migrating waterfowl and also enhance wetland and upland habitats used by many shorebird, wading bird and marsh bird species.

These management tools would help create optimal physical structure of vegetation for many species of shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds and wading birds. Conversely, expanded burning and grazing under this Alternative may reduce habitat availability for some marsh bird species which require dense, tall stands of vegetation. Higher grazing intensities would increase the potential for some negative impacts. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979).

Some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. However, most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. As under Refuge Management Alternative A, overall management under Alternative B would be aimed at maintaining a mosaic of available habitats. This should provide an adequate range of habitats for this group of avian species.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS uses these techniques in prescribed burning operations on the Refuge Complex.

Exotic and invasive plant and animal control activities would continue as described under Refuge Management Alternative A, and would also enhance wetland and upland habitats for many avian species in this group. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative B, the USFWS would continue to maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote

increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

Overall, species requiring less dense, more open marsh habitats would benefit from expanded prescribed burning and intensified controlled grazing under Refuge Management Alternative B, while the amount of habitat for species requiring dense stands of vegetation would decrease.

#### **(4). Impacts to Landbirds**

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative B would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management, and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

##### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative B, several wetland management and restoration activities would continue to have positive impacts on several land bird species including managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and the cooperative rice farming program. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

##### **(b). Uplands Management and Restoration**

###### *Prairie Restoration and Management*

Under Refuge Management Alternative B, approximately 5,774 acres of upland grassland habitats would be maintained and enhanced using an integrated combination of prescribed fire, controlled livestock grazing, herbicide application and expanded mowing / haying.

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. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative B 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, White-tailed Hawk, Loggerhead Shrike, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, Nelson's Sharptailed Sparrow, Henslow's Sparrow, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats on the Refuge Complex under this Alternative.

No additional restoration of native prairie would take place under Refuge Management Alternative B. Benefits to several grassland-dependent songbirds and other native wildlife from ongoing restoration of 270 additional acres of prairie under Alternative A would not be realized.

#### Woodlot Restoration and Management

Under Refuge Management Alternative B, the USFWS would continue current management activities to protect 127 acres of existing coastal woodlots: 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.

Overall, implementation of the USFWS management actions under this Alternative would have similar impacts to those described under Alternative A. These activities would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler.

#### **(c). General Habitat Management Activities**

Prescribed burning, controlled grazing, exotic / invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative B. The integrated combination of water level and salinity management, fire management and controlled livestock grazing on the Refuge Complex which promotes optimum habitat conditions for wetland-dependent migratory birds also enhances wetland and upland habitats used by many land bird species. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

The USFWS would expand prescribed burning and controlled livestock grazing programs under Refuge Management Alternative B. Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife. Increased burning frequency under Refuge Management Alternative B has potential to either positively or negatively impact some landbird species.

## **(5). Impacts to Fisheries Resources**

### **(a). Wetlands Management and Restoration**

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Under Refuge Management Alternative B, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, exotic plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments on the Refuge Complex support highly diverse aquatic vertebrate and invertebrate communities. Disruption of salinity gradients would likely cause adverse impacts on blue crabs (Guillory 1996). Many of the refuge marshes would exceed these thresholds without some type of hydrologic management.

Under Refuge Management Alternative B, an additional 6,500 acres of marsh would be structurally managed. Managing water levels and salinities using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). These design features and management regimes would be also be incorporated under Refuge Management Alternative B.

## **(6). Impacts to Threatened and Endangered Species**

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative B, protection, restoration and management of coastal wetland habitats on the Refuge Complex would continue as under Alternative A, and would benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large

concentrations of wintering waterfowl. Brown pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative B would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

#### **(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates**

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative B which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative B which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) would be particularly beneficial to amphibians and reptiles. Expanded structural marsh management, cooperative rice farming and moist soil management programs under this Alternative would provide additional reliable freshwater habitat critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Under Refuge Management Alternative B, some management activities would continue to have negative impacts on some wildlife species. Control of exotic and / or invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Under Refuge Management Alternative B, the USFWS would prescribe burn more acres annually and initiate annual burning in some habitats. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying “Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil-litter stabilize.” Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

## **b. Impacts from Public Use Programs**

Assuming an increase in visitation to the Refuge Complex under Refuge Management Alternative B, impacts to fish and wildlife resources would likely increase over current levels described under Refuge Management Alternative A. This assumption is based upon the expanded waterfowl hunting opportunities and new hunting programs for doves and snipe, rails and gallinules and the new visitor facilities to support fishing, wildlife observation and photography, and environmental education and interpretation provided under this Alternative.

### **(1). Impacts to Waterfowl**

#### **(a). Waterfowl Hunting**

Under Refuge Management Alternative B, additional waterfowl hunting opportunities would be provided by opening additional areas of the Refuge Complex for September teal hunting, providing additional hunting days (7-days per week) on a portion of McFaddin NWR, allowing guided hunting on portions of the Refuge Complex, and opening the refuges for snipe, gallinule and rail hunting. Assuming an increase in visitation for hunting, the impacts discussed below would increase over current levels.

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Refuge Management Alternative B should not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichhoff 1973, Wolder 1993, Madsen *et al.* 1992 as cited by Fox and Madsen 1997). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995). Cumulatively, the expanded hunting programs under this Alternative would increase disturbance impacts to waterfowl. Of these activities, 7-days per week hunting and the hunting of snipe, rails and gallinules have the greatest potential to reduce waterfowl utilization within hunt areas on the Refuge Complex.

Means of access to and within Refuge Complex hunt areas would remain the same as under Refuge Management Alternative A and would include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required an additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Afton and Saylor in Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and / or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary areas of adequate size, encompassing and / or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998). Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

The continued maintenance of sanctuary areas on the Refuge Complex would be required to mitigate for disturbance impacts from hunting activities under Refuge Management Alternative B. Maintaining existing and developing new refuge-specific hunting regulations under this Alternative would also be necessary help mitigate the impacts of hunting activity-related disturbance to waterfowl. Monitoring would be required to assess impacts of modified / expanded hunting programs, and to make necessary future adjustments. As with the current hunting program, it is possible that hunting activities under Refuge Management Alternative B would result in reduced abundance of wintering waterfowl on the Refuge Complex in years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances.

#### **(b). Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

Under Refuge Management Alternative B, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. Means of access for these uses and the presence of visitors result in disturbance impacts to waterfowl, as described under Refuge Management Alternative A. Increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from "out of vehicle" approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation

platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

## **(2). Impacts to other Migratory Birds, Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds**

### **(a). Waterfowl Hunting**

Although the disturbance impacts of waterfowl hunting under Refuge Management Alternative B on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

Under Refuge Management Alternative B, the Refuge Complex would be opened to the hunting of snipe, rails and gallinules. Harvest would result in direct mortality of individuals of these species. Because regulations governing harvest in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable migratory bird populations are sustained over the long-term, harvest should not have any measurable effect on overall populations and the long-term viability of these populations. Hunting of snipe and rails on the Refuge Complex would likely be accomplished by walking and non-motorized boating, with hunters freely moving through hunt areas rather than hunting a specific location (as over a decoy spread for waterfowl). Additional movement would increase potential for disturbance to migratory birds, and increase the likelihood of conflicts with waterfowl hunters.

Under Refuge Management Alternative B, a small portion of Anahuac NWR would be open to hunting of doves. Harvest of doves would result in direct mortality, but Federal and State regulations governing harvest would ensure that dove populations are sustained over the long-term. Additional refuge-specific regulations would be in place to reduce impacts to habitat and wildlife including means of access and required use of non-toxic ammunition.

### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

Under Refuge Management Alternative B, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. As described under Refuge Management Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Refuge Management Alternative B, increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines

can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen, 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

### **(3). Impacts to Fisheries**

#### **(a). Fishing**

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term.

Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative B, including expanding the hours that McFaddin NWR is open to the public, should not have any measurable effect on overall populations and the long-term viability of these species' populations.

#### **b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative B.

### **(4). Impacts to Threatened and Endangered Species**

#### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities under Refuge Management Alternative B. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative B.

#### **(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex, under Refuge Management Alternative B. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

### **(b). Commercial Alligator Harvest**

Under Refuge Management Alternative B, the current adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Refuge Management Alternative B should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

### **(c). Control of Muskrat Populations**

Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Under Refuge Management Alternative B, muskrat populations could be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

Under Refuge Management Alternative B, all current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue. In addition, the USFWS would work with partners to expand the annual Mottled Duck breeding pair survey and to conduct additional research on factors affecting vital rates for this species, and would expand monitoring of colonial nesting waterbird nesting and fledgling success at a managed site on McFaddin NWR.

Surveys and monitoring / research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information facilitates implementation of an adaptive management approach which allows continual refinement and improvement of management activities. In some cases, monitoring activities are providing baseline information, previously not available. Under Refuge Management Alternative B, the USFWS would focus additional monitoring and research activities on Mottled Ducks in order to gain information needed for the long-term conservation of this important species and in light of growing concern for declining populations of Mottled Ducks on national wildlife refuges in Texas.

### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative B, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduced impact on fish and wildlife resources from these activities.

### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative B, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by:

1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. 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.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that expanded outreach and partnership efforts under Refuge Management Alternative B would result in increased benefits to fish and wildlife resources as important habitats are restored and enhanced. Projects such as those implemented to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat. Ongoing partnerships with the Refuge Friends groups, conservation organizations and volunteers would support a variety of habitat restoration and biological program activities on the Refuge Complex, contributing directly to conservation of fish and wildlife resources.

## **B. Socioeconomic Resources Section**

### **1. Economic Impacts**

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements:

- 1) Direct expenditures made by USFWS to manage operations at the Refuge Complex,
- 2) Value of production from agricultural programs on the Refuge Complex, and
- 3) Expenditures made by recreational visitors to the Refuge Complex.

Second, there are **indirect and induced economic** impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this management alternative were estimated using the data and methods discussed below. The analysis compares the impacts from this management alternative to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

#### **a. Direct Economic Impacts**

##### **(1). Value of Refuge Operations (Direct Expenditures)**

Based on information about the activities proposed under Refuge Management Alternative B, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this Refuge Management Alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. The estimate of the annual average cost, per five-year period, for Alternative B is

summarized in Table 4-13. The estimate of Refuge Operation's direct expenditures under this alternative shows a modest increase [no more than 10%] compared to the \$2,695,184 estimate under the Refuge Management Alternative A (No Action).

Table 4-13 Average Annual Operational Costs for the Refuge Complex – Refuge Management Alternative B (Direct Expenditures)			
Cost Category	Annual Average Expenditures		
	Year 1 – 5	Year 5 - 10	Year 10 - 15
Staff Salaries	\$1,736,727	\$1,775,894	\$1,819,561
Utilities	\$38,500	\$38,500	\$38,500
Travel	\$43,035	\$43,035	\$43,035
Heavy Equip. Rental and Replacement	\$77,000	\$77,000	\$77,000
Annual and Deferred Maintenance	\$1,065,217	\$940,883	\$944,217
Special Programs	\$16,500	\$16,500	\$16,500
<b>Total Average Annual Expenditures</b>	<b>\$2,976,980</b>	<b>\$2,891,813</b>	<b>\$2,938,813</b>

## (2). Value of Production from Refuge Agricultural Programs

### (a). Cattle Grazing

The estimate for the value of grazing included some development assumptions regarding the annual average number of AUMs expected to occur under Refuge Management Alternative B. The annual average AUMs are expected to increase from 23,900 under the Refuge Management Alternative A (No Action) to about 29,875 under this Alternative. Using the estimated value of \$88.02 / AUM determined in the analysis for the Alternative A, there is an increase in the estimate of the production value of grazing in excess of \$500,000. A summary comparing the changes in AUMs and value of production between Refuge Management Alternatives A and B is contained in Table 4-14.

Table 4-14 Estimated Production Value of Grazing Activities On Refuge Complex - Refuge Management Alternative B		
Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
Refuge Mgmt. Alternative B	29,875	\$2,629,598

### (b). Rice Production

Under the development assumptions for this alternative the annual acreage in rice production is expected to increase from 600 acres under Refuge Management Alternative A (No Action) to approximately 1000 acres under Refuge Management Alternative B. Using the estimated value for rice production of \$416.45 / acre determined in the "No Action" alternative, there is about a ⅔ increase in the estimate of value for rice production on the Refuge Complex. A summary comparing the changes in annual average acreage produced and value of production between Refuge Management Alternatives A and B is contained in Table 4-15.

Table 4-15 Estimated Value of Rice Production On Refuge Complex - Refuge Management Alternative B		
Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
Refuge Mgmt. Alternative B	1000	\$416,450

### (3) Value of Refuge Recreational Programs

For each Refuge Management Alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under the "No Action" alternative. The estimated changes in recreational visitors under this alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	10% Increase
Upland Bird Hunting	New activity - 100 hunter / days per year
Fishing	No change
Wildlife Observation	5% Increase

These changes were then applied to the estimate of annual non-resident visits and the estimates of itemized expenditures by recreational activity which were developed for Refuge Management Alternative A (No Action). Table 4-16 contains a summary of the comparison of the annual direct expenditures associated with Recreational visitors to the Refuge Complex between Refuge Management Alternatives A and B.

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
Refuge Mgmt. Alternative B	36,682	\$1,189,014

#### b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

**Employment:** The annual average estimated employment is measured as Full-Time Equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

**Labor Income:** Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

**Other Property Type Income:** This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

**Indirect Business Taxes:** Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

### 1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Alternative B and the "No Action" alternative is summarized in Table 4-17.

Table 4-17 Indirect & Induced Economic Impacts of Refuge Operations at Refuge Complex – Refuge Management Alternative B			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	45	45	45
Refuge Management Alternative B	48	47	47
<b>Labor Income</b>			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative B	\$1,199,076	\$1,157,810	\$1,171,821
<b>Other Property Type Income</b>			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative B	\$272,669	\$257,929	\$257,417
<b>Indirect Business Taxes</b>			
No Action Alternative	\$493,149	\$493,149	\$493,149
Refuge Management Alternative B	\$502,252	\$511,181	\$522,302

## (2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternatives A (No Action) and B is summarized in Table 4-18.

Table 4-18. Indirect and Induced Economic Impacts of Agricultural Activities at Refuge Complex - Refuge Management (RM) Alternative B			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	20	20	20
Refuge Management Alternative B	27	27	27
<b>Labor Income</b>			
No Action Alternative	\$587,382	\$587,382	\$587,382
Refuge Management Alternative B	\$785,861	\$785,861	\$785,861
<b>Other Property Type Income</b>			
No Action Alternative	\$272,759	\$272,759	\$272,759
Refuge Management Alternative B	\$371,550	\$371,550	\$371,550
<b>Indirect Business Taxes</b>			
No Action Alternative	\$87,668	\$87,668	\$87,668
Refuge Management Alternative B	\$118,065	\$118,065	\$118,065

Table 4-19 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex - RM Alternative B			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	25	26	26
RM Alternative B	26	27	27
<b>Labor Income</b>			
No Action Alternative	\$609,908	\$621,374	\$629,040
RM Alternative B	\$634,780	\$647,953	\$656,417
<b>Other Property Type Income</b>			
No Action Alternative	\$224,963	\$229,144	\$231,939
RM Alternative B	\$234,159	\$238,962	\$242,048
<b>Indirect Business Taxes</b>			
No Action Alternative	\$136,816	\$139,559	\$141,394
RM Alternative B	\$142,266	\$145,414	\$147,438

to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

## (3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Refuge Management Alternative B and the "No Action" alternative is summarized in Table 4-19.

## 2. Population Impacts

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under this management alternative is expected to continue to support in excess of 90 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

## 3. Fiscal Impacts on Local Governments

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and / or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under current management or any of the other Refuge Management Alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers-Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area.

#### **4. Social Impacts**

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, ecosystem management actions such as those made by the USFWS within the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

##### **a. Impacts to Social Structures and Lifestyles**

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and / or community cohesiveness and stability)
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of "new" impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and / or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause / effect relationship is not of concern in this EIS analysis.

Overall, most people's lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would

arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

### **b. Impacts to Relationships between the USFWS and Stakeholder Groups**

General categories of stakeholder groups describe those persons and / or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that 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. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and / or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and / or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

### **c. Impacts to USFWS Public Outreach Programs and Activities**

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and / or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative B, current USFWS public outreach efforts would continue and be expanded.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the alternatives for potential management actions:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and / or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions

- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure / lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

#### **d. Environmental Justice**

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex CCP / EIS is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse effects and some beneficial effects by the continued operation and / or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and / or low-income population components. Overall, the identified minority and / or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

### **III. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE C: EMPHASIS ON NATIVE HABITAT RESTORATION AND ADDRESSING MAJOR THREATS TO THE ECOSYSTEM**

#### *Overview*

Under this Alternative, the Refuge Complex would focus its management efforts on restoring wetlands, native prairie and woodlots, and on reversing trends of loss and degradation of these native habitats by increasing efforts to address ongoing and future threats from relative sea level rise and altered hydrological regimes. Restoration of native prairie and prairie wetlands would occur on all suitable upland sites. A portion of the historic fresh and intermediate component of the Refuge Complex's coastal marshes would be restored. Efforts to address coastal habitat loss and degradation resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW and to restore emergent marshes would be intensified by increasing coordination among agencies and other stakeholders. Goals would include implementing a major barrier beach / dune restoration project on McFaddin NWR and marsh restoration on Texas Point NWR through the beneficial use of dredge material. Ongoing interior marsh loss would also be addressed by working with agencies and other stakeholders on major hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion for entire watersheds, and through several smaller hydrologic restoration projects on the refuges. Management efforts to control exotic and invasive plant and animal species would be expanded. The Refuge Complex would continue to provide the current level of opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses.

#### **A. Natural Resources Section**

##### **1. Impacts to Air Quality**

The USFWS fire management program on the Refuge Complex has the greatest potential of all refuge management actions to impact the region's air quality. Fire management activities include both the suppression of unplanned wildland fires and prescribed burning. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Under Refuge Management Alternative C, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Whenever feasible, natural fires ignited by lightning would be allowed to burn.

Under Refuge Management Alternative C, the USFWS' prescribed burning program on the Refuge Complex would be substantially modified relative to Refuge Management Alternative A. The USFWS would use prescribed burning on the Refuge Complex primarily to reduce accumulations of hazardous fuels and to restore and enhance native marsh and prairie habitats. The annual burning objective under this Alternative would be 5,000 to 6,000 acres (compared to 12,000 – 15,000 acres under Refuge Management Alternative A), and most prescribed burning would occur during spring and summer to mimic the historic fire regime.

Although prescribed burning under Refuge Management Alternative C would continue to be beneficial to the Refuge Complex's habitats and wildlife (as discussed under *Section III.A.4. Impacts to Vegetation / Habitats and Section III.A.5. Impacts to Fish and Wildlife Resources below*); this management action could also negatively impact local air quality, primarily through the production of smoke. The scope of this impact would decrease relative to Refuge Management Alternative A because of the reduced amount

of smoke produced from decreased prescribed burning activities. Prevailing wind directions and other climatic parameters are generally unfavorable for conducting prescribed burns during the spring and summer, and smoke management issues would limit the USFWS' ability to meet annual goals under this Alternative. In addition, the prevalence of unfavorable conditions during spring and summer would increase the potential for unintentional smoke management impacts.

Decreased prescribed burning activities on the Refuge Complex under Refuge Management Alternative C would also result in larger areas with higher vegetative fuel loads. Most lightning-caused wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires would be more likely to start in areas with higher fuel loads, and fires that did start would burn with higher intensity, produce more smoke, and would be more difficult to suppress than in areas where prescribed burning reduced accumulations of hazardous fuels.

## **2. Impacts to Geology and Soils**

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under this Alternative. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline.

Under Refuge Management Alternative C, the USFWS would expand coordination efforts with a goal of substantially increasing the scope and extent of these projects, including implementing a major project to restore the barrier beach / dune system on McFaddin NWR and large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. The USFWS would also implement several small-scale erosion abatement projects on the Refuge Complex.

Although shoreline erosion and retreat 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 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). 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 accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach / dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach / dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (2004) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. 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 habitat, 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 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 (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as 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, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 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](http://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. Increased saltwater intrusion and loss of freshwater and sediment / nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Restoration of the barrier beach / dune system on McFaddin NWR and increased use of dredged material on Texas Point NWR would contribute to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). If successfully implemented, large-scale restoration of the barrier beach / dune system on McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR would significantly reduce current rates of land loss. These projects would also restore historic elevations along the shoreline and protect inland marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring would also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines will reduce land loss and increase sedimentation and vertical accretion within vegetation stands.

Other USFWS management activities on the Refuge Complex under Refuge Management Alternative C would also impact soils and soil formation. Under this Alternative, the USFWS would coordinate with other Federal and State agencies to implement major watershed-based hydrological restoration projects to restore freshwater inflows and restrict saltwater intrusion. Once these projects were implemented, the USWS would replace intensively-manipulated water control structures in some marsh semi-impoundments with more passive rock weir structures. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different

hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter from plant productivity, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana.

Watershed-scale hydrologic restoration projects would reduce saltwater intrusion and increase freshwater and sediment inflows to marshes, resulting in increased plant productivity important to soil formation and marsh surface elevation gain. Hydrologic restoration at a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands. Conversion to more passive water management infrastructure on the Refuge Complex would reduce overall water level and salinity management capabilities in individual managed units, but this may be mitigated by the larger projects.

Prescribed burning could also affect soils and vertical accretion in marshes. Insufficient data exists to adequately address the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). In most situations, root and peat fires are avoided by carefully monitoring water levels and soil moisture. Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood.

The USFWS would also coordinate and support expanded monitoring and scientific research under Refuge Management Alternative C to determine impacts of shoreline and marsh restoration efforts and the effects of habitat management activities such as structural marsh management and prescribed burning on marsh soils and vertical accretion. This would lead to a greater understanding of how to reduce the impacts of ongoing and future relative sea level rise and altered hydrological regimes. For example, monitoring and research would help ensure that structural marsh management and prescribed burning programs are being conducted in a way to maximize marsh accretion while meeting short-term habitat objectives.

### **3. Impacts to Hydrology and Water Quality**

#### **a. Hydrology**

Under Refuge Management Alternative C, the USFWS would continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass, and would expand coordination with stakeholders to evaluate ways to provide additional freshwater inflows to marshes south of the GIWW in Jefferson County. Once these projects were implemented, the USFWS would replace some traditional water control structures on the Refuge Complex with more passive rock weir structures. Under this Alternative, the USFWS would also conduct the following hydrologic restoration activities on the Refuge Complex: 1) acquire additional water rights in order to provide additional freshwater inflows, 2) restore natural channels to historical dimensions and several constructed channels to marsh, 3) restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure, and 4) coordinate local agencies and other partners to repair saltwater barriers.

Hydrologic management and restoration activities would reduce saltwater intrusion, reduce tidal energies in formerly non-tidal or micro-tidal marshes, establish freshwater and sediment inflows and manage water levels to mimic historic hydroperiods (wetting and drying cycles). All would help maintain the historic continuum of fresh to saline marshes, and the diverse plant and animal communities associated with these habitats. All would help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, hydrological management and restoration activities may also contribute to marsh soil formation and surface elevation gain (marsh accretion). Hydrologic restoration on a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands.

#### **b. Water Quality**

Under Refuge Management Alternative C, the USFWS would expand efforts to protect water quality on the Refuge Complex. In addition to activities under Alternative A, this would involve developing enhanced spill response capabilities, supporting additional water quality monitoring, and assessing threats from abandoned oil and gas infrastructure and accumulations of lead shot pellets and remediation of any known problem areas. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills on water quality, habitats and fish and wildlife resources.

### **4. Impacts to Vegetation / Habitats**

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative C would include all of the habitat management and restoration activities in wetland and upland habitats described under Alternative A. Changes from Alternative A would include a long-term transition to less intensive water management in coastal marsh habitats following completion of watershed-scale hydrologic restoration projects, phasing out of the cooperative rice farming and moist soil management programs, modified use of prescribed burning and controlled grazing, and expanded restoration of native coastal prairie on suitable upland sites.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, environmental education and interpretation, would continue under Refuge Management Alternative C. Impacts to vegetation and habitats would be similar to those described for these uses under Refuge Management Alternative A.

Systematic monitoring of vegetation and habitats under the Refuge Complex Biological Program would be expanded under Refuge Management Alternative C.

Management of oil and gas activities through issuance of Special Use Permits would continue as under Alternative A, and would be aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

## **a. Impacts to Vegetation and Habitats from Habitat Management / Restoration Activities**

### **(1). Wetland Specific Management and Restoration**

Wetland management and restoration activities under Refuge Management Alternative C would influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

#### **(a). Water Management in Coastal Marshes**

Under Refuge Management Alternative C, the USFWS would continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass. The USFWS would expand coordination with stakeholders to evaluate watershed-scale hydrologic restoration projects, including providing additional freshwater inflows to marshes south of the GIWW in Jefferson County. Use of strategically located below-ground siphons to move freshwater beneath the GIWW to these marshes is one option which would be fully assessed. Once these projects were implemented, the USFWS would replace some traditional water control structures on the Refuge Complex with more passive rock weir structures. Under this Alternative, the USFWS would also conduct the following hydrologic restoration activities on the Refuge Complex: 1) acquire additional water rights in order to provide additional freshwater inflows; 2) restore some natural channels to historical dimensions, and restore several constructed channels to marsh; 3) restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure; and 4) coordinate with local agencies and other partners to repair saltwater barriers.

Hydrologic management and restoration activities would reduce saltwater intrusion, reduce tidal energies in formerly non-tidal or micro-tidal marshes, establish freshwater and sediment inflows and manage water levels to mimic historic hydroperiods (wetting and drying cycles). All would help maintain the historic continuum of fresh to saline marshes, and the diverse plant and animal communities associated with these habitats. All would help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, hydrological management and restoration activities may also contribute to marsh soil formation and surface elevation gain (marsh accretion). Hydrologic restoration on a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands.

#### **(b). Marsh Restoration**

Under the Refuge Management Alternative C, the USFWS would expand coordination with State and Federal agencies with a goal of increasing the level and scope of wetland restoration activities through the beneficial use of dredge material from the maintenance and improvement of navigation channels including the GIWW and the Sabine-Neches Ship Channel. All opportunities to use dredge material in this manner will be fully evaluated. Expanded marsh restoration efforts under Refuge Management Alternative C would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife. Beneficially used dredge material would provide a substrate for reestablishment of marsh vegetation, and increase net sediment supply to marshes which would provides nutrients and increase plant productivity (Chabreck 1976, 1994). Increasing mineral sediment input to marshes through the beneficial use of dredge material would contribute to marsh surface elevation gain. This practice may represent the most practical alternative available to augment marsh vertical accretion and ensure the viability of the region's coastal wetlands in the face of projected relative sea level rise.

Under Refuge Management Alternative C, the USFWS would restore approximately 300 acres of shallow freshwater wetlands in areas currently in the cooperative rice farming program's rotation. Restoration would involve removal of rice field levees to restore surface hydrology and earth moving from designated portions of the lower elevation cuts of the fields to recreate these "pothole" wetlands. Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). These freshwater habitats would support submerged, floating and emergent plant communities valuable to migratory birds and other wetland-dependent fish and wildlife.

### **(c). Moist Soil Management**

Under Refuge Management Alternative C, the USFWS would continue to conduct moist soil management at current levels. Moist soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). On Anahuac NWR, 300-400 acres of moist soil units would continue to be managed annually, primarily to provide habitat for wintering waterfowl. This would involve continued water management and mechanical soil manipulations timed to promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Approximately 150 acres of the Anahuac's NWR's moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime favors the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

### **(d). Cooperative Rice Farming Program**

Under Refuge Management Alternative C, the USFWS would phase out the cooperative rice farming program on Anahuac NWR. Fallowed rice fields would be restored to native prairie and shallow prairie wetlands. Abandoned rice fields would be susceptible to rapid invasion by Chinese tallow, Eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality for native wildlife. Extensive and expensive restoration of areas impacted by these invasive plants would be required to restore and maintain native habitats.

## **(2). Upland Specific Management and Restoration Activities**

### **(a). Native Prairie Restoration and Management**

Under Refuge Management Alternative C, approximately 4,535 acres would be restored to native coastal prairie on the Anahuac NWR. This would include restoration of existing fallowed former croplands (2223 acres) and newly-fallowed areas (2312 acres) created as the cooperative rice farming program is discontinued. Of the five Refuge Management Alternatives, native prairie restoration would be most extensive under Alternative C. The newly restored sites, along with existing native prairie remnants, previously restored native prairie sites and other grasslands would be managed using the variety of management tools described in Refuge Management Alternative A. Together, the management and restoration activities undertaken under Refuge Management Alternative C would protect and enhance approximately 5,774 acres of non-saline grasslands on the Refuge Complex. Impacts of burning, grazing, exotic / invasive species management and mowing / haying to vegetation and habitats are discussed below in *Section C.4.1.c*.

Over 9 million acres of native tallgrass 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).

Prairie restoration and management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity. Many management activities would help control invasive weed and woody species infestations. Restoration and management of native prairie habitat on the Refuge Complex would help conserve an increasingly rare component of the western Gulf Coast ecosystem by restoring and maintaining native prairie plant

associations including little bluestem / brownseed paspalum and eastern gamma grass / switchgrass prairie plant communities.

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. Native prairie restoration on the Refuge Complex under Refuge Management Alternative C would help maintain a small but potentially important source of native prairie seed.

### **(b). Woodlot Restoration and Protection**

Under Refuge Management Alternative C, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 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. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR.

Overall, implementation of the USFWS management actions under this Alternative would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

### **(3). General Habitat Management Activities**

Under Refuge Management Alternative C, the USFWS would reduce the use of prescribed burning and controlled livestock grazing on the Refuge Complex, depending more on lightning-ignited fires and herbivory by native wildlife to create habitat diversity. Efforts to control and monitor invasive / exotic species would be intensified to enhance native habitats. Coordination in interagency efforts to address threats posed by relative sea level rise would be expanded with a goal of implementing major shoreline restoration projects.

#### **(a). Fire Management - Prescribed Burning / Wildland Fire Suppression**

Under Refuge Management Alternative C, the USFWS fire management program would continue to involve both suppression of unplanned wildland fires and prescribed burning. Suppression activities would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Whenever feasible under this Alternative, natural fires ignited by lightning would be allowed to burn.

Under Refuge Management Alternative C, the USFWS' prescribed burning program on the Refuge Complex would be substantially modified relative to Refuge Management Alternative A. The USFWS would use prescribed burning on the Refuge Complex primarily to reduce accumulations of hazardous fuels and to restore and enhance native marsh and prairie habitats. The annual burning objective under this Alternative would be 5,000 to 6,000 acres (compared to 12,000 – 15,000 acres under Refuge Management Alternative A), and most prescribed burning would occur during spring and summer to mimic the historic fire regime.

Beneficial impacts of the prescribed burning program under this Alternative would be similar but less extensive than those described for burning under Refuge Management Alternative A, and include:

- Hazardous fuels would be reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning over larger areas annually and more frequent burns would further lessen the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds would be enhanced in burned areas by maintaining early successional plant communities which provide important food resources, by increasing production and nutritional quality of these foods, and by enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, would be suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife.

Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, and seashore saltgrass. Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.) and forbs such as purple ammenia and Delta duck potato, increases after a fire, particularly when followed by grazing and suitable hydrology. Under Refuge Management Alternative C, the proportion of marsh habitat with early successional plant communities would decrease on the Refuge Complex relative to current conditions as fewer acres would be burned. Herbivory by native species such as snow geese and muskrats would also decrease, as burning during fall and early winter provides optimal habitat for these species.

The impacts of prescribed burning in upland grassland habitats under Refuge Management Alternative C would remain the same as under Alternative A and include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control exotic and / or invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased. Under this Alternative, increased summer burning would be expected to be more effective in controlling woody plant encroachment.

Prescribed burning can have detrimental impacts to vegetation and habitats, ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water when fires occur at the wrong time. Proper timing of burns under appropriate conditions of soil moisture, fuel loads and fuel moisture is essential to minimize negative impacts. For example, burning under excessively dry conditions could result in plant mortality, consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Fire increases soil erosion potential until plant regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Under Refuge Management Alternative C, the USFWS prescribed burning program would continue to consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive at wetland and

upland habitats on the Refuge Complex. Potential for some adverse effects to vegetation and habitats to occur would decrease under this Alternative because of the reduced acreage burned annually and the reduced frequency of burning.

### **(b). Controlled Livestock Grazing**

Controlled grazing on the Refuge Complex is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats.

Under Refuge Management Alternative C, grazing intensity would be decreased in most fresh and intermediate marsh habitats on the Refuge Complex. Controlled grazing would be applied only in recently burned areas following prescribed burns and natural fires, and lower stocking rates would be used. In upland prairie habitats, where feasible more high intensity / short duration grazing treatments would be used.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relation of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant species and communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Decreased grazing intensity and duration in marsh habitats under this Alternative would decrease the abundance of these early successional plant communities. The impacts of grazing on the physical structure of vegetation would be reduced. Overall, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards more tall, dense stands of vegetation than under current grazing management practices.

In general, the beneficial impacts of grazing in wetland habitats under this Alternative would be similar but less extensive than those described under Refuge Management Alternative A, and include:

- Rank vegetation would be reduced, enabling migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Competing growth of marshhay cordgrass and other dominant climax plant communities would be reduced, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Additional open water habitat would be created, which provides loafing areas for birds and allow them to access aquatic invertebrates.
- Marsh burning would be complemented by prolonging the time that new growth is available for goose use as green browse.
- Plant vigor and plant productivity would be increased, nutrient recycling enhanced, and excessive build-up of residual plant material prevented.
- Hazardous fuel loading would be reduced, reducing the amount and intensity of wildfires.

- Capped soils would be broken through hoof action, assisting in seedling establishment of many preferred food plants.
- Vegetation in recently burned areas would be maintained in more palatable stages for wintering waterfowl.

Carefully managed grazing in coastal prairie habitats increases plant vigor of native prairie grasses and increases overall plant species composition and structural diversity.

Prairie ecosystems in North America are adapted to episodic short duration and high intensity grazing, as bison and other native herbivores concentrated on recently burned areas feeding on new growth and moved on to new recently burned areas as the vegetation matured. Fire and grazing regimes generated a mosaic of prairie habitats, ranging from recently burned and heavily grazed areas to areas with mature grassland plant communities with no recent history of fire or grazing. On a landscape level, this diverse habitat mosaic supported a wide variety of grassland-dependent wildlife species. Under this Alternative, a similar regime would be applied on selected upland units. It is expected that this management regime would increase the diversity of upland habitats (structurally and in plant species composition) on the Refuge Complex, and therefore increase natural biological diversity.

Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1992). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing intensity, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative C, the USFWS would continue to monitor grazing programs and adjust grazing strategies so as to avoid detrimental impacts. The potential for adverse impacts to vegetation and habitats to occur would decrease under this Alternative.

### **(c). Exotic / Invasive Species Management**

Under Refuge Management Alternative C, the USFWS would expand exotic and invasive species management activities on the Refuge Complex, treating additional areas and increasing partnership efforts. Additional field monitoring and research and enhanced GIS capabilities would be utilized to evaluate the effectiveness of ongoing treatments, to map existing infestations, and to quickly discover and initiate control activities on new infestations. The USFWS would continue to control exotic and invasive plant species to conserve native biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program would be implemented to control the following exotic and invasive plant species (USFWS 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice

- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies

In wetland habitats, these activities would result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

The control of Chinese tallow and deep-rooted sedge in prairie and woodlots results in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

Under Refuge Management Alternative C, the USFWS would also continue to control exotic animal species on the Refuge Complex to conserve biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral hog control would be conducted as described under Alternative A. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants. Control activities for nutria under this Alternative would be the same listed for Refuge Management Alternative A and if implemented, would decrease damage to wetland habitats.

#### **(d). Shoreline Protection and Restoration**

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under Alternative C. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Under this Alternative, the USFWS would implement similar projects.

Under Refuge Management Alternative C, the USFWS would expand interagency coordination efforts with a goal of substantially increasing the scope and extent of these projects. Objectives would include implementing major partnership projects to restore the barrier beaches and dunes on McFaddin NWR, beneficially use dredge material along the Gulf shoreline on Texas Point NWR, and construct large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. Potential offshore sand sources for the restoration of the barrier beaches and dunes on McFaddin NWR are currently being investigated through the U.S. Army Corps of Engineers "Sabine Pass to San Luis Pass Shoreline Erosion Feasibility Study." Preliminary data indicate viable offshore sand sources may be present.

Restoration of barrier beaches and dunes and placement of dredged material along existing shorelines would reduce rates of shoreline retreat and resulting direct loss of coastal habitats. These activities would positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier beaches and dunes the Gulf of Mexico would restore an upland native habitat type which has been almost completely lost, and protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events. Rock breakwaters in Galveston Bay and the GIWW would also slow erosion and loss of habitat. They would also enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have

converted to open water. The stands of smooth cordgrass also would provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

#### **(e). Mowing and Haying**

Under the Refuge Management Alternative C, approximately 100 acres of upland grassland habitats would be mowed or hayed annually on the Refuge Complex., the same as current levels. Mowing and haying would result in invigorating growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis. Reduction of this herbaceous and woody cover often results in the “release” of native prairie plants.

#### **b. Impacts from Public Use Programs**

Assuming only a small overall increase in visitation to the Refuge Complex observation (decrease in waterfowl hunting, increase for wildlife observation and photography) under Refuge Management Alternative C, impacts to vegetation and habitats described below would remain similar to those described for Alternative A.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

Although visitation would increase under this Alternative, administration and management of these uses would continue and impacts to vegetation and habitats would be expected to remain localized and not substantial. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative C, the USFWS would continue routine patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

#### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative C. Continued habitat and vegetation monitoring activities and research studies on the Refuge Complex would support an adaptive management approach, by providing information which helps refine and improve existing management practices.

#### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative C, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and / or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex under this Alternative would be a reduction of impacts to vegetation and habitats from these activities.

#### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative C, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance native prairie and coastal woodlot habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program. It is anticipated that outreach and partnership efforts under Refuge Management Alternative C would result in additional native prairie and coastal woodlot habitat restoration and enhancement throughout the project area.

### **5. Impacts to Fish and Wildlife Resources**

Under Refuge Management Alternative C, habitat management and restoration and biological program activities on the Refuge Complex would be focused on restoring native habitats and addressing threats to biological integrity and biological diversity, with impacts to conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS would continue to administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development and community outreach and partnership programs would also impact fish and wildlife resources.

## **a. Impacts from Habitat Management and Restoration Activities**

### **(1). Impacts to Migrating and Wintering Waterfowl**

Under Refuge Management Alternative C, USFWS habitat management and restoration activities would have impacts on wintering and migrating waterfowl populations on the Refuge Complex. Overall and all else being equal, less intensive water level and salinity management, reducing acres of prescribed burning and grazing intensity in marsh habitats, and phasing out of the cooperative rice farming program under this Alternative would be expected to result in a decrease in wintering and migrating waterfowl populations on the Refuge Complex. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and / or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative C, approximately 30,000 acres of marsh habitats would continue be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems. Following implementation of large-scale watershed hydrologic restoration projects, some water control structures would be replaced with more passively managed rock weir structures. Hydrologic restoration and marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. Structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl. Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976).

On Anahuac NWR, the cooperative rice farming program would be phased out under this Alternative. This would result in loss of 500-700 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and weed seeds in these habitats. Although this would partially be mitigated for by prairie wetland restoration, it is expected that elimination of the rice farming program would result in decreased wintering waterfowl populations on the Refuge Complex.

Under Refuge Management Alternative C, 300 acres of shallow freshwater “prairie wetlands” would be restored in fallowed rice fields, and approximately 300-400 acres of moist soil units would continue to be managed on Anahuac NWR (no change from current levels). Moist soil management provides 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.

Marsh restoration and prairie wetland restoration project implemented under this Alternative would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

#### **(b). General Habitat Management and Restoration Activities**

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex promotes optimum habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, reduced prescribed burning and less intensive grazing in marsh habitats under Refuge Management

Alternative C would reduce the amount of optimal habitat for wintering waterfowl on the Refuge Complex. Overall under Refuge Management Alternative C, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards more tall, dense stands of vegetation than under current grazing and prescribed burning management practices.

Waterfowl habitat on the Refuge Complex would be enhanced under this Alternative through expanded control efforts for invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and Salvinia would also be controlled to restore and maintain open water habitats. Maintaining an interspersed of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source for migratory birds. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

If successfully implemented, large-scale restoration of the barrier beach / dune system on McFaddin NWR and beneficial use of dredge material projects on Texas Point NWR under Refuge Management Alternative C would significantly enhance wetland habitats for wintering waterfowl on these refuges by reducing tidal overwash of the eroding beach ridge into inland marshes. This would eliminate the salinity spikes in these intermediate marshes caused by overwash events, which increase salinities over large areas for extended periods of time and kill submerged and floating aquatic plants and invertebrates which provide important food resources for waterfowl. Smaller shoreline protection and restoration projects implemented on the Refuge Complex under this Alternative would also protect and enhance wetland habitats important to wintering waterfowl.

## **(2). Impacts to Resident Waterfowl - Mottled Ducks**

Under Refuge Management Alternative C, several habitat management and restoration activities currently conducted on the Refuge Complex would be expected to have positive impacts on Mottled Ducks. Conversely, less intensive water level and salinity management, reducing acres of prescribed burning and grazing intensity in marsh habitats, and phasing out of the cooperative rice farming program under this Alternative would be expected to result in a decrease in the amount of optimal Mottled Duck habitat on the Refuge Complex as compared to current conditions.

### **(a). Wetlands Management and Restoration**

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative C would provide enhanced habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Large-scale hydrologic restoration projects would restore and maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. Structural marsh management would enhance diversity and productivity of submerged aquatic vegetation in open water habitats, providing an important year-round food sources for Mottled Ducks.

On Anahuac NWR, the cooperative rice farming program would be phased out under this Alternative. This would result in loss of 500-700 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and weed seeds in these habitats. Although this would partially be mitigated for by prairie wetland restoration, it is expected that elimination of the rice farming program would negatively impact Mottled Ducks on the Refuge Complex. Rice farming provides reliable shallow freshwater wetland habitat throughout the year, including during the key recruitment periods of nesting and brood rearing.

Under Refuge Management Alternative C, 300 acres of shallow freshwater "prairie wetlands" would be restored in fallowed rice fields, and approximately 300-400 acres of moist soil units would continue to be managed on Anahuac NWR (no change from current levels). Stutzenbaker (1988) identified shallow depression wetlands found in the prairie zone, known as "sennabean ponds," as valuable brood rearing

habitat. Restoring these natural “prairie wetlands” would provide brood-rearing habitat in close proximity to quality nesting habitat (see below). Approximately 100-150 acres of moist soil units would be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

### **(b). Uplands Management and Restoration**

Expanded native prairie restoration and management activities under Refuge Management Alternative C would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The USFWS would restore an additional 4,606 acres of native prairie under this Alternative (the most of any Refuge Management Alternative), and use the integrated application of prescribed burning, controlled livestock grazing, herbicide application and mowing / haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies. All would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks 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. Protecting extant stands of coastal prairie and restoring adjacent prairie and prairie wetland habitats under Refuge Management Alternative C on the Refuge Complex would increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

### **(c). General Habitat Management Activities**

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex promotes optimum habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, reduced prescribed burning and less intensive grazing in marsh habitats under Refuge Management Alternative C would reduce the amount of optimal habitat for Mottled Ducks on the Refuge Complex. Overall under Refuge Management Alternative C, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards more tall, dense stands of vegetation than under current grazing and prescribed burning management practices.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. These cordgrass ridges are dominated by Gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex.

Fire is necessary in the management of Mottled Duck nesting habitat in salty and non-saline prairies. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Under Refuge Management Alternative C, increased reliance on natural fire starts to achieve management objectives in prairie habitats would result in a less predictable results than under the current burning regime.

Improper application of fire and grazing has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988). The potential for negative impacts to Mottled Duck nesting habitat would generally decrease under Refuge Management Alternative C due to lower cattle stocking rates and grazing durations and reduced prescribed burning in fresh and intermediate marshes.

Expanded control efforts for invasive plants and exotic animals under this Alternative would enhance wetland and upland habitats for Mottled Ducks.

Marsh habitats being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck production and brood rearing habitats. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. If implemented under Refuge Management Alternative C, large-scale restoration of the barrier beach / dune system on McFaddin NWR would significantly enhance wetland habitats important to Mottled Ducks by preventing saltwater intrusion currently resulting from frequent tidal overwash from the Gulf into inland marshes. Smaller shoreline protection and restoration project implemented under this Alternative would also protect and enhance marsh and salty prairie habitats important to Mottled Ducks.

### **(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds**

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Refuge Management Alternative C would positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex. Decreased prescribed burning and reduced grazing intensity and duration under this Alternative would reduce the amount of optimal habitat as compared to current conditions for species requiring more open habitats, but increase habitat availability for some species requiring more dense stands of vegetation. Discontinuation of the cooperative rice farming program would eliminate approximately 500-700 acres of shallow freshwater wetland habitat of high importance to many shorebird and wading bird species.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative C, approximately 30,000 acres of marsh habitats would continue be structurally managed on the Refuge Complex. Following implementation of large-scale watershed hydrologic restoration projects, some water control structures would be replaced with more passively managed rock weir structures. Hydrologic restoration and marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities. Structural management of brackish and intermediate marshes may directly increase the abundance of submerged aquatic vegetation, providing habitat for many invertebrates which serve as an important food source. Management of water levels can provide optimal conditions for foraging and resting shorebirds and wading birds.

Shorebirds and wading birds would benefit from continued moist soil management under Refuge Management Alternative C, but discontinuation of the cooperative rice farming program would result in loss of important shallow freshwater wetland habitat. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source for many avian species in this group (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002).

#### **(b). Uplands Management and Restoration**

Under Refuge Management Alternative C, expanded restoration and enhancement of native prairie habitats would provide improved habitat for several species of migrating and wintering marsh birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

### **(c). General Habitat Management Activities**

As compared to current conditions, reduced prescribed burning and less intensive grazing in marsh habitats under Refuge Management Alternative C would reduce the amount of optimal habitat for shorebirds and wading bird species requiring more open habitats, but may provide additional habitat for some marsh bird species which utilize denser stands of vegetation. Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn. Overall, species requiring denser stands of vegetation in marsh habitats would benefit from burning and grazing regimes under Refuge Management Alternative C, while the amount of habitat for species requiring more open habitats would decrease.

Expanded invasive plant and exotic animal control activities under Refuge Management Alternative C would enhance wetland and upland habitats for many avian species in this group. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including beach / dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative C, the USFWS would continue to maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

### **(4). Impacts to Landbirds**

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other land bird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative C would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative C, wetland management and restoration activities including large-scale hydrologic restoration, structural marsh management and marsh and prairie wetlands restoration would have positive impacts on several land bird species. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

## **(b). Uplands Management and Restoration**

### Prairie Restoration and Management

Under Refuge Management Alternative C, 4,606 acres of existing and newly-fallowed rice fields and other upland areas would be restored to native coastal prairie. This Alternative includes restoration of greatest amount of native prairie of the five Refuge Management Alternatives. The newly restored sites, along with existing native prairie remnants, previously restored native prairie sites and other grasslands would be managed using the variety of management tools described in Refuge Management Alternative A. Together, the management and restoration activities undertaken under Refuge Management Alternative C would protect and enhance approximately 5,774 acres of grassland habitats on the Refuge Complex.

Native prairie remnants, restored sites 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. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative C 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). White-tailed Hawk, Loggerhead Shrike, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, Nelson's Sharptailed Sparrow, Henslow's Sparrow, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from restoration and management of prairie habitats on the Refuge Complex under this Alternative.

### Woodlot Restoration and Management

Under Refuge Management Alternative C, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 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. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR.

Overall, implementation of the USFWS management actions under this Alternative would have similar impacts to those described under Alternative A, with additional benefits provided by the new woodland habitats. These activities would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler

## **(c). General Habitat Management Activities**

Under Refuge Management Alternative C, the USFWS would reduce prescribed burning and decrease grazing intensity and duration. Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersion of nesting and foraging habitat, though this theory has yet to be tested. Gabrey *et al.* (1999) found that

Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife. Decreased burning frequency and increased reliance on natural fire starts to meet habitat objectives under Refuge Management Alternative C has potential to either positively or negatively impact some land bird species.

Under this Alternative, the USFWS would expand exotic and invasive plant and animal control activities. Control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

## **(5). Impacts to Fisheries Resources**

### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative C, the USFWS would expand its coordination with other agencies in support of implementing large-scale hydrologic restoration projects, continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, and exotic plant and animal control. The USFWS would implement additional shoreline restoration and protection, and increase interagency coordination with a goal of implementing major barrier beach / dune restoration on McFaddin and Texas Point NWRs. These activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments on the Refuge Complex support highly diverse aquatic vertebrate and invertebrate communities.

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Structural marsh management using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by

opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). These design features and management regimes would be also be incorporated under Refuge Management Alternative C. Increased use of rock weirs under this Alternative may further enhance fisheries access as these structures are semi-permeable and typically contain larger openings than traditional water control structures.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Knieb and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are experiencing rapid subsidence, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, activities which restore productive wetland habitats and help reduce rates of marsh loss (hydrologic restoration, marsh restoration using dredge material, structural marsh management and shoreline restoration and protection) would help sustain healthy fisheries resources in the long-term.

#### **(6). Impacts to Threatened and Endangered Species**

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative C, protection, restoration and management of coastal wetland habitats on the Refuge Complex would benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative C would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

#### **(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates**

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative C which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative C which maintain and restore freshwater wetland habitats (major hydrologic restoration projects, structural management of marshes, moist soil management, and restoration of freshwater prairie wetlands) would be particularly beneficial to amphibians and reptiles. Conversely, loss of freshwater wetland habitat provided by rice farming under this Alternative would reduce this habitat type on Anahuac NWR. Freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Expanded control of exotic and / or invasive woody species in wetland and upland habitats under this Alternative may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Under Refuge Management Alternative C, the USFWS would prescribe burn fewer acres annually, burn primarily in the spring and summer, and depend more on natural fire starts to meet habitat objectives. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize." Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

## **b. Impacts from Public Use Programs**

Assuming a slight increase in visitation to the Refuge Complex under Refuge Management Alternative C, overall impacts to fish and wildlife resources would likely increase slightly over current levels described under Alternative A. Visitation for waterfowl hunting is projected to decrease slightly under this Alternative, while visitation for wildlife observation, photography, environmental education and interpretation is expected to increase.

### **(1). Impacts to Waterfowl**

#### **(a). Waterfowl Hunting**

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Refuge Management Alternative C should not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichhoff 1973, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies

have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995). Means of access to and within Refuge Complex hunt areas would remain the same as under Refuge Management Alternative A and would include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

The continued maintenance of sanctuary areas on the Refuge Complex would be required to mitigate for disturbance impacts from hunting activities under Refuge Management Alternative C. Maintaining existing regulations under this Alternative would also be necessary to help mitigate the impacts of hunting activity-related disturbance to waterfowl. It is possible that hunting activities under Alternative C would result in reduced abundance of wintering waterfowl on the Refuge Complex in years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances

#### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation**

Under Refuge Management Alternative C, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. Means of access for these uses and the presence of visitors result in disturbance impacts to waterfowl, as described under Refuge Management Alternative A. Increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

### **(2). Impacts to other Migratory Birds, Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds**

#### **(a). Waterfowl Hunting**

Although the disturbance impacts of waterfowl hunting under Refuge Management Alternative C on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many

waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

**(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

Under Refuge Management Alternative C, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. As described under Refuge Management Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Alternative C, increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

**(3). Impacts to Fisheries**

**(a). Fishing**

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term.

Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative C should not have any measurable effect on overall populations and the long-term viability of these species' populations.

**b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative C.

#### **(4). Impacts to Threatened and Endangered Species**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities under Alternative C. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative C.

##### **(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex under Alternative C. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

##### **(b). Commercial Alligator Harvest**

Under Refuge Management Alternative C, the current adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Alternative B should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

##### **(c). Control of Muskrat Populations**

Under Refuge Management Alternative C, muskrat populations could be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

Under Refuge Management Alternative C, all current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue.

Surveys and monitoring / research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information facilitates implementation of an adaptive management approach which allows continual refinement and improvement of management activities. In some cases, monitoring activities are providing baseline information, previously not available.

### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative C, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduced impact on fish and wildlife resources from these activities.

### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative C, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance native prairie and coastal woodland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program. It is anticipated that expanded outreach and partnership efforts under Refuge Management Alternative C would result in increased benefits to fish and wildlife resources, and in particular those species dependent upon coastal prairie and woodland habitats.

## **B. Socioeconomic Resources Section**

### **1. Economic Impacts**

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements: 1) direct expenditures made by the USFWS to manage operations at the Refuge Complex, 2) value of production from agricultural programs on the Refuge Complex, and 3) expenditures made by recreational visitors to the Refuge Complex.

Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this Refuge Management Alternative were estimated using the data and methods discussed below. The analysis compares the impacts from this management alternative to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

**a. Direct Economic Impacts**

**(1). Value of Refuge Operations (Direct Expenditures)<sup>14</sup>**

Based on information about the activities proposed under Refuge Management Alternative C, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this Refuge Management Alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. The estimate of the annual average cost, per five-year period, for Alternative C is summarized in Table 4-20.

The estimate of Refuge Operation's direct expenditures under Refuge Management Alternative C shows a moderate increase [approximately 25%] compared to the \$2,695,184 estimate under the "No Action" alternative.

Table 4-20 Average Annual Operational Costs for the Refuge Complex - Alternative C (Direct Expenditures)			
Cost Category	Annual Average Expenditures		
	Year 1 – 5	Year 5 - 10	Year 10 - 15
Annual Staff Salaries	\$1,768,527	\$1,814,394	\$1,867,894
Utilities	\$43,750	\$43,750	\$43,750
Travel	\$46,948	\$46,948	\$46,948
Water Purchases	\$16,000	\$0	\$0
Heavy Equip. Rental and Replacement	\$93,900	\$84,500	\$84,500
Annual and Deferred Maintenance	\$1,409,283	\$1,325,257	\$1,332,693
Special Programs	\$18,000	\$18,000	\$18,000
<b>Total Average Expenditures</b>	<b>\$3,396,409</b>	<b>\$3,332,849</b>	<b>\$3,393,785</b>

**(2). Value of Production from Refuge Agricultural Programs**

**(a). Cattle Grazing**

The estimate for the value of grazing included some development assumptions regarding the annual average number of AUMs expected to occur under this management scenario. The annual average AUMs are expected to decrease from 23,900 under Refuge Management Alternative A (No Action) alternative to about 11,950 under Refuge Management Alternative C. Using the estimated value of \$88.02 / AUM determined in the analysis for Refuge Management Alternative A, there is about a 50% decrease in the estimate of the production value of grazing. A summary comparing the changes in AUMs and value of production between Refuge Management Alternatives A and C is contained in Table 4-21.

<sup>14</sup> The Value of USFWS Operations Table is essentially done for Refuge Management Alternative A (No Acton). Under the remaining Refuge Management Alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

Table 4-21  
Estimated Production Value of Grazing Activities On Refuge Complex – Refuge Management Alternative C

Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
Refuge Mgmt. Alternative C	11,950	\$1,051,839

**(b). Rice Production**

Under the development assumptions for this alternative the annual acreage in rice production is will decrease from 600 acres under Refuge Management Alternative A (No Action) to ultimately 0 acres as the cooperative farming program is phased out under Refuge Management Alternative C. The estimated annual value for current rice production of \$249,867 determined in the "No Action" alternative would be completely eliminated by the end of the 15 year planning period. A summary comparing the changes in annual average acreage produced and value of production between Refuge Management Alternatives A and C is contained in Table 4-22.

Table 4-22  
Estimated Value of Rice Production On Refuge Complex – Refuge Management Alternative C

Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
Refuge Mgmt. Alternative C	0	0

**(3) Value of Refuge Recreational Programs**

For each management alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under Refuge Management Alternative A (No Action). The estimated changes in recreational visitors under this alternative are broken out by recreational activity as follows:

<b>Activity</b>	<b>Change</b>
Waterfowl Hunting	5% Decrease
Upland Bird Hunting	No change
Fishing	No change
Wildlife Observation	5% Increase

These changes were then applied to the estimate of annual non-resident visits and the estimates of itemized expenditures by recreational activity which were developed for Refuge Management Alternative A (No Action). Table 4-23 contains a summary of the comparison of the annual direct expenditures associated with Recreational visitors to the Refuge Complex between Refuge Management Alternatives A and C.

Table 4-23  
Annual Direct Expenditures Associated with Recreational Visitors on Refuge Complex - RM Alternative C

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
Refuge Mgmt. Alternative C	36,407	\$1,168,996

## b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to estimate the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

**Employment:** The annual average estimated employment is measured as Full-Time Equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

**Labor Income:** Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

**Other Property Type Income:** This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

**Indirect Business Taxes:** Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

### (1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Refuge Management Alternatives A and C is summarized in Table 4-24.

Table 4-24 Economic Impacts of USFWS Operations at Chenier Plain NWR Complex			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	45	45	45
Refuge Management Alternative C	56	54	54
<b>Labor Income</b>			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative C	\$1,398,105	\$1,364,523	\$1,383,730
<b>Other Property Type Income</b>			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative C	\$380,427	\$360,019	\$361,088
<b>Indirect Business Taxes</b>			
No Action Alternative	\$493,149	\$493,149	\$493,149
Refuge Management Alternative C	\$527,874	\$537,309	\$551,526

## 2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternatives A (No Action) and C is summarized in Table 4-25. These impacts reflect a 50% reduction in cattle grazing and a gradual phasing out of the rice farming over the planning period.

Table 4-25 Indirect and Induced Economic Impacts of Agricultural Activities on Refuge Complex – Alternative C			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	20	20	20
Alternative C	12	11	9
<b>Labor Income</b>			
No Action Alternative	\$587,382	\$587,382	\$587,382
Alternative C	\$347,390	\$314,345	\$273,037
<b>Other Property Type Income</b>			
No Action Alternative	\$272,759	\$272,759	\$272,759
Alternative C	\$173,100	\$148,620	\$124,139
<b>Indirect Business Taxes</b>			
No Action Alternative	\$87,668	\$87,668	\$87,668
Alternative C	\$52,653	\$47,226	\$40,442

## (3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Refuge Management Alternative A (No Action) and C is summarized in Table 4-26.

Table 4-26 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex - Alternative C			
Impact on:	Year 1-5	Year 6 – 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	25	26	26
Alternative C	26	27	27
<b>Labor Income</b>			
No Action Alternative	\$609,908	\$621,374	\$629,040
Alternative C	\$631,754	\$644,737	\$653,076
<b>Other Property Type Income</b>			
No Action Alternative	\$224,963	\$229,144	\$231,939
Alternative C	\$233,073	\$237,808	\$240,849
<b>Indirect Business Taxes</b>			
No Action Alternative	\$136,816	\$139,559	\$141,394
Alternative C	\$141,569	\$144,674	\$146,669

## **2. Population Impacts**

Management actions associated with the Refuge Complex under any of the Refuge Management Alternatives are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under this management alternative is expected to continue to support nearly 90 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

## **3. Fiscal Impacts on Local Governments**

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and / or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under any of the Refuge Management Alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers-Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area. Under Refuge Management Alternative C, purchase of water from the District would likely cease with the phasing out the cooperative rice program.

## **4. Social Impacts**

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, natural resource management actions such as those made by the USFWS on the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

### **a. Impacts to Social Structures and Lifestyles**

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and / or community cohesiveness and stability)

- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and / or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause / effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

#### **b. Impacts to Relationships between the USFWS and Stakeholder Groups**

General categories of stakeholder groups describe those persons and / or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that 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. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and / or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and / or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

### **c. Impacts to USFWS Public Outreach Programs and Activities**

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and / or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative C, current USFWS public outreach efforts would continue and be expanded.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the Refuge Management Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and / or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure / lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however, the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among Alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

### **d. Environmental Justice**

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex CCP / EIS is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse and some beneficial effects by the continued operation and / or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and / or low-income population components. Overall, the identified minority and / or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

## **IV. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE D – PREFERRED ALTERNATIVE: EMPHASIS ON AN INTEGRATED MANAGEMENT APPROACH COMBINING: 1) EXPANDED HABITAT MANAGEMENT AND RESTORATION PROGRAMS, 2) NEW RESEARCH AND WILDLIFE POPULATION MONITORING, AND 3) INCREASED EFFORTS TO ADDRESS MAJOR THREATS TO THE ECOSYSTEM**

### *Overview*

Under this Alternative, the Refuge Complex would continue and expand current habitat management and native habitat restoration programs, with increased monitoring and research to assess management actions and facilitate a more effective adaptive management approach. Wetland habitat management activities for waterfowl, shorebirds and other wetland-dependent migratory birds including structural water management in marshes, prescribed burning, controlled grazing, and moist soil management would be refined and enhanced, and in some cases expanded through development of new infrastructure. Concurrently, additional restoration of native habitats including wetlands, prairie and woodlots would be undertaken to benefit a variety of native fauna, with a focus on priority species identified as in need of conservation through national and international conservation initiatives.

Efforts to address coastal habitat loss and degradation resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW and to restore emergent marshes would be intensified by increasing coordination among agencies and other stakeholders. Goals would include implementing large-scale partnership projects including barrier beach / dune restoration on McFaddin NWR, marsh and shoreline restoration on Texas Point NWR through the beneficial use of dredge material, and structural shoreline protection along the GIWW and East Galveston Bay. Ongoing interior marsh loss would be addressed by working with agencies and other stakeholders on watershed-scale hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion. The USFWS would also implement several smaller hydrologic restoration and shoreline protection projects on the Refuge Complex. Management efforts to control exotic and invasive plant and animal species would be expanded.

Through new partnerships with universities and other agencies, additional research and monitoring would be conducted to better assess impacts of relative sea level rise and to support future conservation planning to address these impacts. Additional monitoring of exotic / invasive plant species, including research to assess the efficacy of ongoing and new control techniques, would be conducted. Additional baseline data on fish and wildlife populations and habitat use would also be collected, with an emphasis on documenting the status of several sensitive or declining species.

The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. The Refuge Complex would seek to provide additional recreational opportunities and improve the quality of visitor services and of the visitor experience through construction of additional public use facilities, expanding law enforcement efforts to protect public safety and natural resources, providing additional hunting and fishing opportunities, and developing additional educational programs.

### **A. Natural Resources Section**

#### **1. Impacts to Air Quality**

The USFWS fire management program on the Refuge Complex activities include both the suppression of unplanned wildland fires and prescribed burning. Under Refuge Management Alternative D, suppression of wildland fires would continue as described in the Refuge Complex Fire Management Plan (USFWS

2001). Suppression involves utilization of “Appropriate Management Response” to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under Refuge Management Alternative D, the USFWS would continue to implement a rotational prescribed burning program on the Refuge Complex. Burning would be conducted in emergent marsh habitats during fall and early winter, and burning in upland grassland habitats during late winter and early spring. Limited summer burning would be initiated where needed to control invasive woody vegetation. The overall annual burning objective would remain unchanged from current levels of 12,000 - 15,000 acres.

The USFWS fire management program has the greatest potential of all refuge management actions to impact the region’s air quality. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Smoke is made up primarily of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organics, nitrogen oxides, and trace minerals. The composition of smoke varies with fuel type. In general, particulate matter is the major pollutant of concern from wildland fire and prescribed fire smoke. Particulate matter is a general term for a mixture of solid particles and liquid droplets found in the air. Particulate matter from smoke tends to be very small (less than one micron in diameter) and, as a result, is more of a health concern than the coarser particles that typically make up road dust. Because of their size range, particulates scatter light effectively and therefore, reduce visibility easily.

The human health effects from smoke run from irritation of the eyes and respiratory tract to more serious disorders including asthma, bronchitis, reduced lung function, and premature death. Particulate matter is the main source of health effects, but carbon dioxide and toxic air pollutants from wildfires can also cause health concerns (Therriault 2001).

The atmospheric conditions that affect the movement and dispersal of smoke include the following: wind direction, wind speed, mixing height (the elevation in the atmosphere that the smoke mixes and disperses), transport wind speed and direction (the direction and speed of upper level winds responsible for moving the smoke from the immediate area), and Category day / dispersion (a combination of mixing height and transport wind speed to give an over all indicator of smoke dispersion potential). The Category Day 1, 2, 3, 4 or 5 equates to poor, fair, good, very good and excellent smoke dispersal (USFWS 2003).

The USFWS uses prescribed burning on the Refuge Complex primarily to maintain and improve habitat for wintering and migrating waterfowl and other migratory birds and to reduce accumulations of hazardous fuels. Prescribed burning under Refuge Management Alternative D would continue to be beneficial to the Refuge Complex’s habitats and wildlife (as discussed under *Section IV.A.4 Impacts to Vegetation / Habitats* and *Section IV.A.5 Impacts to Fish and Wildlife Resources* below).

Prescribed burning has the potential to negatively impacts local air quality through the production of smoke. Because prescribed burning is conducted on the Refuge Complex under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality from the USFWS fire management program will be minimal. Prescription parameters which must be met prior to ignition and for the predicted duration of a prescribed burn specifically aimed at preventing smoke impacts include surface and transport wind direction and speed, mixing height, ambient air temperature and humidity, and fuel moisture. Both current and predicted climatic conditions are considered when deciding whether to proceed with a burn, and are regularly monitored during the burns as a further safeguard. Reducing smoke impacts to surrounding communities is also an important consideration in planning and implementing suppression actions on all wildland fires occurring on the Refuge Complex.

Prescribed burning on the Refuge Complex under these controlled conditions also reduces the potential for smoke impacts to air quality from unplanned wildland fires by effectively managing vegetative fuels. Most lightning-cause wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires are less likely to start in areas with reduced fuel loads because of prescribed burning, and fires that do start burn with less intensity, produce less smoke, and are easier to suppress than in unburned areas with excessive accumulations of hazardous fuels.

Wildlife can also be negatively impacted by smoke, particularly where large areas are ignited in a short period of time. The USFWS utilizes techniques to minimize air quality hazards for wildlife on the Refuge Complex, specifically by conducting ignition in a way that provides interspersions of clean air for wildlife to escape to.

Under Refuge Management Alternative D, the USFWS would use updated technologies associated with predictive modeling of climatic conditions and smoke dispersal and movement. The USFWS would conduct additional monitoring of fire behavior, fuel loading, fuel and soil moisture, and climatic conditions and research on the relationship of these variables with smoke production. These tools and information would help to further reduce risks of adverse impacts to local and regional air quality from USFWS fire management program activities.

## **2. Impacts to Geology and Soils**

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations under Refuge Management Alternative D to address threats which are resulting in ongoing coastal land loss. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Under Refuge Management Alternative D, the USFWS would expand coordination efforts with a goal of substantially increasing the scope and extent of these projects, including implementing a major project to restore the barrier beach / dune system on McFaddin NWR, expanded beneficial use of dredge material on Texas Point NWR, and large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. The USFWS would also implement several smaller scale projects on the Refuge Complex.

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 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](http://www.tidesandcurrents.noaa.gov)). Recent scientific information on changes in polar ice caps suggests that current projections of relative sea level rise may be 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. Increased saltwater intrusion and loss of freshwater and sediment / nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity.

Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Although shoreline erosion and retreat 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 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). 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 accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach / dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach / dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (1998) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. 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 habitat, 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 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 (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as 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, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Restoration of the barrier beach / dune system on McFaddin NWR and increased use of dredged material on Texas Point NWR under Refuge Management Alternative D would contribute to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). If successfully implemented, large-scale restoration of the barrier beach / dune system on McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR would significantly reduce current rates of land loss. These projects would also restore historic elevations along the shoreline and protect inland marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring would also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines will reduce land loss and increase sedimentation and vertical accretion within vegetation stands.

Other USFWS management activities on the Refuge Complex under Refuge Management Alternative D would also impact soils and soil formation. Under this Alternative, the USFWS would enhance hydrologic management in several existing marsh units by developing additional infrastructure. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter from plant productivity, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana.

Large and small hydrologic restoration projects implemented under Refuge Management Alternative D would reduce saltwater intrusion and / or increase freshwater inflows to marshes on the Refuge Complex, resulting in increased plant productivity important to soil formation and marsh surface elevation gain.

Prescribed burning could also affect soils and vertical accretion in marshes. Insufficient data exists to adequately address the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). In most situations, root and peat fires are avoided by carefully monitoring water levels and soil moisture. Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood.

The USFWS would also coordinate and support expanded monitoring and scientific research through partnerships with the U.S. Geological Survey and universities under Refuge Management Alternative D to determine impacts of shoreline and marsh restoration efforts and the effects of habitat management activities such as structural marsh management and prescribed burning on marsh soils and vertical accretion. This would lead to a greater understanding of how to reduce the impacts of ongoing and future relative sea level rise and altered hydrological regimes. For example, monitoring and research would help ensure that structural marsh management and prescribed burning programs are being conducted in a way to maximize marsh accretion while meeting short-term habitat objectives.

### **3. Impacts to Hydrology and Water Quality**

#### **a. Hydrology**

Under Refuge Management Alternative D, the USFWS would expand current wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources wetland. Under this Alternative, the USFWS would improve water management capabilities in managed marsh units by installing new infrastructure, attempt to adjudicate additional water rights in order to provide additional freshwater inflows, develop on-refuge capabilities to deliver additional freshwater inflows, reduce saltwater intrusion by restoring man-made channels on refuges and by working with partners to repair several off-refuge saltwater barriers, restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure, and restore hydrology by restoring natural channels to historical dimensions. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass and on projects to reestablish freshwater inflows to the marshes south of the GIWW in Jefferson County.

Watershed-scale and refuge-specific hydrologic management and restoration projects implemented under Refuge Management Alternative D would help maintain and / or restore the region's historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats would support a natural diversity of native plant, fish and animal communities. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes would also help to prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain.

#### **b. Water Quality**

Under Refuge Management Alternative D, the USFWS would expand efforts to protect water quality on the Refuge Complex. In addition to activities under Alternative A, this would involve developing enhanced spill response capabilities, supporting additional water quality monitoring, assessing threats from abandoned oil and gas infrastructure and accumulations of lead shot pellets, and remediation of any known problem areas. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills on water quality, habitats and fish and wildlife resources.

### **4. Impacts to Vegetation / Habitats**

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative D would include all of the habitat management and restoration activities in wetland and upland habitats described under Refuge Management Alternative A. The USFWS would refine in some cases expand these programs, as directed by new research and monitoring programs aimed at facilitating a truly adaptive approach to management.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, environmental education and interpretation, would continue under Refuge Management Alternative D. The USFWS would seek to provide additional recreational opportunities and improve the quality of visitor services and of the visitor experience through construction of additional public use facilities, expanding law enforcement efforts to protect public safety and natural resources, providing additional hunting and fishing opportunities, and developing additional educational programs. Impacts to vegetation and habitats would be similar to those described for these uses under Refuge Management Alternative A.

Systematic monitoring of vegetation and habitats under the Refuge Complex Biological Program would be expanded under Refuge Management Alternative D.

Management of oil and gas activities through issuance of Special Use Permits would continue as under Alternative A, and would be aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

### **a. Impacts to Vegetation and Habitats from Habitat Management / Restoration Activities**

#### **(1). Wetland Specific Management and Restoration**

As discussed under *Sections IV.A.2 Impacts to Geology and Soils* and *IV.A.3. Impacts to Hydrology and Water Quality*, wetlands management and restoration activities on the Refuge Complex impact geology, soils and hydrologic regimes. Such activities also strongly influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

#### **(a). Water Management in Coastal Marshes**

Under Refuge Management Alternative D, the USFWS would expand current wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. The USFWS would continue to coordinate with State and Federal agencies on a watershed-scale hydrological restoration projects including projects to reestablish freshwater inflows to the marshes south of the GIWW in Jefferson County in the eastern Salt Bayou watershed for marshes affected by the Keith Lake Fish Pass. Use of strategically located below-ground siphons to move freshwater beneath the GIWW to these marshes is one option which would be fully assessed. Under Refuge Management Alternative D, the USFWS would expand use of GIS and remote sensing technologies to detect and track changes in emergent marsh to open water ratios and in vegetative communities relative to hydrologic management and restoration activities.

The USFWS would continue to structurally manage approximately 12,000 and 18,000 acres of marsh habitats on the Anahuac NWR and McFaddin NWR, respectively. Water management on Texas Point NWR would continue to be conducted in a passive manner, primarily using rock weirs in man-made ditches and canals. The USFWS would improve water management capabilities in managed marsh units by installing new infrastructure. Under this Alternative, the USFWS would also conduct the following hydrologic restoration activities on the Refuge Complex: 1) adjudicate additional water rights in order to provide additional freshwater inflows; 2) restore some natural channels to historical dimensions, and restore several constructed channels to marsh; 3) restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure; and 4) coordinate with partners to repair saltwater barriers.

Coastal marshes provide important food resources and cover to a diversity of wetland-dependent resident and migratory fish and wildlife species. These marshes also provide buffering of tidal storm surge, reduce flooding, and filter excessive nutrients and other contaminants. Threats to the Chenier Plain region's coastal marshes include altered hydrology resulting in increased saltwater intrusion and loss of freshwater and sediment inflows, and rising sea levels and land subsidence. These processes are resulting in coastal land loss as shorelines are eroded and recede and as inland vegetated wetlands convert to open water, which in turn is decreasing habitat quantity and quality for native fish and wildlife.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization (Hess *et al.* 1989). This restoration project caused both emergent and submergent vegetation to flourish. Monitoring efforts on and around McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exacerbate flooding, further reducing plant vigor. USFWS water management activities in fresh to brackish coastal marshes on the Refuge Complex reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. These management activities therefore benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils.

Hydrologic management and restoration activities on the Refuge Complex under this Alternative would help to maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes and the native plant, fish and animal communities that depend on these habitats. On a watershed scale, restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater and sediment inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes would also help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, these activities may also contribute to marsh soil formation and surface elevation gain (marsh accretion). Hydrologic restoration on a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands.

#### **(b). Marsh Restoration**

Under the Refuge Management Alternative D, the USFWS would expand coordination with State and Federal agencies with a goal of increasing the level and scope of wetland restoration activities through the beneficial use of dredge material from the maintenance and improvement of navigation channels including the GIWW and the Sabine-Neches Ship Channel. All opportunities to use dredge material in this manner will be fully evaluated. Expanded marsh restoration efforts under Refuge Management Alternative D would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife. Beneficially used dredge material would provide a substrate for reestablishment of marsh vegetation, and increase net sediment supply to marshes which would provides nutrients and increase plant productivity (Chabreck 1976, 1994). Increasing mineral sediment input to marshes would contribute to marsh surface elevation gain. This practice may represent the most practical alternative available to augment marsh vertical accretion and ensure the viability of the region's coastal wetlands in the face of projected relative sea level rise.

Under Refuge Management Alternative D, the USFWS would restore approximately 100 acres of shallow freshwater wetlands. Restoration would involve removal of rice field levees to restore surface hydrology and earth moving from designated portions of the lower elevation cuts of the fields to recreate these "pothole" wetlands. Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). These freshwater habitats would support submerged, floating and emergent plant communities valuable to migratory birds and other wetland-dependent fish and wildlife.

#### **(c). Moist Soil Management**

Approximately 690 additional acres of moist soil units would be developed on the Refuge Complex under Refuge Management Alternative D (590 acres on Anahuac NWR, 100 acres on McFaddin NWR).

Expanded moist soil management would increase biological diversity on the Refuge Complex. Moist-soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Water management and mechanical soil manipulations in new moist soil

units would promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Additional moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime would favor the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

#### **(d). Cooperative Rice Farming Program**

Under the Refuge Management Alternative D, the USFWS would continue to implement a cooperative rice farming program on Anahuac NWR to provide shallow freshwater wetland habitat and nutritious food resources for wintering and migrating waterfowl, resident Mottled Ducks, shorebirds, and wading birds. Rice farming would continue on 500 to 700 acres annually on a three-year rotation, leaving approximately 1,000 to 1,200 acres of the Refuge farm as “maintenance” acreage. Almost 80% of the rice produced on the Refuge is now organically grown. Under this Alternative, the USFWS would continue the trend towards increased use of organic farming in the cooperative farming program.

Continuation of the cooperative rice farming program on Anahuac NWR under Refuge Management Alternative D would provide shallow freshwater wetland habitat and serve several management outcomes for migratory bird management on the Refuge Complex: creating forage for migrating and wintering waterfowl, habitat for migrating shorebirds, and fresh water habitat for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also left for wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest ricefields that were cultivated and at least partially flooded (Czech and Parsons 2002). Managed rice fields on the Refuge Complex provide wintering and migrational habitat for Blue-winged teal, Northern Pintail, Green-winged Teal and Snow Geese, several shorebird 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. Mottled Ducks also heavily use habitats adjacent to rice fields for nesting (Stutzenbaker 1988). Rice farming also helps to offset waterfowl consumption of crops on adjacent privately-owned croplands.

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. Other changes in rice cultivation practices may also have deleterious effects on waterbird populations. Abandoned rice fields and pasturelands are susceptible to invasion by Chinese tallow, eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality and will require extensive restoration efforts.

## **(2). Upland Specific Management and Restoration Activities**

### **(a). Native Prairie Restoration and Management**

Under Refuge Management Alternative D, approximately 2,223 acres of native prairie would be restored on fallowed former croplands on Anahuac NWR. The USFWS would continue to protect and manage newly and previously restored sites, existing prairie remnants and other grasslands using an integrated program which includes: 1) conducting a rotational prescribed burning program on remnant and restored prairies which includes initiation of summer burning where needed to control invasive woody species; 2) conduct a rotational livestock grazing program on upland grassland habitats which includes more short duration, high intensity grazing applications; 3) utilize an integrated pest management program, consisting of herbicide application, mechanical removal, burning and controlled livestock grazing to manage exotic / invasive plant species such as Chinese tallow and deep-rooted sedge which are negatively impacting upland habitats; and 5) mow or hay approximately 100 acres annually. In addition, the USFWS would develop a 5-acre native prairie propagation area to increase availability viable seeds for future restoration efforts.

Over 9 million acres of native tallgrass 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, respectively, 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).

Together, the management and restoration activities undertaken under Refuge Management Alternative D would protect and enhance approximately 5,774 acres of non-saline grasslands on the Refuge Complex. Impacts of burning, grazing, exotic/invasive species management and mowing / haying to vegetation and habitats are discussed below in *Section IV.A.4.(3) Other Habitat Management Activities*. Overall, prairie restoration and management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity. Many management activities would help control invasive weed and woody species infestations. Management and restoration of native prairie habitat on the Refuge Complex would help conserve an increasingly rare component of the western Gulf Coast ecosystem by restoring and maintaining native prairie plant associations including little bluestem / brownseed paspalum and eastern gamma grass / switchgrass prairie plant communities.

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. Native prairie restoration on the Refuge Complex under Refuge Management Alternative D would help maintain a small but potentially important source of native prairie seed.

### **(b). Woodlot Restoration and Protection**

Under Refuge Management Alternative D, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 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. In, addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR under this Alternative.

Overall, implementation of the USFWS management actions under this Alternative would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

### **(3). Other Habitat Management Activities**

Under Refuge Management Alternative D, the USFWS would refine and enhance prescribed burning and controlled livestock grazing programs to increase benefits to migratory birds and other wildlife. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Efforts to control and monitor invasive / exotic species would be intensified to enhance native

habitats. Coordination in interagency efforts to address threats posed by relative sea level rise would be expanded with a goal of implementing major shoreline restoration projects.

#### **(a). Fire Management - Prescribed Burning / Wildland Fire Suppression**

Under Refuge Management Alternative D, the USFWS fire management program would continue to involve both suppression of unplanned wildland fires and prescribed burning. Suppression activities would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of “Appropriate Management Response” to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources.

Under Refuge Management Alternative D, the USFWS would initiate summer prescribed burning in wetland and upland habitats on the Refuge Complex. The USFWS would continue to use prescribed burning on the Refuge Complex primarily to reduce accumulations of hazardous fuels and to restore and enhance native marsh and prairie habitats. The annual burning objective under this Alternative would remain at current levels of 12,000 to 15,000 acres annually.

Beneficial impacts of the prescribed burning program under this Alternative would be similar to those described for burning under Refuge Management Alternative A, and include:

- Hazardous fuels would be reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning over larger areas annually and more frequent burns would further lessen the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds would be enhanced in burned areas by maintaining early successional plant communities which provide important food resources, by increasing production and nutritional quality of these foods, and by enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, would be suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife.

Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, and seashore saltgrass. Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.) and forbs such as purple ammenia and Delta duck potato, increases after a fire, particularly when followed by grazing and suitable hydrology. Under Refuge Management Alternative D, the proportion of marsh habitat with early successional plant communities would increase over current conditions due the application of more intensive grazing in some areas. Initiation of summer burning under this Alternative would be expected to be more effective in controlling woody plant encroachment.

The impacts of prescribed burning in upland grassland habitats under Refuge Management Alternative D would remain the same as under Alternative A and include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control exotic and / or invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased. Under this Alternative, initiation of summer burning would be expected to be more effective in controlling woody plant encroachment. An

example of an adaptive management approach likely to be implemented in prairie habitats under this Alternative is as follows. Once healthy stands of native warm-season grass cover has been established through late dormant-season burning, growing season burning would be initiated to reduce Chinese tallow and Eastern baccharis and increase diversity of native prairie grasses and forbs. It is expected that healthy stands of native prairie grasses would provide sufficient fuels to induce fire behavior and intensity capable of reducing infestations of invasive woody vegetation. A complete change to growing season burning is not anticipated. The frequency and seasonality of burning would be adjusted based on continuous monitoring of habitat conditions.

Under Refuge Management Alternative D, the USFWS would establish partnerships with the U.S. Geological Survey and universities to conduct research to further define the relationship between seasonality of fire and its effects on Chinese tallow and native grasses. Winter and early spring burning promotes warm-season grasses, but the overall diversity is low compared to the nearly 600 species that are found in prairie remnants in Texas and Louisiana (Allain and Johnson 1997). Ideally, burn regimes should be varied to promote greater overall species diversity and simulate the conditions under which these grasslands evolved (Howe 1994). However, while summer fires may increase overall species diversity in coastal prairies, they might also reduce the cover of native warm-season grasses and thus increase the competitive advantage of invasive species such as Chinese tallow. Native grasses contribute greatly to fuel loading and continuity. If summer burning reduces the relative abundance of warm season grasses, it may compromise the ability to control Chinese tallow with fire.

Prescribed burning can have detrimental impacts to vegetation and habitats, ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water when fires occur at the wrong time. Proper timing of burns under appropriate conditions of soil moisture, fuel loads and fuel moisture is essential to minimize negative impacts. For example, burning under excessively dry conditions could result in destruction of desirable vegetation, consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Under Refuge Management Alternative D, the USFWS prescribed burning program would continue to consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive wetland and upland habitats on the Refuge Complex. Potential for some adverse effects to vegetation and habitats would remain Under this Alternative; the USFWS would conduct short- and long-term fire effects monitoring to more clearly define relationships between fire and vegetation communities.

#### **(b). Controlled Livestock Grazing**

Under Refuge Management Alternative D, the USFWS would continue a rotational controlled grazing program on approximately 41,000 acres of the Refuge Complex. Grazing intensity would be increased in selected fresh and intermediate marsh habitats and applications of short-duration, high-intensity grazing would be initiated in selected upland units. To effectively implement these changes, additional infrastructure including fencing and watering sources would be developed. Controlled grazing on the Refuge Complex is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats. Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relation of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use

of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant species and communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Grazing also helps provide optimal physical structure of vegetation for waterfowl utilization in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Increased grazing intensity and duration in selected fresh and intermediate marsh habitats under this Alternative would increase the abundance of early successional plant communities. The impacts of grazing on the physical structure of vegetation would be increased in areas grazed more intensively. Overall, plant succession in marshes would trend toward more area with lower successional plant communities, and physical structure towards more openings and more stands of low-growing plants such as seashore paspalum.

Studies conducted on Sabine National Wildlife Refuge in Cameron Parish, Louisiana (Valentine 1961) determined that increased grazing can change tall climax marshhay cordgrass stands to more diverse community such as seashore paspalum, *Setaria*, and longtom (*Paspalum lividum*), that are more beneficial to certain types of wildlife. Depending on site conditions (elevation, soil, and hydrology) annual grasses and forbs (including millets, fall Panicum (*Panicum dichotomiflorum*), sprangletop, and *Setaria*) can be produced through proper grazing.

Pate (2001) found that grazed marshes remained in a sub-climax state, while habitat within grazing exclosures reverted to marshhay cordgrass. At the onset of the study *Spartina* spp. made up 20% of the plant community, while seashore paspalum comprised 80%. By the end of the study, communities within grazing exclosures changed to 65% *Spartina* spp. and 25% seashore paspalum. In contrast, the grazed area maintained high cover of seashore paspalum throughout the study. Seashore paspalum provides habitat for many species of waterfowl, wading birds and shorebirds, depending on hydrology, while marshhay cordgrass largely precludes these species.

In general, the beneficial impacts of grazing in wetland habitats under this Alternative would be similar to those described under Refuge Management Alternative A, and include:

- Rank vegetation would be reduced, enabling migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Competing growth of marshhay cordgrass and other dominant climax plant communities would be reduced, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Additional open water habitat would be created, which provides loafing areas for birds and allow them to access aquatic invertebrates.
- Marsh burning would be complemented by prolonging the time that browse is available for goose use.

- Plant vigor and plant productivity would be increased, nutrient recycling enhanced, and excessive build-up of residual plant material prevented.
- Hazardous fuel loading would be reduced, reducing the amount and intensity of wildfires.
- Capped soils would be broken through hoof action, assisting in seedling establishment of many preferred food plants.
- Vegetation in recently burned areas would be maintained in more palatable stages for wintering waterfowl.

Prairie ecosystems in North America are adapted to episodic short duration and high intensity grazing, as bison and other native herbivores concentrated on recently burned areas feeding on new growth and moved on to new recently burned areas as the vegetation matured. Fire and grazing regimes generated a mosaic of prairie habitats, ranging from recently burned and heavily grazed areas to areas with mature grassland plant communities with no recent history of fire or grazing. On a landscape level, this diverse habitat mosaic supported a wide variety of grassland-dependent wildlife species. Under this Alternative, a similar regime would be applied on selected upland units. It is expected that this management regime would increase the diversity of upland habitats (structurally and in plant species composition) on the Refuge Complex, and therefore increase natural biological diversity.

Potential detrimental affects of grazing includes the risk of overgrazing, excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay National Estuary Program 1992). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative D, the USFWS would expand monitoring of grazing programs and adjust grazing strategies as needed. The potential for detrimental impacts should decrease as management is refined in response to monitoring information.

### **(c). Exotic / Invasive Species Management**

Under Refuge Management Alternative D, the USFWS would expand exotic and invasive species management activities on the Refuge Complex, treating additional areas and increasing partnership efforts. Additional field monitoring and research and enhanced GIS capabilities would be used to evaluate the effectiveness of ongoing treatments, to map existing infestations, and to quickly discover and initiate control activities on new infestations. The USFWS would continue to control exotic and invasive plant species to conserve native biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program would be implemented to control the following exotic and invasive plant species (USFWS 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.

- Red rice, coffeebean, barnyard grass, and other grasses in rice
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies

In wetland habitats, these activities would result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

The control of Chinese tallow and deep-rooted sedge in prairie and woodlots results in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

Under Refuge Management Alternative D, the USFWS would also continue to control exotic animal species on the Refuge Complex to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral hog control would be conducted as described under Alternative A. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants. Control activities for nutria under this Alternative could be implemented if populations reach levels which threaten wetland habitats.

#### **(d). Shoreline Protection and Restoration**

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under Alternative D. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Under this Alternative, the USFWS would continue to implement similar projects.

Under Refuge Management Alternative D, the USFWS would expand interagency coordination efforts with a goal of substantially increasing the scope and extent of these projects. Objectives would include implementing major partnership projects to restore the barrier beaches and dunes on McFaddin NWR, beneficially use dredge material along the Gulf shoreline on Texas Point NWR, and construct large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. Potential offshore sand sources for the restoration of the barrier beaches and dunes on McFaddin NWR are currently being investigated through the U.S. Army Corps of Engineers "Sabine Pass to San Luis Pass Shoreline Erosion Feasibility Study." Preliminary data indicate viable offshore sand sources may be present.

Restoration of barrier beaches and dunes and placement of dredged material along existing shorelines would reduce rates of shoreline retreat and resulting direct loss of coastal habitats. These activities would positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier beaches and dunes the Gulf of Mexico would restore an upland native habitat type which has been almost completely lost, and .protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events. Rock breakwaters in Galveston Bay and the GIWW would also slow erosion and loss of habitat. They would also enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have

converted to open water. The stands of smooth cordgrass also would provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

### **(e). Mowing and Haying**

Under the Refuge Management Alternative D, approximately 100 acres of upland grassland habitats would be mowed or hayed annually on the Refuge Complex., the same as current levels. Mowing and haying would result in invigorating growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis. Reduction of this herbaceous and woody cover often results in the “release” of native prairie plants.

### **b. Impacts from Public Use Programs**

Assuming an overall increase in visitation to the Refuge Complex for additional and enhanced opportunities for hunting, fishing, wildlife observation and photography and environmental education and interpretation under Refuge Management Alternative D, impacts to vegetation and habitats described below would remain similar to but have the potential to increase over to those described for Alternative A.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

These impacts would be expected to remain localized and minimal under this Alternative. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative D, the USFWS would expand law enforcement efforts on Gulf beaches within McFaddin NWR to provide enhanced protection of public safety and natural resources. The USFWS would also initiate coordination with the Texas General Office and local counties to begin jointly addressing public safety and natural resource issues associated with recreational use of this area.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative D.

Under Alternative D, the USFWS would expand systematic habitat monitoring and develop additional partnerships with the U.S. Geological Survey and universities to conduct research on the effects of

management activities on habitats. This will include determining effects of fire on marsh accretion and to define the relationship between seasonality of fire and its effects on Chinese tallow and native grasses. The USFWS will also expand the use of GIS technology to track habitat trends such as changes in open water in wetland habitats and in support of invasive / exotic plant management. Expanded habitat and vegetation monitoring activities and research studies on the Refuge Complex would facilitate more effective adaptive management by providing information which helps refine and improve management practices.

#### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative D, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and / or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities. Under this Alternative, the USFWS would develop a comprehensive Oil and Gas Management Plan to enhance management of oil and gas activities on the Refuge Complex.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex under this Alternative would be a reduction of impacts to vegetation and habitats from these activities.

#### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative D, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance wetland, native prairie and coastal woodlot habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. 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.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs, including native habitat restoration.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative D would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

## 5. Impacts to Fish and Wildlife Resources

Under Refuge Management Alternative D, habitat management and restoration and biological program activities on the Refuge Complex would be focused on conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS also would administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development and community outreach and partnership programs would continue to have positive impacts on fish and wildlife resources.

### a. Impacts from Habitat Management and Restoration Activities

#### (1). Impacts to Migrating and Wintering Waterfowl

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on landscape scale has increased the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.<sup>15</sup> Many wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Expanding and enhancing wetland management and restoration under Refuge Management Alternative D can be expected to increase wintering and migrating waterfowl populations on the Refuge Complex. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and / or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual

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<sup>15</sup> During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

Under the Refuge Management Alternative D, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations on the Refuge Complex:

**(a). Wetlands Management and Restoration**

Under Refuge Management Alternative D, approximately 30,000 acres of marsh habitats would be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

Approximately 590 additional acres of moist soil units would be developed on the Refuge Complex under Refuge Management Alternative D, specifically to provide additional high quality habitat for wintering and migrating waterfowl. Moist soil management would 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.

On Anahuac NWR, rice production through the cooperative rice farming program would be continue at current levels of 500-700 acres annually under this Alternative to provide habitat for wintering and migrating waterfowl. Management of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Marsh restoration and other wetland restoration activities would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

Marsh and wetland restoration activities would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

**(b). General Habitat Management and Restoration Activities**

Under Refuge Management Alternative D, the USFWS would continue an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex to create optimal habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, enhanced water management capabilities and more intensive grazing in selected marsh units under Refuge Management Alternative D would provide enhanced habitat conditions for wintering waterfowl on the Refuge Complex. Prescribed burning and grazing would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing would also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in

otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Under Alternative D, waterfowl habitat on the Refuge Complex would be enhanced through expanded control programs for invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would also be controlled to restore and maintain open water habitats. Maintaining an interspersed of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

Declines in habitat quality caused by regular tidal overwash are currently adversely affecting migratory waterfowl use, especially on McFaddin and Texas Point NWRs. If successfully implemented, large-scale restoration of the barrier beach / dune system on McFaddin NWR and beneficial use of dredge material projects on Texas Point NWR under Refuge Management Alternative D would significantly enhance wetland habitats for wintering waterfowl on these refuges by reducing tidal overwash of the eroding beach ridge into inland marshes. This would eliminate the salinity spikes in these intermediate marshes caused by overwash events, which increase salinities over large areas for extended periods of time and kill submerged and floating aquatic plants and invertebrates which provide important food resources for waterfowl. Smaller shoreline protection and restoration projects implemented on the Refuge Complex under this Alternative would also protect and enhance wetland habitats important to wintering waterfowl. Implementation of these projects would be expected to increase wintering waterfowl populations on the Refuge Complex.

## **(2). Impacts to Resident Waterfowl - Mottled Ducks**

Mottled ducks are year-round residents of the Chenier Plain region. This species prefers fresh to slightly brackish marshes (Gosselink *et al.* 1979), although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled ducks on the Refuge Complex are part of the western Gulf Coast population of Mottled Ducks. Banding studies have indicated that WGC Mottled Ducks do move between Mexico, Texas, Louisiana and Mississippi and Alabama, but no interchange occurs between this population and the Florida population of Mottled Ducks.

Mottled Duck numbers on the Refuge Complex (and other national wildlife refuges on the Texas Coast) have declined precipitously during the last 20 years, as indexed by annual breeding pair surveys and monthly aerial counts conducted September through March (USFWS, Division of Migratory Birds, unpublished reports). Stutzenbaker (1988) reported that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include conversion of native habitats for agricultural and urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988, Morton and Paine 1990), as well as increased pollutants (Cain 1988). Saltwater intrusion into wetlands that range from fresh to moderately brackish probably affects growth and survival of ducklings (Moorman *et al.* 1991). Encroachment of Chinese tallow into nesting habitat probably leads to abandonment of nesting areas (Stutzenbaker 1988). Other potential factors influencing Mottled Duck populations in Texas include declines in rice agriculture, extended periods of drought, mortality from predation due to increasing populations of alligators and possible increases in mammalian predators, a continued high incidence of lead pellet ingestion, and harvest (USFWS Division of Migratory Birds, unpublished reports).

Under Refuge Management Alternative D, many habitat management and restoration activities currently conducted on the Refuge Complex would be continued, and all would be expected to have positive impacts on this species although the landscape level issues described above are likely to control population dynamics of the WGC Mottled Duck population. Several habitat management and restoration

activities would be expanded specifically to benefit Mottled Ducks. Management and enhancement of nesting and brood-rearing habitats would be targeted.

#### **(a). Wetlands Management and Restoration**

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative D would provide additional enhancement of habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Expanded and enhanced structural marsh management would maintain existing and restore additional fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. It would enhance diversity and productivity of submerged aquatic vegetation in open water habitats, providing an important year-round food sources for Mottled Ducks. Moist soil management and cooperative rice farming programs would provide shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. Rice farming would continue to provide 500-700 acres of wetland habitat annually, and moist soil management an additional 690 acres over current levels on the Refuge Complex under this Alternative. Approximately 400 acres of moist soil units would be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

Under Refuge Management Alternative D, 100 acres of shallow freshwater “prairie wetlands” would be restored in fallowed rice fields. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as “sennabean ponds,” as valuable brood rearing habitat. Restoring these natural “prairie wetlands” would provide brood-rearing habitat in close proximity to quality nesting habitat (see below).

#### **(b). Uplands Management and Restoration**

Expanded native prairie restoration and management activities under Refuge Management Alternative D would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The USFWS would restore an additional 2,223 acres of native prairie under this Alternative and use the integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing / haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies. All would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks 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. Protecting extant stands of coastal prairie and restoring adjacent prairie and prairie wetland habitats under Refuge Management Alternative D on the Refuge Complex would increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

#### **(c). General Habitat Management Activities**

Under Refuge Management Alternative D, prescribed burning would be continued at current levels and grazing intensity (higher stocking rates) and duration in selected fresh and intermediate marshes would be increased. The integrated combination of expanded water level and salinity management, prescribed burning and intensified livestock grazing in wetland habitats on the Refuge Complex under this Alternative would increase the acreage of optimal wetland habitat for Mottled Ducks. Expanded exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting

areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex. These cordgrass ridges are dominated by gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania spp.*) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Initiation of summer burning under this Alternative would be expected to improve nesting habitat in salty prairies by more effectively controlling Eastern baccharis and other woody vegetation.

Improper application of these habitat management practices has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988). The potential for some negative impacts to Mottled Duck nesting habitat would increase under Refuge Management Alternative D. Higher cattle stocking rates and grazing durations in fresh and intermediate marshes could reduce availability of suitable nesting cover in contiguous salty prairies and non-saline grassland habitats under this Alternative.

Marsh habitats currently being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRS provide important Mottled Duck production and brood rearing habitats. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. If implemented under Refuge Management Alternative D, large-scale restoration of the barrier beach / dune system on McFaddin NWR would significantly enhance wetland habitats important to Mottled Ducks by preventing saltwater intrusion currently resulting from frequent tidal overwash from the Gulf into inland marshes. Smaller shoreline protection and restoration project implemented under this Alternative would also protect and enhance marsh and salty prairie habitats important to Mottled Ducks.

### **(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds**

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally-listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migratory, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Alternative D would continue to positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative D, expanded and enhanced structural marsh management would improve habitat conditions for many avian species in this group. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species.

Under Refuge Management Alternative D, cooperative rice farming would continue at current levels and moist soil management programs would be expanded to provide additional shallow freshwater wetland habitat. In total, rice farming would provide approximately 500-700 acres on Anahuac NWR, and Complex-wide moist soil management would provide approximately 1,200 acres under this Alternative. Approximately 300 acres of the Anahuac NWR's moist soil units would be managed specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species would include Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. Under this Alternative, 1,200 acres of moist soil units would provide wetland habitat for shorebirds, wading birds, and other marsh and water birds over the winter months. Wading and marsh bird species using moist soil habitats on the Refuge Complex include 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.

In general, shorebirds and wading birds would also benefit from expanded moist soil management under this Alternative. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields influences the type of and intensity of use by such birds (Huner *et al.* 2002).

#### **(b). Uplands Management and Restoration**

Under Refuge Management Alternative D, expanded restoration and enhancement of native prairie habitats would provide improved habitat for several species of migrating and wintering marsh birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

#### **(c). General Habitat Management Activities**

Under Refuge Management Alternative D, the USFWS would continue the integrated combination of water level and salinity management, prescribed burning and controlled livestock grazing in wetland habitats on the Refuge Complex. The USFWS would enhance water management capabilities, continue prescribed burning at current levels and intensify grazing in selected marsh units under this Alternative. These management activities would enhance wetland and upland habitats used by many shorebird, wading bird and marsh bird species.

These management tools would help create optimal physical structure of vegetation for many species of shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant

communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds. Conversely, intensified grazing under this Alternative may reduce habitat availability in some refuge units for some marsh bird species which require dense, tall stands of vegetation. Higher grazing intensities would increase the potential for some negative impacts. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979). Overall, species requiring less dense, more open marsh habitats would benefit from intensified controlled grazing under Refuge Management Alternative D, while the amount of habitat for species requiring dense stands of vegetation would decrease.

Some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. However, most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. As under Refuge Management Alternative A, overall management under Alternative D would be aimed at maintaining a mosaic of available habitats. This should provide an adequate range of habitats for this group of avian species.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae, Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS uses these techniques in prescribed burning operations on the Refuge Complex.

Expanded invasive plant and exotic animal control activities under Refuge Management Alternative D would enhance wetland and upland habitats for many avian species in this group. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including beach / dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative D, the USFWS would continue to maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

#### **(4). Impacts to Landbirds**

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., Red-tailed Hawks and owls). Other land bird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative D would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

##### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative D, the following wetland management and restoration activities would continue to have positive impacts on several land bird species including managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and the cooperative rice farming program. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

##### **(b). Uplands Management and Restoration**

###### *Prairie Restoration and Management*

Under Refuge Management Alternative D, 2,223 acres of fallowed rice fields and other upland areas would be restored to native coastal prairie. The newly restored sites, along with existing native prairie remnants, previously restored native prairie sites and other grasslands would be managed using a variety of management tools. Together, the management actions undertaken under Refuge Management Alternative D would protect and enhance approximately 5,774 acres of non-saline grassland habitats on the Refuge Complex.

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 land birds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative A are species that are declining in the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 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, 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 on the Refuge Complex.

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 Sharp-tailed Sparrow, and nesting habitat for species including Dickcissel 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. Land birds listed as Avian Species of Conservation Concern utilizing prairie grassland habitats and which would benefit from native prairie

restoration and management activities on the Refuge Complex under Refuge Management Alternative D include LeConte's Sparrow, Nelson's Sharp-tailed Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk.

#### Woodlot Restoration and Management

Under Refuge Management Alternative D, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 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. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR.

Although comprising less than 1 percent of the Refuge Complex acreage, 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).

A primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially *Lepidopteron* larvae. Chinese tallow woodlots may thus be an "ecological trap" that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001). In addition, activities by feral hogs can also damage understory vegetation and soils, as a result of their rooting habits, and may also cause a shift in plant succession. Such activities can also create disturbed areas that enable easier establishment of some exotic species. Feral hogs may also directly compete with several species of native wildlife for certain foods.

Overall, implementation of the USFWS management actions discussed above under the Refuge Management Alternative D would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler. Since woodlot acreage is small relative to its importance to migrating neotropical migratory birds and other bird species that require trees and / or understory for cover, such positive impacts for each acre protected would be proportionately significant.

#### **(c). General Habitat Management Activities**

Prescribed burning, grazing, and exotic / invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative D. The integrated combination of water level and salinity management, fire management and controlled livestock grazing on the Refuge Complex which promotes optimum habitat conditions for wetland-dependent migratory birds also enhances wetland and upland habitats used by many land bird species. Exotic and invasive plant and animal control activities would enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of

the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersion of nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife.

## **(5). Impacts to Fisheries Resources**

### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative D, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct management activities including prescribed burning, controlled livestock grazing, exotic plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments on the Refuge Complex support highly diverse aquatic vertebrate and invertebrate communities. Disruption of salinity gradients would likely cause adverse impacts on blue crabs (Guillory 1996). Many of the refuge marshes would exceed these thresholds without some type of hydrologic management.

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Structural marsh management is employed on portions of the Refuge Complex to reduce impacts of saltwater intrusion and subsequent marsh loss as well as to maintain the historic salinity gradient that characterized coastal marshes of the Chenier Plain.

Managing water levels and salinities using water control structures and levees in managed marsh units may restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Target salinity ranges typical of structurally managed marshes on the Refuge Complex range from fresh to the low end of brackish, being primarily intermediate (0.5-5.0ppt). While these salinity ranges are used by estuarine species, a study of fisheries use along a salinity gradient in Galveston Bay (Zimmerman *et al.* 1990) found estuarine fisheries were not greatly attracted to intermediate (oligohaline) marshes of the Trinity River delta. This study concluded that the oligohaline environment was not favorable for development of preferred foods, primarily epiphytic algae and peracarid crustaceans. Further, while transient species such as juvenile shrimp, crabs, and fishes had ready access to oligohaline marshes in this area, they did not use them extensively. These data indicate that while water control structures may limit ingress / egress of estuarine organisms, the habitat within may not be optimum for these organisms compared to brackish and saline marshes available on the Refuge Complex.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). Ingress / egress slots allow more marine organism passage than fixed crest weirs, with larger openings allowing greater fisheries access (Herke *et al.* 1992). These slots provide a means of allowing movement of estuarine organisms in and out of structurally managed marshes, but assist in maintaining the fresher end of the coastal marsh continuum that so many of the Refuge Complex's priority species depend on. Periods of peak ingress and egress movements are associated with water level fluctuations and tidal cycles. Highest peak fisheries resource movements are often related to periods of combined lunar cycles and major tidal movements. Manipulating water control structures during the full moon and new moon of the lunar cycle allows opportunity for the maximum ingress potential of fisheries resources. Holding slight levels of excess water for several days prior to these cycles and releasing during peak ingress periods greatly increases access to the unit from fisheries species dependent on coastal estuaries. Many species will move towards fresher water during incoming tides (Guillory 1996). The USFWS would continue to use these techniques on the Refuge Complex to enhance fisheries utilization of managed marsh units under this Alternative.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Knieb and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are experiencing rapid subsidence, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, activities which restore productive wetland habitats and help reduce rates of marsh loss (hydrologic restoration, marsh restoration using dredge material, structural marsh management and shoreline restoration and protection) would help sustain healthy fisheries resources in the long-term.

#### **(6). Impacts to Threatened and Endangered Species**

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative D, protection, restoration and management of coastal wetland habitats on the Refuge Complex would benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative D would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

#### **(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates**

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative D which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative D which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Expanded moist soil management and restoration of prairie wetlands would increase available wetland habitat over current levels. Habitat conditions which increase the abundance of insects, crustaceans, and other small prey benefit most species of amphibians and reptiles during at least a portion of their lifecycle. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Expanded control of exotic and / or invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Under Refuge Management Alternative D, suppression of wildland fires and prescribed burning would continue on the Refuge Complex unchanged from current programs. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying “Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize.” Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor

desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

## **b. Impacts from Public Use Programs**

Assuming an increase in visitation to the Refuge Complex under Refuge Management Alternative D, impacts to fish and wildlife resources would likely increase over current levels described under Alternative A. This assumption is based upon the expanded and enhanced waterfowl hunting opportunities, new hunting programs for doves and the development of new visitor facilities to support and enhance fishing, wildlife observation and photography, and environmental education and interpretation programs provided under this Alternative.

### **(1). Impacts to Waterfowl**

#### **(a). Waterfowl Hunting**

Under Refuge Management Alternative D, the USFWS would enhance waterfowl hunting opportunities on the Refuge Complex by improving access facilities, implementing administrative changes aimed at improving quality of the hunting experience, and providing additional services and informational materials to refuge hunters.

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest of migratory birds in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable waterfowl populations are sustained over the long-term, the hunting program on the Refuge Complex under Refuge Management Alternative D should not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichhoff 1973, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). . These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas would remain the same under this Alternative and include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during

winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required and additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and / or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary areas of adequate size, encompassing and / or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998). Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

Overall, it is expected that the maintenance of sanctuary areas on the Refuge Complex under Refuge Management Alternative D will mitigate for disturbance impacts from hunting activities. In years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances, however, it is possible that hunting activities would result in reduced abundance of wintering waterfowl on the Refuge Complex.

Maintaining Refuge-specific hunting regulations under Refuge Management Alternative D would also help mitigate the impacts of hunting activity-related disturbance to waterfowl. Waterfowl hunting in hunt areas is allowed three days per week (with the exception of the 1,500-acre Pace Tract on Anahuac NWR which is open for hunting seven days per week), and all hunting activity is curtailed each day at noon. The non-hunted days and afternoon and evening closures provide undisturbed periods within the hunt areas, facilitating waterfowl utilization of hunt area habitats for foraging and resting. Boat use on the Refuge Complex occurs primarily in bayous, canals and ditches, limiting disturbance impacts to these narrow corridors (exceptions are Star Lake and Clam Lake on McFaddin NWR and Pole Lake on Texas Point NWR). The majority of the hunt areas therefore are not impacted by boating activity, being accessible primarily by foot. In addition, a variety of regulations govern means of access to hunt areas, including boat motor and horsepower restrictions, prohibition of airboat and all-terrain vehicle use, and establishment of areas in which only non-motorized boat access is allowed. While these regulations are in place primarily to protect habitats and public safety, they also reduce overall disturbance impacts to waterfowl and other migratory birds.

#### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation**

Under Refuge Management Alternative D, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. Means of access for these uses and the presence of visitors would result in disturbance impacts to waterfowl, as described under Alternative A. Increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Primary means of access to areas on the Refuge Complex use for fishing and wildlife observation and photography would include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small

number of visitors use bicycles on public roads and levee trails on all three refuges. An even smaller number ride horses on roads at Anahuac NWR and on the Gulf beach at McFaddin NWR. Motorized vehicles and walking are used to access areas used for environmental education and interpretation on Anahuac NWR. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

## **(2). Impacts to other Migratory Birds Shorebirds, Wading Birds and other Marsh and Waterbirds, Land Birds**

### **(a). Waterfowl Hunting**

Although the impacts of waterfowl hunting under Refuge Management Alternative D on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and land birds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

Under Refuge Management Alternative D, the USFWS would open a portion of Anahuac NWR to hunting of doves. The most direct effect of dove hunting on the Refuge Complex would be the mortality of harvested birds resulting from the hunting activities. However, because regulations governing harvest of migratory birds including doves are developed annually and are designed to ensure that viable populations are sustained over the long-term, this new hunting opportunity should not have any measurable effect on overall populations and the long-term viability of these populations. Disturbance impacts to other wildlife species would be localized and minimal. Refuge-specific regulations for this hunt would be developed to protect wildlife and habitats and public safety, and to minimize conflicts with refuge management activities and other public uses.

### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

Under Refuge Management Alternative D, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. As described under Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Alternative D, increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Primary means of access to areas on the Refuge Complex for fishing, wildlife observation and photography would include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors would use bicycles on public roads and levee trails on all three refuges. An even

smaller number would ride horses on roads at Anahuac and McFaddin NWRs. Motorized vehicles and walking would be used to access areas used for environmental education and interpretation on Anahuac NWR.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

On Anahuac NWR, visitors would be allowed to access a 10-acre area within the Yellow Rail Prairie Management Unit to attempt to flush and view yellow rails. This is accomplished by walking slowly through the area, and is most successful when groups of people slowly walk parallel to each other dragging a rope in between participants. This activity occurs primarily during the months of March and April, and includes several guided “Yellow Rail Walks” led by refuge staff or trained volunteers. Disturbance of rails flushed during this activity undoubtedly occurs and likely leads to reduced utilization of this area by rails. Suitable undisturbed habitats exist adjacent to this site, and is unlikely that this disturbance results in long-term negative impacts to individual rails or rail populations. Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen, 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

### **(3). Impacts to Fisheries**

#### **(a). Fishing**

Enhancement of fishing and crabbing opportunities on the Refuge Complex under Refuge Management Alternative D would include developing new access facilities and expanding the hours that McFaddin NWR is open to the public.

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term. Fishing on the Refuge Complex under this Alternative should not have any measurable effect on overall populations and the long-term viability of these species’ populations.

#### **(b). Waterfowl Hunting, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach and other Uses**

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative D.

#### **(4). Impacts to Threatened and Endangered Species**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities on the Refuge Complex under this Alternative. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative D.

##### **(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates**

##### **(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex under this Alternative. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

##### **(b). Commercial Alligator Harvest**

Under Refuge Management Alternative D, an adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Alternative D should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

##### **(c). Control of Muskrat Populations**

Under Refuge Management Alternative D, muskrat populations could be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

Under Refuge Management Alternative D, all current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue. In addition, the USFWS would work with partners to expand the annual Mottled Duck breeding pair survey and to conduct additional research on factors affecting vital rates for this important resident waterfowl species. The USFWS would also expand biological monitoring and research through expanded partnerships for several priority migratory birds (including shorebirds, wading birds, marsh and waterbirds and several migratory and resident land birds) which utilize Refuge Complex habitats and which have been identified as priority species for conservation.

Expanded surveys and monitoring / research activities conducted under Refuge Management Alternative D would be useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information will facilitate implementation of an adaptive management approach which allows continual refinement and improvement of management activities on the Refuge Complex. Additional information on Mottled Ducks and other priority migratory birds will enhance conservation efforts for these species.

### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative D, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls. Under this Alternative, the USFWS would develop a comprehensive Oil and Gas Management Plan to enhance management of oil and gas activities on the Refuge Complex.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be reduced impacts on fish and wildlife resources from these activities.

### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative D, the USFWS would expand efforts to develop partnerships with private land owners to restore and enhance wetland, native prairie and coastal woodlot habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. 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. It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative D would result in additional habitat restoration and enhancement throughout the project area.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative D would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

It is anticipated that expanded outreach and partnership efforts under Refuge Management Alternative D would result in benefits to fish and wildlife resources as important habitats are restored and enhanced. Projects such as those implanted to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat. Restoration and enhancement of upland habitats including native prairie and coastal woodlots would benefit many avian species, including many Avian Species of Conservation Concern.

## **B. Socioeconomic Resources Section**

### **1. Economic Impacts**

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements: 1) direct expenditures made by USFWS to manage operations at the Refuge Complex, 2) value of production from agricultural programs on the Refuge Complex, and 3) expenditures made by recreational visitors to the Refuge Complex.

Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this management alternative were estimated using the data and methods discussed below. The analysis compares the impacts from this management alternative to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

#### **a. Direct Economic Impacts**

##### **(1). Value of Refuge Operations (Direct Expenditures)<sup>16</sup>**

Based on information about the activities proposed under Refuge Management Alternative D, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this management alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. The estimate of the annual average cost, per five-year period, for Refuge Management Alternative D is summarized in Table 4-27 on the following page.

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<sup>16</sup> The Value of USFWS Operations Table is essentially done for the No Acton Alternative (Alt. A). Under the remaining management alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

Table 4-27

## Average Annual Operational Costs for the Refuge Complex – Refuge Management Alternative D (Direct Expenditures)

Cost Category	Annual Average Expenditures		
	Year 1 - 5	Year 5 - 10	Year 10 - 15
Annual Staff Salaries	\$1,777,927	\$1,903,894	\$2,060,061
Utilities	\$24,500	\$17,500	\$17,500
Travel	\$27,386	\$19,562	\$19,562
Water Purchases	\$66,000	\$50,000	\$50,000
Heavy Equip. Rental and Replacement	\$115,600	\$87,333	\$86,667
Annual and Deferred Maintenance	\$1,707,883	\$1,552,050	\$1,454,050
Special Programs	\$19,500	\$19,500	\$19,500
Total Average Expenditures	\$3,738,797	\$3,649,839	\$3,707,339

The estimate of Refuge Operation's direct expenditures under this alternative shows an approximate \$1,000,000 increase compared to the \$2,695,184 estimate under the "No Action" alternative.

## (2). Value of Production from Refuge Agricultural Programs

### (a). Cattle Grazing

The estimate for the value of grazing included some development assumptions regarding the annual average number of AUMs expected to occur under this management scenario. The annual average AUMs are expected to increase somewhat from 23,900 under the "No Action" alternative to about 27,485 under this management alternative. Using the estimated value of \$88.02 / AUM determined in the analysis for the "No Action" alternative, there is about a \$300,000 increase in the estimate of the production value of grazing. A summary comparing the changes in AUMs and value of production between the "No Action" alternative and Alternative D is contained in Table 4-28.

Table 4-28

## Estimated Production Value of Grazing Activities on Refuge Complex - Refuge Management Alternative D

Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
RM Alternative D	27,485	\$2,419,230

### (b). Rice Production

Under the development assumptions for this alternative the annual acreage in rice production will stay basically the same as the current 600 acres under the "No Action" alternative. Therefore, the estimated annual value for rice production under this alternative would be the same as the \$249,867 determined for the "No Action" alternative. A summary comparing the changes in annual average acreage produced and value of production between the "No Action" alternative and Alternative D is contained in Table 4-29.

Table 4-29

## Estimated Value of Rice Production on Refuge Complex - Refuge Management Alternative D

Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
RM Alternative D	600	\$249,867

### (3) Value of Refuge Recreational Programs

For each management alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under the "No Action" alternative. The estimated changes in recreational visitors under Refuge Management Alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	5% Increase
Dove Hunting	New activity - 100 hunter / days per year
Fishing	10% Increase
Wildlife Observation	10% Increase

These changes were then applied to the estimate of annual non-resident visits and the estimate of itemized expenditures by recreational activity which were developed for the "No Action" alternative. Table 4-30 contains a summary of the comparison of the annual direct expenditures associated with Recreational visitors to the Refuge Complex between the "No Action" alternative and Refuge Management Alternative D.

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
RM Alternative D	38,552	\$1,278,784

#### b. Indirect and Induced Economic Impacts

Indirect and induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

**Employment:** The annual average estimated employment is measured as Full-Time equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

**Labor Income:** Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

**Other Property Type Income:** This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

**Indirect Business Taxes:** Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses

**(1). Refuge Operations**

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Alternative D and the "No Action" alternative is summarized in Table 4-31.

Table 4-31 Indirect and Induced Economic Impacts of Operations at Refuge Complex – RM Alternative D			
	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	45	45	45
Refuge Management Alternative D	61	59	56
<b>Labor Income</b>			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative D	\$1,605,157	\$1,593,034	\$1,554,094
<b>Other Property Type Income</b>			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative D	\$226,829	\$423,406	\$401,978
<b>Indirect Business Taxes</b>			
No Action Alternative	\$493,149	\$493,149	\$493,149
Alternative D	\$551,300	\$578,967	\$614,541

## (2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternative D and the "No Action" alternative is summarized on the following page in Table 4-32.

Table 4-32 Indirect and Induced Economic Impacts of Agricultural Activities at Refuge Complex – RM Alternative D			
	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	20	20	20
Refuge Management Alternative D	22	22	22
<b>Labor Income</b>			
No Action Alternative	\$587,382	\$587,382	\$587,382
Refuge Management Alternative D	\$656,901	\$656,901	\$656,901
<b>Other Property Type Income</b>			
No Action Alternative	\$272,759	\$272,759	\$272,759
Refuge Management Alternative D	\$302,657	\$302,657	\$302,657
<b>Indirect Business Taxes</b>			
No Action Alternative	\$87,668	\$87,668	\$87,668
Refuge Management Alternative D	\$97,766	\$97,766	\$97,766

## (3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Alternative D and the "No Action" alternative is summarized in Table 4-33.

Table 4-33 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex – RM Alternative D			
	Year 1 - 5	Annual Average Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	25	26	26
Refuge Management Alternative D	28	29	29
<b>Labor Income</b>			
No Action Alternative	\$609,908	\$621,374	\$629,040
Refuge Management Alternative D	\$611,468	\$684,011	\$692,478
<b>Other Property Type Income</b>			
No Action Alternative	\$224,963	\$229,144	\$231,939
Refuge Management Alternative D	\$247,623	\$252,244	\$255,331
<b>Indirect Business Taxes</b>			
No Action Alternative	\$136,816	\$139,559	\$141,394
Refuge Management Alternative D	\$150,623	\$153,657	\$155,684

## **2. Population Impacts**

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under this management alternative is expected to support over 100 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

## **3. Fiscal Impacts on Local Governments**

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and / or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under any of the Refuge Management Alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area.

## **4. Social Impacts**

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, natural resource management actions such as those made by the USFWS on the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

### **a. Impacts to Social Structures and Lifestyles**

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and / or community cohesiveness and stability)
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and / or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause / effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

#### **b. Impacts to Relationships between the USFWS and Stakeholder Groups**

General categories of stakeholder groups describe those persons and / or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that 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. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and / or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and / or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

#### **c. Impacts to USFWS Public Outreach Programs and Activities**

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and / or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative D, current USFWS public outreach efforts would continue and be expanded.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the Refuge Management Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and / or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure / lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among Alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

#### **d. Environmental Justice**

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex CCP / EIS is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse effects and some beneficial effects by the continued operation and / or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and / or low-income population components. Overall, the identified minority and / or

low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

## **V. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE E: EMPHASIS ON A PASSIVE MANAGEMENT APPROACH**

### *Overview*

Under this Alternative, the Refuge Complex would change its management focus from active habitat management and restoration to a more passive management approach, in which plant communities and wildlife populations would be influenced primarily by natural events such as lightning-caused fires, herbivory by native wildlife, and tidal or stream flooding. Active habitat management and restoration activities including structural management of water levels and salinities in marshes, prescribed burning, controlled cattle grazing, rice farming, moist soil management and control of invasive / exotic species would be discontinued. Efforts to address threats to ecosystem health would focus on monitoring rather than active restoration or protection. The Refuge Complex would continue to provide opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation, but administrative oversight and management would occur at reduced levels.

### **A. Natural Resources Section**

#### **1. Impacts to Air Quality**

The USFWS fire management program on the Refuge Complex has the greatest potential of all refuge management actions to impact the region's air quality. Fire management activities currently include both the suppression of unplanned wildland fires and prescribed burning. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Under Refuge Management Alternative E, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001), and the USFWS would discontinue its prescribed burning program on the Refuge Complex. Suppression would involve utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under this Alternative, whenever feasible, natural fires ignited by lightning would be allowed to burn.

Discontinuation of prescribed burning activities on the Refuge Complex under Refuge Management Alternative E would eliminate potential air quality impacts from smoke generated from these burns. However, lack of prescribed burning would result in rapid accumulation of vegetative fuels over large areas on the Refuge Complex. Most lightning-caused wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires would be more likely to start in areas with higher fuel loads, and fires that did start would burn with higher intensity, produce more smoke, and would be more difficult to suppress than in areas where previous fires had reduced accumulations of hazardous fuels. Under this Alternative, the likelihood that smoke from unplanned wildland fires would be transported by prevailing winds and negatively impact air quality and transportation safety in the region would increase, both in terms of increased frequency of events which negatively impact regional air quality and an increase in the amount of smoke and associated particulates during these events.

#### **2. Impacts to Geology and Soils**

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the

western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

Under Refuge Management Alternative E, the USFWS would discontinue participation in current partnership efforts with other federal and state agencies and conservation organizations aimed at addressing threats which are resulting in ongoing coastal land loss, and would discontinue implementation of small scale shoreline and hydrologic restoration projects on the Refuge Complex. Habitat management activities on the Refuge Complex including structural management of water levels and salinities and prescribed burning which can impact soils and soil formation would be discontinued. Under this Alternative, the USFWS would monitor coastal land loss from shoreline erosion and conversion of vegetated marshes to open water.

Although shoreline erosion and retreat 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 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). 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 accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach / dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach / dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (1998) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. 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 habitat, 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 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 (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as 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, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 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](http://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. Increased saltwater intrusion and loss of freshwater and sediment / nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Under Refuge Management Alternative E, the future effects of relative sea level rise and altered hydrological regimes on coastal habitats will likely be significant. Without efforts to augment coarse sediment supply along the Gulf and to construct breakwaters along the GIWW and East Galveston Bay, rates of shoreline retreat and land loss would likely accelerate. Increased saltwater intrusion would result in decreased plant productivity in fresh and intermediate marshes, reducing soil formation and vertical accretion and leading to submergence and conversion of vegetated marsh to open water. Potential contributions to marsh accretion from mineral sediment supply using dredge material would not be realized. The likelihood of peat burns occurring would increase under this Alternative, with subsequent negative impacts to marsh soils and vertical accretion.

### **3. Impacts to Hydrology and Water Quality**

#### **a. Hydrology**

Under Refuge Management Alternative E, the USFWS would discontinue wetland management and restoration activities conducted on the Refuge Complex and aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. These include structural marsh management, rice farming and moist soil management, marsh and prairie wetland restoration, and shoreline protection and restoration. The USFWS would also discontinue coordination with other State and Federal agencies on a large-scale hydrological restoration projects. Under this Alternative, the USFWS would monitor status and trends of wetland habitats on the Refuge Complex.

Implementation of this Alternative would result in three major hydrological impacts - increased saltwater intrusion, additional loss of freshwater inflows, and permanently altered marsh hydroperiods resulting in rapid drainage and drying and / or excessive flooding and inundation. Fresh and intermediate marshes would be converted to more brackish regimes, resulting in a loss of overall biological diversity. Marshes would be more susceptible to the negative impacts of excessive drying and oxidation of soils and water logging, both of which could lead to conversion to open water.

#### **b. Water Quality**

Potential sources of contaminants affecting water quality include accidental releases from oil and gas exploration and production activities on and adjacent to the Refuge Complex, including spills and leaks from wells, production facilities, and pipelines. In addition, a high volume of petrochemicals is transported through the Refuge Complex on a daily basis via the GIWW. Municipal development and agricultural practices may also impact water quality in the Refuge Complex. Non-point pollution sources such as storm drain run-off from local cities and towns are major sources of pollutants entering the Galveston Bay estuarine ecosystem (Galveston Bay Estuary Program 1995). Point source pollution from upstream facilities such as landfills is also of concern. Rice cultivation contributes important freshwater inflows to the Galveston Bay and Sabine Lake estuarine ecosystems, but agricultural practices as a whole may also contribute excess nutrients and toxins to surface waters within these coastal watersheds. Herbicide application is used on rice, soybeans, sorghum, and hay throughout the region. Concentrations of herbicides are greatest during May, June and July, with the lowest concentrations occurring in the fall and

winter. Nitrates from nutrient loading are common in agricultural areas where fertilizer application enters into streams, creeks, and bayous during storm events.

Under Refuge Management Alternative E, the USFWS would continue current water quality monitoring efforts described under Alternative A, but would no longer proactively work to address water quality issues affecting Refuge resources. Impacts of point and non-point source pollution sources and accidental spills on water quality, habitats and fish and wildlife resources on the Refuge Complex would likely increase.

#### **4. Impacts to Vegetation and Habitats from**

##### **a. Impacts from Habitat Management / Restoration Activities**

Under Refuge Management Alternative E, the USFWS would curtail most habitat management and restoration activities on the Refuge Complex. Vegetative communities and habitats would be influenced primarily by events such as lightning-ignited fires, herbivory by native wildlife, and tidal and precipitation-related flooding.

##### **(1). Wetland Specific Management and Restoration**

###### **(a). Water Management in Coastal Marshes**

Under Refuge Management Alternative E, the USFWS would discontinue structural management of approximately 30,000 acres of coastal marshes on the Refuge Complex.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization, allowing both emergent and submergent vegetation to flourish (Hess *et al.* 1989). Monitoring efforts on and around McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exacerbate flooding, further reducing plant vigor.

Implementation of this Alternative would result in three major hydrological impacts on the Refuge Complex - increased saltwater intrusion, additional loss of freshwater inflows, and permanently altered marsh hydroperiods resulting in rapid drainage and drying and / or excessive flooding and inundation. The historic continuum of fresh, intermediate, brackish and saline marshes would no longer be maintained. Fresh and intermediate marshes would be converted to more brackish regimes, resulting in a loss of overall biological diversity. Marshes would be more susceptible to the negative impacts of excessive drying and oxidation of soils and water logging, both of which could lead to lack of vertical accretion, submergence, and ultimately to conversion to open water.

### **(b). Marsh Restoration**

Under the Refuge Management Alternative E, the USFWS would discontinue coordination efforts with other agencies to implement wetland restoration on the Refuge Complex through the beneficial use of dredge material and hydrological restoration.

Implementation of this Alternative would result in loss of opportunities to restore vegetated emergent marsh in areas which have converted to open water. It would also result in not implementing what may be the most practical alternative available to augment marsh vertical accretion and ensure the viability of the Refuge Complex' coastal wetlands in the face of projected relative sea level rise, i.e., increasing mineral sediment input to marshes through the beneficial use of dredge material.

### **(c). Moist Soil Management**

Under Refuge Management Alternative E, the USFWS would discontinue moist soil management on the Refuge Complex.

Implementation of this Alternative would result in loss of 500 acres of shallow freshwater wetlands and associated moist soil plants which provide important food resources for waterfowl, shorebirds, wading birds and marsh birds. Abandoned moist soil units would be highly susceptible to rapid encroachment by invasive plant species, including Chinese tallow, deep-rooted sedge, Eastern baccharis and common rush. Invasive plant encroachment would displace native vegetation and reduce biological diversity.

### **(d). Cooperative Rice Farming Program**

Under Refuge Management Alternative E, the USFWS would discontinue rice farming on the Refuge Complex.

Implementation of this Alternative would result in loss of 500-700 acres of shallow freshwater wetlands which provide important food resources for migrating and wintering waterfowl and other migratory birds. Fallowed rice fields would be highly susceptible to rapid encroachment by invasive plant species including Chinese tallow, deep-rooted sedge, Eastern baccharis and common rush. Invasive plant encroachment would displace native vegetation and reduce biological diversity.

## **(2). Upland Specific Management and Restoration Activities**

### **(a). Native Prairie Restoration and Management**

Under Refuge Management Alternative E, the USFWS would discontinue active native prairie restoration and grassland management activities (burning, grazing, invasive / exotic plant control, mowing and haying) on the Refuge Complex. The USFWS would monitor plant community changes in upland prairie habitats.

Implementation of this Alternative would allow plant succession to proceed in the 5,774 acres of upland grassland habitats on the Refuge Complex, including former moist soil units and rice fields. Some reversion to grassland habitat would occur in these newly-fallowed areas, although the diversity of native prairie plants would be less than under current management and restoration programs. Fallowed rice fields and abandoned moist soil units would be highly susceptible to rapid encroachment by invasive plant species including Chinese tallow, deep-rooted sedge, Eastern baccharis and common rush. Invasive plant encroachment would displace native vegetation and reduce biological diversity in all grassland habitats on the Refuge Complex.

### **(b). Woodlot Restoration and Protection**

Under Refuge Management Alternative E, the USFWS would discontinue efforts to protect and enhance coastal woodlots on the Refuge Complex. The USFWS would monitor plant community changes in coastal woodlots.

Overall, implementation of this Alternative would be expected to result in decreased abundance and diversity of native canopy and understory plants, and reduced natural regeneration of native woody species in the 127 acres of woodland habitats on the Refuge Complex. Chinese tallow encroachment would occur and would reduce value of woodlots to many avian species.

### **(3). General Habitat Management Activities**

The USFWS uses fire management, controlled livestock grazing and exotic / invasive species management and mowing / haying to enhance habitats for migratory birds and other native fish and wildlife species. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Shoreline restoration and protection activities are being implemented on the Refuge Complex to counter ongoing coastal land loss caused by relative sea level rise, altered hydrological regimes and loss of coarse sediment supply. These management and restoration activities are used to conserve, enhance and restore both wetland and upland habitats on the Refuge Complex.

#### **(a). Fire Management - Prescribed Burning / Wildland Fire Suppression**

Under Refuge Management Alternative E, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001), and the USFWS would discontinue its prescribed burning program on the Refuge Complex. Suppression would involve utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under this Alternative, whenever feasible, natural fires ignited by lightning would be allowed to burn.

Under Refuge Management Alternative E, the proportion of marsh habitat with early successional plant communities would decrease on the Refuge Complex relative to current conditions as fewer acres would be burned annually. Herbivory by native species such as snow geese and muskrats would also decrease, as burning during fall and early winter provides optimal habitat for these species. In combination, the elimination of prescribed burning and controlled grazing under this Alternative would favor a trend toward higher successional plant communities in intermediate and brackish marshes, primarily marshhay cordgrass. The habitat mosaic created by the current integrated use of burning, grazing and water management in Refuge Complex marshes would become less diverse. Discontinuation of prescribed burning in upland prairie habitats would result in more encroachment by woody species including Chinese tallow and Eastern baccharis. Native prairie plant species dependent upon frequent fire would be negatively impacted. Over time, native prairie plant species diversity and relative abundance would decrease.

#### **(b). Controlled Livestock Grazing**

Under Refuge Management Alternative E, the USFWS would discontinue use of controlled grazing in marsh and upland habitats.

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several "early successional" target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Elimination of grazing by cattle and prescribed burning under this Alternative would decrease

the abundance of these early successional plants in marsh habitats. Overall, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards tall, dense and rank stands of vegetation. The habitat mosaic created by the current integrated use of burning, grazing and water management in Refuge Complex marshes would become less diverse. In upland habitats, positive impacts of controlled grazing including increased plant vigor, enhanced nutrient recycling and increased plant diversity would not be realized. Encroachment by woody species would increase.

Under this Alternative, the potential for negative impacts of grazing to habitats and water quality on the Refuge Complex would be eliminated. Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1992). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing intensity, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

### **(c). Exotic / Invasive Species Management**

Under Refuge Management Alternative E, the USFWS would discontinue exotic and invasive species management activities on the Refuge Complex. Field monitoring would be conducted to document occurrence and distribution of exotic and invasive species, and any changes in occurrence and distribution.

Under this Alternative, abundance and distribution of the following invasive species would likely increase, with concurrent impacts on native habitats and fish and wildlife:

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, fallowed rice fields and moist soil units, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in fresh and intermediate marshes, managed wetland units and in waterways.
- Red rice, coffeebean, barnyard grass, and other grasses in fallowed rice fields and moist soil units.
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies

Monocultures of exotic and invasive plants reduce natural biological diversity, increase erosion, alter nutrient cycling and displace macro- and micro-fauna that depend on native plants for habitat and food (Sheley *et al.* 1999). Invasive aquatic plant species such as water hyacinth, common reed, and cattail can form dense, monotypic stands which reduce open water habitats on the Refuge Complex.

Under Alternative E, the USFWS would discontinue control of exotic animal species on the Refuge Complex. Feral hog populations would increase, resulting in increased damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging. Additional soil disturbance would enable establishment of Chinese tallow and other undesirable plants. Potential for damage to wetland habitats due to high populations of nutria would increase.

#### **(d). Shoreline Protection and Restoration**

Under Refuge Management Alternative E, the USFWS would discontinue participation in current partnership efforts with other federal and state agencies and conservation organizations to implement shoreline protection and restoration to reduce coastal land loss. Under this Alternative, the USFWS would monitor coastal land loss from shoreline erosion.

Although shoreline erosion and retreat 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 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). 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 accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach / dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach / dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (1998) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. 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 habitat, 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 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 (DeLaune *et al.* 1983, Nyman *et al.* 1993).

Under Refuge Management Alternative E, the future effects of relative sea level rise and altered hydrological regimes on coastal habitats will likely be significant. Without efforts to augment coarse sediment supply along the Gulf and to construct breakwaters along the GIWW and East Galveston Bay, rates of shoreline retreat and land loss would likely accelerate. Increased saltwater intrusion would result in decreased plant productivity in fresh and intermediate marshes, especially on McFaddin and Texas Point NWRs, reducing soil formation and vertical accretion and leading to submergence and conversion of vegetated marsh to open water.

#### **(e). Mowing and Haying**

Under the Refuge Management Alternative E, the USFWS would discontinue mowing / haying of upland grassland habitats on the Refuge Complex. Encroachment of Chinese tallow and Eastern baccharis would increase in grassland habitats.

#### **b. Impacts from Public Use Programs**

Assuming an overall decrease in visitation to the Refuge Complex under Refuge Management Alternative E, impacts to vegetation and habitats described below would be similar but less extensive than those described for Alternative A.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and

fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submerged aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

These impacts would be expected to remain localized and minimal under this Alternative. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts. Under this Alternative, the USFWS would generally decrease the scope of public use program management and oversight on the Refuge Complex, including field law enforcement. Consequently, the USFWS' ability to protect public safety, habitats and fish and wildlife resources would decline.

#### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative E. Surveys and monitoring / research activities would help track and document impacts of a passive management approach on vegetation and habitats on the Refuge Complex.

#### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative E, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and / or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex under this Alternative would be a reduction of impacts to vegetation and habitats from these activities.

#### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative E, Refuge staff would no longer coordinate with private landowners on partnership projects to restore and enhance native habitats on private lands. The USFWS would continue to work with Refuge Friends groups, volunteers and other community partners, but at a reduced level. The overall impact would be a reduction in partnership activities aimed at restoring and enhancing native habitats on the Refuge Complex and throughout the project area.

## **5. Impacts to Fish and Wildlife Resources**

Under Refuge Management Alternative E, discontinuation of most habitat management and restoration activities on the Refuge Complex would have impacts to conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS would continue to administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development would also impact fish and wildlife resources.

### **a. Impacts from Habitat Management and Restoration Activities**

#### **(1). Impacts to Migrating and Wintering Waterfowl**

Under Refuge Management Alternative E, wintering and migrating waterfowl populations on the Refuge Complex would decline as active habitat management and restoration would be curtailed.

On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and / or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative E, structural marsh management and hydrological restoration projects which currently help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl would be curtailed. Habitat values and use by waterfowl would decrease.

On Anahuac NWR, the cooperative rice farming program would be phased out and moist soil management discontinued under this Alternative. This would result in loss of 800-1,000 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and native moist soil plants in these habitats. Elimination of the rice farming and moist soil management programs would result in decreased wintering waterfowl populations on the Refuge Complex.

No additional wetland habitats would be restored through marsh restoration projects under this Alternative.

## **(b). General Habitat Management and Restoration Activities**

Under Refuge Management Alternative E, the USFWS would discontinue use of an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex to promote optimum habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, discontinuation of prescribed burning and grazing in marsh habitats under Refuge Management Alternative E would reduce habitat quality for and use by wintering waterfowl on the Refuge Complex. Overall, plant succession in intermediate and brackish marshes would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards tall, dense and rank stands of vegetation.

Stopping control efforts for invasive vegetation such as common reed, cattail, and California bulrush which form dense homogeneous stands would result in loss of open water habitats under this Alternative. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and Salvinia would increase and also negatively impact these habitats. Loss of open water and associated submerged and floating plant communities would decrease habitat quality for wintering waterfowl and other migratory birds.

Under Refuge Management Alternative E, the USFWS would discontinue coordination with other agencies aimed at implementing shoreline protection and restoration projects. Tidal overwash of the eroding beach ridge into inland marshes would continue, and likely increase in frequency and magnitude, on McFaddin and Texas Point NWRs. Resulting salinity spikes in intermediate marshes would kill submerged and floating aquatic plants and invertebrates which provide important food resources waterfowl and other migratory birds.

### **(2). Impacts to Resident Waterfowl - Mottled Ducks**

Under Refuge Management Alternative E, discontinuation of habitat management and restoration activities currently conducted on the Refuge Complex would be expected to have negative impacts on Mottled Ducks.

#### **(a). Wetlands Management and Restoration**

Current wetland management and restoration activities on the Refuge Complex provide enhanced habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting.

Under Refuge Management Alternative E, structural marsh management and hydrological restoration projects on the Refuge Complex which currently help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl would be curtailed. Habitat values and use by Mottled Ducks would decrease.

On Anahuac NWR, the cooperative rice farming and moist soil management programs would be discontinued under this Alternative. This would result in loss of 800 -1,100 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and moist soil plants in these habitats. Rice farming and moist soil management provides reliable shallow freshwater wetland habitat throughout the year, including during the key recruitment periods of nesting and brood rearing.

#### **(b). Uplands Management and Restoration**

Under Refuge Management Alternative E, curtailment of native prairie restoration and management activities would decrease the quality of nesting habitat for Mottled Ducks on the Refuge Complex. Brush encroachment by exotic and native woody plants in salty and non-saline prairies would reduce the value of these habitats to Mottled Ducks and other ground-nesting avian species.

### **(c). General Habitat Management Activities**

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats currently used on the Refuge Complex creates a diverse habitat mosaic which provides ideal habitat conditions for Mottled Ducks and many other migratory bird species. As compared to current conditions, discontinuation of prescribed burning and grazing in marsh habitats under Refuge Management Alternative E would reduce the amount of optimal habitat for Mottled Ducks on the Refuge Complex. Overall under Refuge Management Alternative E, plant succession in marshes would trend toward higher successional plant communities, (primarily marshhay cordgrass in brackish and intermediate marshes), and physical structure towards more tall, dense stands of vegetation.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. These cordgrass ridges are dominated by Gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex.

Fire is necessary in the management of Mottled Duck nesting habitat in salty and non-saline prairies. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Under Refuge Management Alternative E, occurrence of lightning-ignited natural fires in salty and non-saline prairies would likely be so infrequent that brush encroachment would be widespread in these important nesting habitats.

Lack of control efforts for invasive plants and exotic animals under this Alternative would also reduce habitat quality for Mottled Ducks in wetland and upland habitats.

Marsh habitats being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRS provide important Mottled Duck production and brood rearing habitats. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. Refuge Management Alternative E, increased frequency and magnitude of tidal inundation in these intermediate marshes would continue to negatively impact these habitats and Mottled Ducks.

### **(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds**

Because of the wide diversity of habitat requirements by this category of birds, current USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. Discontinuing wetland and upland habitat management and restoration activities under Refuge Management Alternative E would negatively impact many shorebird, wading bird and marsh bird species currently found on the Refuge Complex. Curtailing prescribed burning and grazing under this Alternative would reduce the amount of optimal habitat for species requiring more open habitats, but increase habitat availability for some species requiring more dense stands of vegetation. Discontinuation of the cooperative rice farming and moist soil management programs would eliminate approximately 800-1,100 acres of shallow freshwater wetland habitat of high importance to many shorebird and wading bird species.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative E, structural marsh management and hydrological restoration projects on the Refuge Complex which currently help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl would be curtailed. Habitat values and use by many shorebird, wading bird and marsh and waterbird species would decrease.

Discontinuation of the cooperative rice farming and moist soil management programs would result in loss of 800 to 1,100 acres of important shallow freshwater wetland habitat. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source for many avian species in this group (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002).

#### **(b). Uplands Management and Restoration**

Under Refuge Management Alternative E, curtailment of native prairie restoration and management activities would decrease the quality of upland habitats. Brush encroachment by invasive woody plants including Chinese tallow and Eastern baccharis would increase. Habitat quality and use by several species of shorebirds and marsh birds would decline. Impacted species would include three Avian Species of Conservation Concern (USFWS 2005): Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

#### **(c). General Habitat Management Activities**

As compared to current conditions, discontinuing prescribed burning and grazing in marsh habitats under Refuge Management Alternative E would reduce the amount of optimal habitat for shorebirds and wading bird species requiring more open habitats, but may provide additional habitat for some marsh bird species which utilize denser stands of vegetation. Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (*Emberizidae*) and wrens (*Troglodytidae*, Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn. Overall, species requiring denser stands of vegetation in marsh habitats would benefit Refuge Management Alternative E, while the amount of habitat for species requiring more open habitats would decrease.

Stopping control efforts for invasive vegetation such as common reed, cattail, and California bulrush which form dense homogeneous stands would result in loss of open water habitats under this Alternative. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would increase and also negatively impact these habitats. Loss of open water and associated submerged and floating plant communities would decrease habitat quality for many wading bird species.

#### **(4). Impacts to Landbirds**

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., Red-tailed Hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

#### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative E, discontinuing wetland management and restoration activities including hydrological restoration, structural marsh management and marsh restoration would have negative impacts on several land bird species. This include land birds listed as Avian Species of Conservation Concern, the Seaside Sparrow and Sprague's Pipit (USFWS 2005), which currently benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

## **(b). Uplands Management and Restoration**

### Prairie Restoration and Management

Under Refuge Management Alternative E, discontinuing native prairie restoration and management activities would negatively impact habitat quality for several land bird species. Native prairie remnants and other upland grassland habitats on the Refuge Complex currently 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.

Brush encroachment by invasive woody plants including Chinese tallow and Eastern baccharis would increase under this Alternative. Habitat quality and use by several species of land birds would decline. Impacted species include species that are declining in the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 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). These include White-tailed Hawk, Loggerhead Shrike, Northern Bobwhite, Short-eared Owl, Sedge Wren, Nelson's Sharptailed Sparrow, Henslow's Sparrow, and LeConte's Sparrow.

### Woodlot Restoration and Management

Under Refuge Management Alternative E, the USFWS would discontinue management activities which protect and diversify 60 acres of existing coastal woodlots and riparian woodlands on the Refuge Complex. Encroachment by Chinese tallow would decrease habitat quality for several neotropical migratory birds that require native trees or understory for cover and foraging. Impacted species on the Refuge Complex would include three neotropical migratory birds listed as Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler

## **(c). General Habitat Management Activities**

Under Refuge Management Alternative E, the USFWS would curtail prescribed burning and grazing on the Refuge Complex. Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested. Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife. In the short-term, decreased burning frequency under Refuge Management Alternative E could positively impact some species and negatively impact others. In the long-term, reduced habitat diversity under this Alternative will have an overall negative impact on land birds.

Under this Alternative, the USFWS would discontinue exotic and invasive plant and animal control activities. Rapid encroachment of Chinese tallow would occur and would lead to decreased diversity of native woody plants in the coastal woodlots, as well as decreased forage insects (especially Lepidopteran

larvae ) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

## **(5). Impacts to Fisheries Resources**

### **(a). Wetlands Management and Restoration**

Under Refuge Management Alternative E, the USFWS would curtail several wetland management and restoration activities which currently protect, restore and enhance estuarine wetlands and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The present continuum of fresh to saline aquatic environments on the Refuge Complex supports highly diverse aquatic vertebrate and invertebrate communities. Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Under this Alternative, the USFWS would discontinue structural marsh management. This would have a short-term beneficial impact to certain marine organisms which spend a portion of their lifecycles in estuarine marshes by increasing ingress and egress to these habitats. Structural marsh management using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Kneib and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are being impacted by rapid subsidence, sea level rise, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, the USFWS would discontinue hydrologic restoration, marsh restoration using dredge material, structural marsh management and shoreline restoration and protection, all of which restore and protect wetland habitats and help reduce rates of marsh loss. Ultimately, continued habitat loss and degradation would negatively impact fisheries resources.

### **(6). Impacts to Threatened and Endangered Species**

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth

green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative E, protection, restoration and management of coastal wetland habitats on the Refuge Complex which currently benefit the three avian T&E species would be curtailed. Habitat quality and use by T&E species and other declining or sensitive species would decline

#### **(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates**

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative C which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

Current USFWS management activities on the Refuge Complex which maintain and restore freshwater wetland habitats such hydrological restoration, structural management of marshes, moist soil management and rice farming are particularly beneficial to amphibians and reptiles. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas. Conversion of fresh and intermediate marshes to brackish and loss of freshwater wetland habitat provided by rice farming and moist soil management under this Alternative would negatively impact most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators.

Under Refuge Management Alternative E, the USFWS would curtail prescribed burning. Fire frequency would decrease, but natural fires would burn hotter and likely burn larger acres. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil-litter stabilize." Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data).

Under Refuge Management Alternative E, the habitat mosaic created by the current integrated use of burning, grazing and water management in Refuge Complex wetland and upland habitats would become less diverse. Overall, this would have negatively impact resident fish and wildlife.

## **b. Impacts from Public Use Programs**

Assuming a decrease in visitation to the Refuge Complex under Refuge Management Alternative E, overall disturbance impacts to fish and wildlife resources would likely decrease from current levels described under Alternative A. Under this Alternative, the USFWS would generally decrease the scope of public use program management and oversight on the Refuge Complex, including field law enforcement. Consequently, the USFWS' ability to protect public safety, habitats and fish and wildlife resources would decline.

### **(1). Impacts to Waterfowl**

#### **(a). Waterfowl Hunting**

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Refuge Management Alternative C should not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichholf 1973, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas would remain the same as under Alternative A and would include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating. The continued maintenance of sanctuary areas on the Refuge Complex would be required to mitigate for disturbance impacts from hunting activities under Refuge Management Alternative E. Maintaining existing regulations under this Alternative would also be necessary help mitigate the impacts of hunting activity-related disturbance to waterfowl.

#### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation**

Under Refuge Management Alternative E, existing visitor facilities on the Refuge Complex would be maintained but no new facilities would be developed. Means of access for these uses and the presence of visitors results in disturbance impacts to waterfowl, as described under Alternative A. Decreased visitation would decrease these impacts.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance

from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

## **(2). Impacts to other Migratory Birds Shorebirds, Wading Birds and other Marsh and Waterbirds, Land Birds**

### **(a). Waterfowl Hunting**

Although the disturbance impacts of waterfowl hunting under Refuge Management Alternative E on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and land birds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole, 1995), as will non-motorized boats, vehicles and walking through the marsh.

### **(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses**

Under Refuge Management Alternative E, existing visitor facilities on the Refuge Complex would be maintained but no new facilities would be developed. As described under Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Alternative E, decreased visitation would reduce these impacts.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

## **(3). Impacts to Fisheries**

### **(a). Fishing**

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term.

Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative E should not have any measurable effect on overall populations and the long-term viability of these species' populations.

**(b). Hunting, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach and other Uses**

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative E.

**(4). Impacts to Threatened and Endangered Species**

**(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities under Alternative E. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative E.

**(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates**

**(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation**

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex, under Alternative E. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

**(b). Commercial Alligator Harvest**

Under Refuge Management Alternative E, the commercial adult alligator harvest program would no longer be administered as an economic use on the Refuge Complex. Alligator populations would be monitored. The long-term impact of curtailing harvest on alligator populations on the Refuge Complex is unknown. Initially, it is likely that alligator populations would increase. Alligator populations could reach densities at which migratory bird management objectives are compromised due to high levels of predation on Mottled Ducks and other nesting species. Potential impacts would also include increased damage to water management infrastructure and increased conflicts with the public.

**(c). Control of Muskrat Populations**

Under Refuge Management Alternative E, no active management of muskrat populations would occur. Muskrat populations would be monitored. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Under this Alternative, the potential for negative impacts to marsh habitats would increase.

### **c. Impacts from Biological Program – Surveys, Monitoring, and Research**

Under Refuge Management Alternative E, current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue. Surveys and monitoring / research activities would help track and document impacts of a passive management approach on fish and wildlife resources on the Refuge Complex.

### **d. Impacts from Management of Oil and Gas Exploration and Development**

Under Refuge Management Alternative E, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduced impact on fish and wildlife resources from these activities.

### **e. Impacts from Community Outreach and Partnership Efforts**

Under Refuge Management Alternative E, Refuge staff would no longer coordinate with private landowners on partnership projects to restore and enhance native habitats on private lands.

The USFWS would continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. The number and extent of partnership activities and projects would likely be less than current levels, due primarily to the reductions in refuge staff under this Alternative.

It is anticipated that reduced outreach and partnership efforts under Refuge Management Alternative E would result in decreased levels of habitat restoration and enhancement on the Refuge Complex and throughout the project area.

## **B. Socioeconomic Resources Section**

### **1. Economic Impacts**

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways. First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements: 1) direct expenditures made by the USFWS to manage operations at the Refuge Complex, 2) value of production from agricultural programs on the Refuge Complex, and 3) expenditures made by recreational visitors to the Refuge Complex. Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this management alternative were estimated using the data and methods discussed below. The analysis compares the impacts from Refuge Management Alternative E to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

**a. Direct Economic Impacts**

**(1). Value of Refuge Operations (Direct Expenditures)<sup>17</sup>**

Table 4-34 Average Annual Operational Costs for the Refuge Complex – RM Alternative E (Direct Expenditures)			
Cost Category	Annual Average Expenditures		
	Year 1 - 5	Year 5 - 10	Year 10 - 15
Annual Staff Salaries	\$1,614,653	\$1,339,986	\$1,034,801
Utilities	\$35,000	\$35,000	\$35,000
Travel	\$39,123	\$39,123	\$39,123
Water Purchases	\$0	\$0	\$0
Heavy Equip. Rental and Replacement	\$0	\$0	\$0
Annual and Deferred Maintenance	\$28,000	\$28,000	\$28,000
Special Programs	\$0	\$0	\$0
<b>Total Average Expenditures</b>	<b>\$1,716,776</b>	<b>\$1,442,110</b>	<b>\$1,136,924</b>

Based on information about the activities proposed under this management alternative, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this management alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. As the USFWS scales back active management at the Refuge Complex, direct expenditures on habitat management, operations and staffing will be reduced. The estimate of the annual average cost, per five-year period, for Refuge Management Alternative E is summarized in Table 4-34.

The estimate of Refuge Operation's direct expenditures under this alternative shows a decrease by more than half by the end of the planning period compared to the \$2,695,184 estimate under the "No Action" alternative.

**(2). Value of Production from Refuge Agricultural Programs**

**(a). Cattle Grazing**

Grazing is eliminated in this management scenario along with most other active management strategies. The estimated production value of \$2,103,678 for grazing activities under the "No Action" alternative is reduced to 0. A summary comparing the changes in AUMs and value of production between the "No Action" alternative and Refuge Management Alternative E is contained in Table 4-35.

Table 4-35 Estimated Production Value of Grazing Activities on Refuge Complex - RM Alternative E		
Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
Refuge Management Alternative E	0	0

<sup>17</sup> The Value of USFWS Operations Table is essentially done for the No Action Alternative (Alt. A). Under the remaining management alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

## (b). Rice Production

Refuge Management Alternative E will eliminate the cooperative farm program at the beginning of the study period along with the grazing program. Therefore, the estimated annual value for rice production of \$249,867 under the "No Action" alternative would be reduced to 0. A summary comparing the changes in annual average acreage produced and value of production between the "No Action" alternative and Refuge Management Alternative E is contained in Table 4-36.

Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
Refuge Management Alternative E	0	0

## (3) Value of Refuge Recreational Programs

For each management alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under the "No Action" alternative. The estimated changes in recreational visitors under this alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	10% Decrease
Upland Bird Hunting	No Change
Fishing	No Change
Wildlife Observation	5% Decrease

These changes were then applied to the estimate of annual non-resident visits and the estimate of itemized expenditures by recreational activity which were developed for the "No Action" alternative. Table 4-37 contains a summary of the comparison of the annual direct expenditures associated with recreational visitors to the Refuge Complex between the "No Action" alternative and Refuge Management Alternative E.

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
Refuge Management Alternative E	33,438	\$1,018,007

## b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to

employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

**Employment:** The annual average estimated employment is measured as Full-Time Equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

**Labor Income:** Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

**Other Property Type Income:** This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

**Indirect Business Taxes:** Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses

### (1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Refuge Management Alternative E and the "No Action" alternative is summarized in Table 4-38.

	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	45	45	45
Refuge Management Alternative E	31	27	22
<b>Labor Income</b>			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative E	\$641,785	\$553,290	\$464,795
<b>Other Property Type Income</b>			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative E	\$25,065	\$25,065	\$25,065
<b>Indirect Business Taxes</b>			
No Action Alternative	\$493,149	\$493,149	\$493,149
Refuge Management Alternative E	\$439,499	\$377,526	\$315,553

## (2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternative E and the "No Action" alternative is summarized in Table 4-39.

Table 4-39 Indirect and Induced Economic Impacts of Agricultural Activities at Refuge Complex – RM Alternative E			
	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	20	20	20
Refuge Management Alternative E	0	0	0
<b>Labor Income</b>			
No Action Alternative	\$587,382	\$587,382	\$587,382
Refuge Management Alternative E	\$0	\$0	\$0
<b>Other Property Type Income</b>			
No Action Alternative	\$272,759	\$272,759	\$272,759
Refuge Management Alternative E	\$0	\$0	\$0
<b>Indirect Business Taxes</b>			
No Action Alternative	\$87,668	\$87,668	\$87,668
Refuge Management Alternative E	\$0	\$0	\$0

This Table reflects the elimination of both the Grazing Program and the Cooperative Farming Program under Refuge Management Alternative E.

## (3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Refuge Management Alternative E and the "No Action" alternative is summarized in Table 4-40.

Table 4-40 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex – RM Alternative E			
	Annual Average		
	Year 1 - 5	Year 6- 10	Year 11 - 15
<b>Employment (FTEs)</b>			
No Action Alternative	25	26	26
Refuge Management Alternative E	22	18	14
<b>Labor Income</b>			
No Action Alternative	\$609,908	\$621,374	\$629,040
Refuge Management Alternative E	\$612,891	\$423,679	\$347,310
<b>Other Property Type Income</b>			
No Action Alternative	\$224,963	\$229,144	\$231,939
Refuge Management Alternative E	\$193,175	\$156,187	\$127,938
<b>Indirect Business Taxes</b>			
No Action Alternative	\$136,816	\$139,559	\$141,394
Refuge Management Alternative E	\$117,599	\$95,644	\$78,894

## **2. Population Impacts**

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Under Refuge Management Alternative E, employment associated with the Refuge Complex is expected to fall by nearly half relative to the No Action Alternative. While the decline in employment resulting from this alternative is not expected to have significant impacts to population in the two county study area, there may be noticeable changes to overall employment in some local, largely rural areas which are closest to the Refuge Complex (e.g. Anahuac).

## **3. Fiscal Impacts on Local Governments**

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and / or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under current management or any of the proposed alternatives.

Management actions can also affect local government services directly. For instance, the USFWS currently purchases water from the Chambers Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area. These water purchases would likely cease under Refuge Management Alternative E with the discontinuation of the cooperative rice farming program.

## **4. Social Impacts**

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, natural resource management actions such as those made by the USFWS on the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

### **a. Impacts to Social Structures and Lifestyles**

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and / or community cohesiveness and stability)

- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and / or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause / effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

#### **b. Impacts to Relationships between the USFWS and Stakeholder Groups**

General categories of stakeholder groups describe those persons and / or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that 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. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and / or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and / or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

### **c. Impacts to USFWS Public Outreach Programs and Activities**

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and / or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative E, current USFWS public outreach efforts would continue but likely at reduced levels.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the Refuge Management Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and / or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure / lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among Alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

### **d. Environmental Justice**

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex CCP / EIS is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both adverse and beneficial effects by the continued operation and / or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and / or low-income population components. Overall, the identified minority and / or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

## VI. IMPACTS TO CULTURAL RESOURCES FROM REFUGE MANAGEMENT ALTERNATIVES

### *Impacts on Cultural Resources*

Impacts on cultural resources can include inundation, destruction, damage, and / or disruption. Impacts can directly result from ground-disturbing activities or indirectly from human use or land use and management. Potential ground-disturbing activities include facilities construction, road construction, ditch digging, oil and gas activities, and water control projects (such as levee construction, repair, or removal). Human use activities include increased public access and watercraft wakes. Intense wildfires and cattle tromping may indirectly impact cultural sites as well. Natural phenomenon may also impact cultural sites through inundation, wind / water / wave erosion, subsidence, tree bioturbation, and animal burrowing.

### *Impact Analysis for Refuge Management Alternatives*

There is a potential for direct and indirect impacts to cultural sites under all of the management alternatives; however, avoidable impacts would not be considered adverse, but rather minor in nature. Unavoidable adverse impacts are anticipated to continue to occur at potentially eligible sites from natural phenomenon.

Natural impacts, including inundation, wind / water / wave erosion, subsidence, tree bioturbation, and animal burrowing, poses the greatest threat to shell middens. Due to the marshy, undeveloped nature of the Refuge Complex and location of the shell middens along shorelines, full protection of the shell middens is not feasible without completely altering the site or removing the material from its context. Inundation of many of the sites has already occurred and the unavoidable adverse impacts are highly likely to continue. The eligible McFaddin beach site is already inundated by the naturally altered coastline and is subject to water erosion and loss of material. Cultural resource management actions are not proposed for the shell midden sites under the management alternatives. Existing and proposed shoreline protection projects and water control structures under Refuge Management Alternatives A, B, C, and D would reduce wave fetch and intensity of wave action. Shoreline protection projects under the Section 227 National Shoreline Erosion Demonstration Project may indirectly benefit shoreline sites by reducing wave intensity under all management alternatives. Offshore wavebreaks on McFaddin under Refuge Management Alternatives C and D may also reduce wave action at the McFaddin Beach site. Discontinuing water control management under Refuge Management Alternative E would reduce the protection of the middens indirectly afforded by the management actions.

Ground disturbing activities, including facilities construction, road construction, ditch digging, oil and gas activities, and water control projects (such as levee construction, repair, or removal), would be subject to a ground survey and consultation requirements with the State Historic Preservation Officer (SHPO) under the NHPA Section 106 regulations. Privately initiated oil and gas activities create the most ground disturbance in the Refuge Complex with road, pipeline, and well pad construction. Any dredge or fill projects in the Refuge Complex would be proposed and conducted by the U.S. Army Corps of Engineers. Shoreline protection projects under the Section 227 National Shoreline Erosion Demonstration Project under all management alternatives and offshore wavebreaks on McFaddin under Refuge Management Alternatives C and D would be subject the Section 106 process and potential impacts to the NHRP eligible sites. All ground-disturbing activities, whether initiated by the USFWS or other entities, would be subject to restrictions imposed on Refuge Complex lands and consultation with the SHPO under Section 106 regulations. The potential for any ground-disturbing activities to impact known sites or undiscovered sites would be identified and resolved appropriately through the Section 106 process.

Maintenance of existing shoreline protection projects and water control infrastructure as well as additional water control projects under Refuge Management Alternatives A, B, C, and D may result in the identification of addition cultural resources sites and better protection of the sites from wake action. Because water control and facilities construction and improvements occur more frequently under Refuge Management Alternatives C and D, cultural resources may indirectly benefit. Discontinuing water control

management under Refuge Management Alternative E may lead to greater wave fetch and potentially lead to increased erosion of shell middens along shorelines indirectly over time.

The burn intensity of fires may affect archaeological and historical resources. Low-intensity burns are usually associated with lightly burned grasslands during prescribed burns. Low-intensity burns are not anticipated to affect cultural resources, but may cover the resources in soot. High-intensity burns are typically associated with wildfires in dry areas that have abundant litter accumulation due to unnatural fire suppression. High-intensity fires may char or consume cultural resources leading to a potential impact. There is very little likelihood of a high-intensity fire occurring since the Chenier Plain Refuge Complex is primarily wet, has high soil moisture content, and was subject to burning by Native Americans, present-day natural resource managers, and lightning-ignited fires. According to the Fire Management Plan (2001), wildland fires on the Refuge Complex are rarely controlled with suppression tactics, firebreaks, or chemical retardants, which are only used sparingly if necessary to protect life and / or property. Natural wildfires are suppressed only when they threaten Refuge Complex facilities, adjacent private property, and / or public health and safety. Rotational prescribed burning considered in Refuge Management Alternatives A, B, C, and D would reduce the potential for damage to cultural resources from intense wildfires. Reliance on natural lightning starts only under Refuge Management Alternative E may lead to more fuel accumulation and higher intensity fires; however, due to the high soil moisture, severe damage is not anticipated and minor charring, at worst, may occur on the surface of cultural sites in the long-term.

Cattle grazing may damage cultural resources by inadvertent tromping. Some of the shell midden sites recorded have already experienced damage by cattle tromp. Cattle on the Refuge Complex typically feed as they disperse in the wet areas and congregate on higher, dry grounds, which typically include manmade dykes or berms. Shell middens are typically associated with undisturbed, wet areas and may be subject to occasional tromping from the dispersed cattle; however, damage by cattle tromp is not likely to be exceeded by damage through natural erosion. The potential for inadvertent cattle tromping is likely to occur under Refuge Management Alternatives A, B, C, and D. Inadvertent tromping is not anticipated under Refuge Management Alternative E in which grazing is discontinued.

Recreation visitors and activities may inadvertently damage cultural sites; however, recreation access in the Refuge Complex is highly limited by the under-developed character of the area. Recreation activities are limited to Anahuac, McFaddin, and Texas Point NWRs. Bird and wildlife observation, fishing, and hunting would continue under all management alternatives and typically occur in previously disturbed areas. Minor improvements to recreation access, such as trails and boat launches, under the management alternatives is limited to existing developed areas under Refuge Management Alternatives B, C, and D and would be subject to ground truthing for cultural items before disturbance. Bird and wildlife observation is typically limited to easily accessible areas that comprise a small portion of Refuge Complex lands, where existing shell midden sites are typically not found. Fishing and hunting recreationalists may reach more remote areas by boat. Most of the recreational boat traffic occurs on the interconnected manmade bayous, ditches, and water delivery systems that have already be modified from their original landforms through straightening and dredging before the Refuge Complex was created. Impacts to shell middens from wake action created by smaller fishing boats in the Refuge Complex is likely to be minor since airboats are not allowed and motor sizes are regulated in the Refuge Complex. Continuing and expanding public interpretation and education programs under Refuge Management Alternatives A, B, C, D, and E may indirectly lead to improved public appreciation and awareness of the Refuge Complex lands and resources contained therein. Public appreciation and awareness would be promoted most under Refuge Management Alternative D and least under Refuge Management Alternative E.

## VII. IMPACTS COMPARISON TABLE FOR THE REFUGE MANAGEMENT ALTERNATIVES

The impacts discussed in detail in the preceding section, *Part A: Impact Analysis for the Five Refuge Management Alternatives*, are summarized and condensed in the following table. The impacts under the "No Action" Alternative A are the base of comparison for the other four "Action" Refuge Management Alternatives. The table is organized by resource area, the same way the detailed impact analysis in Part A is organized. The table allows for a quick comparison of the impacts in a specific resource area between Alternatives.

NO ACTION ALTERNATIVE	ACTION ALTERNATIVES			
	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
<b>Impacts to Air Quality</b>				
Potential smoke impacts to air quality from USFWS prescribed burns on 12-15,000 acres annually	Potential smoke impacts to air quality increased by expanding prescribed burns to 35,000 acres annually. Decreased potential for smoke impacts from wildfires	Potential smoke impacts to air quality decreased by reducing prescribed burns to 5-6000 acres annually. More potential smoke impacts from wildfires	Same as RM Alternative A.	Prescribed burning discontinued; more potential for smoke impacts to air quality from wildfires
<b>Impacts to Geology and Soils</b>				
Shoreline protection & marsh restoration help reduce coastal land loss. Water management and prescribed burning may contribute to organic soil formation.	Same as RM Alternative A. Additional prescribed burning and structural marsh management may contribute to enhanced organic soil formation	Substantial increase in shoreline protection & restoration using dredge material through expanded interagency coordination.	Same as RM Alternative A. Substantial increase in shoreline protection and marsh restoration using dredge material through expanded interagency coordination. Expanded monitoring and research on factors affecting coastal land loss.	Discontinued shoreline protection & restoration projects resulting in increased coastal land loss and saltwater intrusion.
<b>Impacts to Hydrology and Water Quality</b>				
Extensive water management helps maintain historic continuum of coastal marsh habitats by reducing saltwater intrusion, managing water levels, and providing freshwater inflows. Protects nationally-declining wetland types.	Same as RM Alternative A. Water management enhanced by two new marsh semi-impoundments of 6500 acres.	Expand interagency coordination on watershed-scale hydrologic restoration projects to reduce saltwater intrusion and increase freshwater inflows. Acquire additional water rights.	Same as RM Alternative A. Expand interagency coordination on watershed hydrologic restoration projects, enhance water management, and acquire additional water rights. Expand water quality monitoring.	Active water management & restoration discontinued resulting in saltwater intrusion, loss of freshwater & altered hydroperiods.

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
<b>Impacts to Vegetation / Habitats</b>				
Impacts from Habitat Management and Restoration Activities				
<p>Structural marsh management helps maintain / restore historic continuum of coastal marshes and plant &amp; animal communities that are dependent on these habitats. Moist soil units and cooperative rice farming provide high quality freshwater wetland habitat for migratory birds. Native prairie restored and coastal woodlots protected. Integrated burning, grazing &amp; water management creates and maintains diverse plant communities. Integrated Pest Management (IPM) program helps control exotic and invasive plant &amp; animal species. Shoreline protection &amp; restoration beneficially protects wetland habitats.</p>	<p>Added marsh semi-impoundments, expanded moist soil and cooperative rice farming increase provide additional wetland habitats for migratory birds. Reduced scope of prairie restoration. Expanded burning and grazing programs enhance wetland and upland habitats for waterfowl and other migratory birds. IPM program, shoreline protection same as RM Alternative A.</p>	<p>Hydrologic restoration to restore freshwater inflows. Cooperative rice farming phased-out with expanded restoration to native prairie and wetlands. Native prairie plant associations increased by restoring 4535 acres to native prairie (a Globally Imperiled habitat) &amp; 29 acres to woodlands. Reduced burning and grazing. IPM program expanded to additional areas. Expand interagency coordination efforts to increase shoreline and marsh protection &amp; restoration.</p>	<p>Enhanced structural marsh management same as Alt. A. Expanded moist soil units and same levels of cooperative rice farming. Native prairie plant associations increased by restoring 2223 acres to native prairie &amp; 29 acres to woodlands. Refined burning and grazing to increase benefits to migratory birds and other wildlife. IPM program expanded to additional areas. Expand interagency coordination efforts to increase shoreline protection and marsh restoration. Additional monitoring and research to assess threats to habitats.</p>	<p>Active marsh management ends resulting in saltwater intrusion, loss of freshwater inflows, and altered hydro-periods. Moist soil units and coop rice farming terminate. No active habitat restoration. End of prescribed burning and grazing results in higher successional plant communities. End of IPM program results in increased populations of exotic / invasive plant and animal species. Shoreline protection &amp; restoration discontinued increasing rate of shoreline retreat and coastal land loss, including conversion of vegetated marshes to open water.</p>
Impacts from Public Use Programs				
<p>Some impacts to wetland vegetation, primarily from motorized boating (associated with hunting/fishing) and local impacts to habitats in heavily used areas. Regulations help ensure that Impacts are localized and not substantial</p>	<p>Same as RM Alternative A.</p>	<p>Same as RM Alternative A, except for reduced impacts in wetland habitats due to decrease in hunting use.</p>	<p>Same as RM Alternative A except with potential to increase with overall increase in visitation.</p>	<p>Same as RM Alternative A except less extensive with overall decrease in visitation.</p>

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
<b>Impacts to Vegetation / Habitats</b>				
Impacts from Biological Program, Management of Oil & Gas Exploration/Development, and Community Outreach and Partnerships				
Surveys & monitoring support an adaptive habitat management approach. Oil & gas management minimized impacts to habitats. Outreach and partnerships result in additional habitat restoration/enhancement.	Same as RM Alternative A.	Same as RM Alternative A with more focus on restoration and enhancement of native prairie & coastal woodlot habitats.	Same as RM Alternative A with expanded monitoring and research to guide habitat management and restoration and improve exotic and invasive species management. Expanded outreach and partnerships increase habitat restoration and protection.	Surveys and monitoring only document impacts of passive management. Oil & gas management same as RM Alternative A. Reduced outreach & partnerships results in little habitat restoration or enhancement.
<b>Impacts to Fish and Wildlife Resources</b>				
Impacts from Habitat Management and Restoration Activities				
Management/restoration activities have greatest beneficial impact on wintering, resident and migrating waterfowl. Management activities which result in a mosaic of diverse habitats positively impact other avian species. Activities which maintain/restore productive wetland habitats benefit fisheries in long-term. Management aimed at ensuring biological diversity & ecological integrity benefit T&E and declining species. Most other wildlife species benefit from management activities.	Focus on enhancing waterfowl habitats provide additional benefits for wintering, resident and migrating waterfowl and other wetland-dependent birds. Impacts on fisheries, T&E species and other wildlife species generally same as RM Alternative A.	Emphasis on restoration with less water management reduces benefits to waterfowl and other wetland-dependent migratory birds. Prairie restoration and woodlot protection benefit many declining species. Impacts on fisheries, T&E species and other wildlife generally same as RM Alternative A.	Expanded and enhanced management results in a diverse habitat mosaic which increases benefits to wintering waterfowl, Mottled Ducks, shorebirds, wading birds and other wetland-dependent migratory birds. Prairie restoration and woodlot protection benefit many declining landbird species. Overall, this Alternative provides greatest diversity of habitats benefiting several Avian Species of Conservation Concern. Increased beneficial impacts to fisheries by incorporating fish passage into water management protocols. Impacts to T&E species and other wildlife species same as RM Alternative A.	Discontinued management would decrease habitat values and use by waterfowl and other migratory birds. Habitat values and use by other avian species would also decrease. Curtailed wetland management has short-term benefit for fisheries but habitat loss/degradation of coastal wetlands would have long-term negative impact. Passive management has negative impacts on T&E and other wildlife species.

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
<b>Impacts to Fish and Wildlife Resources</b>				
Impacts from Public Use Programs				
<p>Waterfowl harvest managed through regulations has no impacts on overall populations &amp; long-term viability of these populations. Sanctuary areas mitigate disturbance impacts from hunting. Minimal disturbance impacts to other wildlife species from other wildlife-dependent recreational activities. No impacts to T&amp;E species or fisheries.</p>	<p>Same as RM Alternative A.</p>	<p>Same as RM Alternative A.</p>	<p>Increase in all types of visitation expected to result in minimal, localized increase in impacts to migratory birds and other wildlife. No change in impacts to T&amp;E species or fisheries.</p>	<p>Expected overall decrease in visitation over time would decrease impacts. No impacts to fisheries or T&amp;E species.</p>
Impacts from Biological Program, Management of Oil & Gas Exploration/Development, and Community Outreach and Partnerships				
<p>Surveys and monitoring track &amp; document impacts of management strategies on fish &amp; wildlife supporting adaptive management approach. Oil &amp; gas management reduces impacts on fish &amp; wildlife. Outreach &amp; partnerships result in benefits to fish &amp; wildlife as habitats are restored or enhanced.</p>	<p>Same as RM Alternative A except with more benefits from expanded outreach &amp; partnerships.</p>	<p>Same as RM Alternative A except with more benefits from expanded outreach &amp; partnerships especially in restored prairie woodland habitats.</p>	<p>Expansion of all programs would enhance benefits to fish and wildlife resources. Additional monitoring and research focuses on priority avian and other wildlife species.</p>	<p>Surveys and monitoring would only document impacts from passive management approach. Continued oil &amp; gas management reduces impacts on fish &amp; wildlife. Reduced outreach and partnerships reduce habitat restoration/enhancement and benefits to fish &amp; wildlife.</p>

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
<b>Economic Impacts</b>				
<p>Refuge operations contribute \$2.7m* direct to local economy &amp; refuge agriculture programs add \$2.1m* (grazing) and \$.25m* (rice farming). Direct expenditures by recreational visitors contribute another \$1.1m*. Indirect &amp; induced economic impacts from these direct impacts contribute an estimated \$3.3m* more to local economies. *m = million \$</p>	<p>Increased direct contributions from refuge operations by 10%, from grazing by \$.5m*, rice farming by \$.16m*, and recreational visitors by \$.1m*. Corresponding increases in indirect &amp; induced economic impacts from increases in direct impacts.</p>	<p>Increased direct contributions from refuge operations by 25%, but substantial decrease from grazing by \$1.1m* and rice farming by \$.25m*. Very small increase in direct expenditures by recreational visitors. Corresponding increases or decreases in indirect &amp; induced economic impacts dependent on direction of change in direct impacts.</p>	<p>Substantial increase in direct contributions from refuge operations by \$1.0m*. Smaller increases in grazing, \$.3m* &amp; recreational visitors, \$.2m* but rice farming same as Alt. A. Corresponding increases in indirect &amp; induced economic impacts with increases in direct impacts.</p>	<p>Major decreases in direct contributions from refuge operations (by more than half by end of planning period) along with complete elimination of all refuge agricultural programs. Small decrease in direct expenditures by recreational visitors. Corresponding major decreases in indirect &amp; induced economic impacts with decreases in direct impacts.</p>
<b>Impacts on Population, Fiscal Impacts on Local Governments, and Social Impacts</b>				
<p>No environmental justice or population impacts. Payments to local gov't entities under Refuge Revenue Sharing Act. Social conditions remain generally unchanged with unresolved issues.</p>	<p>Same as Refuge Management Alternative A.</p>	<p>Same as Refuge Management Alternative A.</p>	<p>Same as Refuge Management Alternative A.</p>	<p>Same as Refuge management Alternative A except for small localized reduction in employment in a rural area.</p>