PART B: IMPACT ANALYSIS FOR FOUR REFUGE BOUNDARY EXPANSION ALTERNATIVES

.

Summary of Refuge Boundary Expansion Alternatives

The four Refuge Boundary Expansion Alternatives are graphically depicted on the maps beginning on page 86 of Chapter 2, Part B. The following is a summary describing each of the Refuge Boundary Expansion Alternatives and the focus for each one:

*Refuge Boundary Expansion Alternative A **(NEPA No Action Alternative)** - No Expansion, Current Status*

This Alternative assumes no change from the existing refuge boundaries within the Refuge Complex. This is the "No Action" alternative as required under NEPA and is considered the base from which to compare the other Refuge Boundary Expansion Alternatives. There would be no expansion of any of the four refuge boundaries within the Refuge Complex.

Refuge Boundary Expansion Alternative B - 33,590 Acre Expansion

This Alternative continues the four refuges' historic focus on land acquisition primarily in the coastal marsh and the adjacent agricultural uplands. Acquisition would continue to focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. This Refuge Boundary Expansion Alternative concentrates on high-value wintering waterfowl habitats near the coast that are contiguous to existing refuges. In addition to these high biological value wetland habitats, this Alternative also includes areas adjacent to existing refuges identified as necessary for refuge management. Expansion is proposed for each of the four refuges in the Refuge Complex.

Refuge Boundary Expansion Alternative C ***(Preferred Alternative) -*** *64,260 Acre Expansion*

Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative B. Similar to Refuge Boundary Expansion Alternative B, this Alternative continues the four refuge's historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetland portions of this Refuge Boundary Expansion Alternative concentrate on high-value wintering waterfowl habitats near the coast that are contiguous to existing refuges. In addition to these primarily wetland areas, this Alternative includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. In addition to these two kinds of high biological value habitats, this alternative also includes areas adjacent to existing refuges identified as necessary for refuge management. Expansion is proposed for each of the four refuges in the Refuge Complex.

Refuge Boundary Expansion Alternative D - 104,120 Acre Expansion

Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative C. Similar to Refuge Boundary Expansion Alternative C, this alternative continues the four refuge's historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetlands portions of this Refuge Boundary Expansion Alternative concentrate on high-value wintering waterfowl habitats near the coast which are contiguous to existing refuges. In addition to these primarily wetland areas, this Alternative includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks,

many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. This Alternative also includes an important near-coast bottomland hardwood area, which is an acquisition target new to this Refuge Complex. The primary habitat type in this area is forested wetlands which provide high quality wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species, and important migration stop-over habitats for many neotropical migratory birds making trans- and circum-Gulf migrations. And finally, in addition to these various kinds of high biological value habitats, this Alternative also includes areas adjacent to existing refuges identified as necessary for refuge management.

The estimated acreage for each proposed expansion (Alternative A – D) is summarized for each of the four refuges in the Refuge Complex in Table 4-41.

Table 4-41
Total Estimated Acreage within the Refuge Boundary Expansion Alternatives

Refuge	Estimated Acreage			
	Alternative A "No Action"	Alternative B	Alternative C	Alternative D
Moody	0	5,050	7,920	7,920
Anahuac	0	20,500	47,750	64,910
McFaddin	0	7,190	7,190	29,890
Texas Point	0	850	1,400	1,400
Total	**0**	**33,590**	**64,260**	**104,120**

Assumptions

- **The impacts for the Refuge Boundary Expansion Alternatives are analyzed assuming that all of the lands within an expansion area would be acquired in fee simple within the first year following approval of that proposed boundary expansion. This assumption assures that the maximum possible impacts are addressed even though the proposed "willing seller" acquisition program would obviously not produce this result.**

- **The impacts for the Refuge Boundary Expansion Alternatives are analyzed assuming that the lands within the existing Refuge Complex and those lands acquired in the future would be managed according to the strategies contained in Refuge Management Alternative D, the Preferred Alternative.**

Impacts to Cultural Resources

The impacts to cultural resources on the Complex from the actions proposed in the Refuge Boundary Expansion Alternatives are discussed in a separate section at the end of this part. The impacts for all of the alternatives are grouped together in one discussion because the impacts are very similar and only differ in quantity of acreage proposed for acquisition.

Organization of Impact Analysis

As in Part A of this Chapter, all of the impacts for Refuge Boundary Expansion Alternative A (No Action) will be presented in its own separate section. The impacts occurring under this Alternative become the base for comparison of the impacts from the other "action" alternatives.

Impacts for the other three Refuge Boundary Expansion Alternatives will be presented together in one section. This is done because the impacts from each of the three "action" alternatives are the same and differ only in quantity depending on the size of the expansion proposal. The only exception is the impact to the development potential in Taylors Bayou within Refuge Boundary Expansion Alternative D and this impact is described separately.

I. IMPACT ANALYSIS FOR REFUGE BOUNDARY EXPANSION ALTERNATIVE A (NO ACTION) NO EXPANSION, CURRENT STATUS

Overview

Under Refuge Boundary Expansion Alternative A, the refuge boundaries would not be expanded. Lands within the proposed boundary expansion areas in Refuge Boundary Expansion Alternatives B, C and D would not be acquired by the USFWS, and would likely remain in private ownership. Current land uses within the areas in identified in Refuge Boundary Expansion Alternatives B, C, and D are primarily agricultural, and include livestock grazing and rice farming. Many privately-owned agricultural properties in the project area are leased by individuals or commercial guides and outfitters for waterfowl hunting and dove hunting. These uses would likely continue as long as they are economically beneficial to the landowner.

Rice farming, which can provide valuable wildlife habitat when managed for those purposes, is declining in the project area. Much of the acreage in the USDA farm program in Chambers and Jefferson counties is now either fallow or has been converted to improved pasture. Fallowed rice fields and improved pasture are now being managed primarily for cattle grazing. Areas not grazed are quickly invaded by exotic plant species, particularly Chinese tallow and deep-rooted sedge. Once infested, these areas provide few benefits for wildlife and require restoration at significant costs to resume rice production or provide suitable pasture for cattle.

Changes in land ownership patterns in the project area may be impacting the extent to which management on private lands specifically includes providing enhanced habitats for fish and wildlife. Many large land holdings formerly owned and managed under single ownership have been divided into multiple ownerships. In many of these cases, land management for wildlife which formerly occurred over large areas is now less likely to occur.

Some land owners in the project area are intensively and very successfully managing properties to enhance wetland habitats for wintering waterfowl, and agricultural practices such as rice farming and cattle grazing can provide substantial benefits to waterfowl and other migratory birds. Overall within the project area, however, economic considerations other than fish and wildlife benefits dictate land uses and land management practices on private lands. This will likely continue to be the case under Refuge Boundary Expansion Alternative A.

Under Refuge Boundary Expansion Alternative A, future land uses would be subject to the discretion of the landowners. Land could remain undeveloped with continued agricultural uses, or be converted to other uses such as residential, recreational or industrial development.

The authorized acquisition boundary for each of the refuges would remain as it is today. The USFWS would continue to manage the lands already acquired and could only acquire the remaining lands, if any, within their existing boundaries.

Summary of Current Land Acquisition Status:

Refuge	Approved Boundary	Acquired Lands	Percent Acquired
Moody NWR	3,516 acres	3,516 acres	100%
Anahuac NWR	34,339 acres	34,339 acres	100%
McFaddin NWR	70,710 acres	58,861 acres	83%
Texas Point NWR	8,952 acres	8,952 acres	100%

A. Natural Resources Section

1. Impacts to Air Quality

The predominant impact to the region's air quality from current land uses is from agricultural burning in support of grazing and rice production. Burning on private lands is conducted mainly to improve forage for livestock and to control brush. Some landowners also burn marshes to enhance habitat for wintering waterfowl. Under Refuge Boundary Expansion Alternative A, private landowners would continue to conduct burning on their lands. Marsh burning generally occurs in September or October. In upland areas, private landowners tend to burn in the late spring for brush control and to create more palatable forage for cattle. Marshes and pastures are typically burned annually. In heavily grazed areas, reduced fuel loads allow only portions of pastures to burn.

The primary source of negative air impacts from burning is from smoke. Regional air quality is affected only when many acres are burned concurrently on the same day. Temporary, localized decreases in air quality occur more frequently, but may be severe at times due to the large quantities of smoke that can be produced in a given area during a short period of time (USFS 1989). 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. Nitrogen oxides are usually produced at temperatures only reached in piled slash or very intense wildfires; only inconsequential amounts are produced in prescribed fires (USFS 1989). Particulate matter is the major pollutant of concern from wildfire 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 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).

Burning may temporarily expose local residents to low concentrations of drift smoke, which is more of a temporary inconvenience than a health problem. However, high smoke concentrations typically produced from large burns can present health concerns, particularly near homes of people with respiratory illnesses or near health-care facilities (USFS 1989). The human health effects from smoke vary 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). Additionally, the burning of noxious plants such as poison ivy can affect human respiratory systems, as well as cause severe skin rashes (USFS 1989). Wildlife can also be negatively impacted by smoke, particularly where large areas are ignited in a short period of time.

Burning on private lands in the project area often occurs under conditions of low humidity associated with frontal passages and north winds which typically transport smoke away from communities and other smoke sensitive areas. However, burning activities on private lands also regularly do not adhere to State regulations governing outdoor burning. These include regulations under the Texas Commission on Environmental Quality's Outdoor Burning Rule: 1) sensitive receptors must not be within 300 feet downwind of burning activities; 2) burning must occur no earlier that one hour after sunrise and no later than one hour before sunset; 3) burning must not be permitted when surface winds are less than six mph or more than 23 mph; and 4) burning must not be permitted during periods of persistent (actual or predicted) low level atmospheric temperature inversions (Therriault 2001, USFWS 2003). As such, burning on private lands under conditions which cause smoke impacts to communities in the area is not

uncommon. Burning in areas with heavy fuel accumulations which extends over several days produces the most severe smoke impacts.

2. Impacts to Geology and Soils

Soil erosion is a physical process whereby soils are degraded by the action of water and wind. Other forms of soil degradation including soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinization, and soil acidity problems usually contribute to accelerated soil erosion. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil.

Current agricultural uses on private lands within the project area are impacting soil characteristics. Fertilization, fresh water irrigation that desalinizes soils, and aeration that increases oxidation positively affect soil chemistry and stabilize soils thereby preventing accelerated erosion. Conversely, heavy grazing or intense agricultural uses can destabilize soils and lead to increased soil erosion through excessive removal of vital soil nutrients, soil compaction, removal of vegetation and extensive use of broad spectrum herbicides and pesticides.

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. 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)). 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).

Although shoreline retreat and along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as 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 loss on both the Texas Point and McFaddin NWRs and adjacent private lands in Jefferson County. Shoreline erosion and retreat along the Gulf is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline is eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of beach and dune habitat, this loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively

impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease of the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water. (On McFaddin NWR, coastal erosion and damage from storm tidal surges have 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 on public and private lands throughout the project area. 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. Erosion along the GIWW in the project area is occurring at rates between 5 to 10 feet annually. This is resulting in current or pending loss of intermediate and brackish marsh habitats, and 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 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. It is likely that these impacts have been the most severe in areas subject to both saltwater intrusion and rapid subsidence.

Under Refuge Boundary Expansion Alternative A, it is expected that coastal land loss (as shorelines erode and retreat and emergent marshes convert to open water) would continue at existing or accelerated rates in areas now under private ownership. To date, most shoreline protection projects on private lands in the area have focused on protecting residential and recreational infrastructure. In general, sufficient economic incentives are not in place for private landowners to participate in the types of major conservation-oriented hydrologic restoration and shoreline protection projects which will be required to counter the future effects of relative sea level rise and altered hydrological regimes.

Other land management practices occurring on private lands such as burning are impacting soils and soil formation. 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). Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood. Burning frequency and timing will likely determine the net effect on vertical accretion. Marsh burning on private lands occurs primarily in support of grazing and hunting operations, and typically marshes are burned annually.

Some landowners in the project area are managing water levels and salinities in coastal marshes, primarily to enhance habitats for wintering waterfowl and to reduce saltwater intrusion which can negatively impact grazing and rice farming operations. 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, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana. Water management activities on private lands in fresh to brackish coastal marshes which reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying would benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils. Conversely, management which results in increased saltwater intrusion or excessive inundation or "drowning" of emergent marshes may result in lowered plant productivity and reduced soil formation.

In general, it is likely that economic considerations rather than the potential impacts of burning and water management on marsh accretion will continue to dictate the scope, extent and timing of these activities on private lands under Refuge Boundary Expansion Alternative A.

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 throughout the project area have been greatly modified by the construction of the GIWW and numerous smaller canals and ditches, upstream dams and reservoirs, 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 in the region (Moulton *et al*. 1997).

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.

Saltwater 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 have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

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)). 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).

Some landowners in the project area are managing water levels and salinities in coastal marshes, primarily to enhance habitats for wintering waterfowl and to reduce saltwater intrusion which can negatively impact grazing and rice farming operations. 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 marshes. Water management activities on private lands in fresh to brackish coastal marshes which reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying helps maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats support a natural diversity of native plant, fish and animal communities. Such management also helps prevent the conversion of vegetated marsh to open water, promotes plant productivity and contributes to marsh surface elevation gain (accretion). Conversely, management on private lands which results in increased saltwater intrusion, excessive inundation or "drowning" and / or too rapid drainage and excessive drying of emergent marshes is likely resulting in loss and degradation of coastal wetlands.

Changes in land ownership patterns in the project area may be impacting the extent and scope of water management and other land management practices which formerly benefited wildlife and habitat on private lands. Many large land holdings formerly owned and managed under single ownership have been divided into multiple ownerships, making it less likely that management activities such as large-scale hydrologic management or restoration in marshes will take place. In general, it is likely that economic considerations rather than habitat and fish and wildlife conservation objectives will dictate the types and scope of management activities affecting hydrology on private lands under Refuge Boundary Expansion Alternative A.

b. Water Quality

Potential sources of contaminants affecting water quality in the project area include accidental releases from oil and gas exploration and production activities, including spills and leaks from wells, production facilities, and pipelines. Oil and gas exploration and development activities have increased in the project area in recent years. A high volume of petrochemicals is transported through the project area 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 National

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.

In general, it is likely that economic considerations will dictate the types and scope of activities which affect water quality on privately-owned lands under Refuge Boundary Expansion Alternative A.

4. Impacts to Vegetation / Habitats

Land management practices affecting vegetation and habitats on private lands within the project area are undertaken in support of agricultural uses, primarily livestock grazing and rice cultivation. Practices include pasture management (including haying, conversion to "improved" pasture, and control of Chinese tallow), burning, and the soil and water manipulations associated with rice farming. Some landowners implement structural water management in coastal marshes, primarily to enhance habitats for wintering waterfowl and to reduce saltwater intrusion which can negatively impact grazing and rice farming operations. Concurrent with agricultural uses, some private lands are also being managed to provide wildlife benefits, primarily in support of waterfowl hunting. Some rice farming operations are managed so as to provide quality habitat for wintering and migrating waterfowl. A small number of land owners are implementing moist soil management practices to create shallow freshwater wetland habitat, also to enhance habitat values for waterfowl. Most private lands capable of supporting waterfowl and / or dove hunting are leased to individuals or commercial hunting guides and outfitters.

Some land owners in the project area are intensively and very successfully managing properties to enhance habitats for wintering waterfowl, and rice farming and cattle grazing can provide substantial benefits to waterfowl and other migratory birds. Overall in the project area, however, economic considerations other than fish and wildlife benefits dictate land uses and land management practices on private lands. This will continue under Refuge Boundary Expansion Alternative A.

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

(1). Wetland Specific Management and Restoration

Water management activities (e.g., establishing freshwater inflows, water level management, and restricting saltwater intrusion) impact geology, soils and hydrologic regimes throughout the project area. Such activities also influence vegetation found in wetland habitats.

(a). Water Management in Coastal Marshes

Some landowners in the project area are managing water levels and salinities in coastal marshes to both support agricultural uses and enhance habitats for wintering waterfowl. Controlling saltwater intrusion in support of grazing and rice farming also increases habitat quality for wintering waterfowl. Managed marshes on private lands within project area are under varying degrees of structural control. Some are entirely or almost entirely behind man-made levees and water control structures, and are intensively managed through manipulation of the water control structures. Most are managed less intensively, relying to some degree on natural topography and drainage to control hydrologic regimes. Ditch construction in marshes for drainage and / or access purposes has occurred extensively throughout the region.

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 these structurally-managed marshes. On lands being managed for waterfowl, water levels and salinities favorable for producing abundant crops of submerged aquatic vegetation in open water habitats are maintained. Water levels during fall and winter months are maintained to promote utilization by puddle ducks and geese.

Water management activities on private lands in fresh to brackish coastal marshes which reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying are helping to maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats will continue to support a natural diversity of native plant, fish and animal communities. Such management would also help prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain (accretion). Conversely, structural marsh management which results in increased saltwater intrusion or excessive inundation or "drowning" of emergent marshes would result in loss and degradation of coastal wetlands.

On many properties being managed for livestock grazing as the primary economic use, marshes are drained immediately following the hunting season and kept dry as long as possible to increase availability of forage for livestock and increase the amount of dry ground available for calving. Marshes are typically "drawn down" as quickly as possible beginning in late January.

(b). Moist Soil Management

A few private landowners in the project area use moist soil management to enhance wintering waterfowl habitat. Water management and mechanical soil manipulations 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. 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.

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, shorebirds, wading birds, waterfowl, gallinaceous birds, raptors, and mammals (Fredrickson and Taylor 1982).

(c). Rice Farming

Rice and livestock production are the predominant agricultural activities in the project area, and rice fields and pastureland are the predominant upland agricultural habitats. Conversion of native habitats to agricultural uses has occurred throughout the project areas on most lands that would support these uses.

Rice production requires seasonal flooding, which creates shallow freshwater wetland habitat utilized by many avian and other wildlife species throughout the spring and summer. During fall and winter, flooded rice stubble and rice fallow, plowed fields, water leveled fields, weedy fields, ryegrass fields, and pastureland in the project area provide habitats that historically have supported large concentrations of wintering and migrating waterfowl, shorebirds, and wading birds. Flooding after harvest makes waste grain available to waterfowl. Reservoirs associated with rice production provide permanent, deepwater wetland habitats.

Rice production in the project area has declined significantly in recent years, and only a relatively small amount of base acreage currently in the USDA farm program is being actively farmed. On lands identified under Refuge Boundary Expansion Alternative B, 3,013 acres are currently being subsidized for

rice under the USDA farm program, on which an average of 99 acres per year have been in rice production in recent years. On lands identified under Refuge Boundary Expansion Alternative C, 3,506 acres are currently being subsidized for rice under the USDA program, of which an average of 211 acres per year has been in rice production in recent years. On lands identified under Refuge Boundary Expansion Alternative D, 13,290 acres are currently being subsidized for rice under the USDA program, of which an average of 1,229 acres per year has been in rice production in recent years.

Former rice fields are either left fallow or are being converted to improved pasture. Much of this acreage is supporting livestock operations. Permanently fallowed rice fields which are not grazed are rapidly being invaded by Chinese tallow and deep-rooted sedge. These exotic plant species are so invasive that they quickly replace native plants and provide few benefits for wildlife. The decline in rice production in the project area has significantly reduced the amount of farmed wetland acreage available to waterfowl and other migratory birds. It has undoubtedly contributed to reduced numbers of waterfowl wintering in the area.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Most of the historic native coastal tallgrass prairie in the project area has been converted to agricultural uses, primarily for rice production and pasture for grazing. Some private lands, primarily in Chambers County, contain some of the only remaining large tracts of native prairie on the upper Texas Coast. Land holdings with remnant native prairie stands are utilized and managed primarily to support grazing by cattle.

Increasingly, fallowed rice fields and other privately-owned uplands in the project area are being converted to “improved pasture” in support of cattle grazing operations. This generally involves planting of tame grasses including Jiggs Bermuda, Coastal Bermuda, and Bahia grasses. Improved pastures are typically used as warm season pastures. Winter wheat and rye grass are planted to produce cattle feed for use during the cool season. Improved pastures do not to support the plant and animal diversity found in native prairie or rice fields.

(b). Woodlot Restoration and Protection

Coastal woodlots found on private lands in the project area are typically part of the overall land area used for livestock grazing. Woodlots are typically found on higher elevation sites, and cattle will typically congregate on these sites for shade. Grazing typically reduces or eliminates understory shrubs in woodlots, and may preclude natural reproduction of woody plant species.

(3). General Habitat Management Activities

(a). Fire Management - Prescribed Burning

Private landowners in the project area routinely use burning in marsh and upland areas, mainly to improve forage and control brush in support of grazing operations. Some landowners with hunting leases and / or commercial hunting operations also burn marshes to enhance habitat for wintering waterfowl.

Under Refuge Boundary Expansion Alternative A, private landowners would continue to conduct agricultural burning on their lands. Marsh burning generally occurs in September or October. In upland areas, private landowners tend to burn in the late spring for brush control and to create more palatable forage for cattle. Marshes and upland pastures are typically burned annually. In heavily grazed areas, reduced fuel loads often allow only portions of pastures to burn. In areas where fire cannot be applied, private landowners are more dependent on herbicides to control brush.

Although primarily done in support of grazing operations, burning on private lands has the potential to provide the following benefits:

- Hazardous fuels are reduced within immediate proximity to facilities and structures, which ensures protection of 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 strands of vegetation. For example, prescribed burning (integrated with grazing and water management) encourages seed producing annual grasses such as sprangletops and millets, and tuber producing plants such as Olney bulrush preferred by waterfowl. Snow geese heavily use recent marsh burns because they can readily access roots, tubers, and young green shoots of the regrowth. Both geese and ducks use burned areas as roosts or loafing areas.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, is suppressed. Without fire disturbance, both marsh and prairie habitats are subject to invasion by such woody plant species, shrubs, which in turn reduces habitat quality for many grassland-dependent avian species. 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 burning in wetland habitats conducted specifically to enhance habitats for waterfowl (in combination with controlled grazing and water level and salinity management) 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. Burning (integrated with control livestock grazing and water management) in wetland habitats 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). In intermediate and brackish marsh habitats, these 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. The impacts of 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.

While burning can have many positive effects on native habitats, it can also have detrimental impacts ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water. 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). Annual burning over a long period time likely reduces plant species diversity in both wetland and upland habitats.

(b). Livestock Grazing

Livestock grazing is the primary agricultural use on private lands within the project area. 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 (especially when integrated with fire and water management) in wetland habitats promotes the germination, growth and reproduction of several "early successional" plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et a*l.. 1979). In intermediate and brackish marsh habitats, these 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. Private grazing operations involving high stocking rates in marsh habitats often result in improved habitat conditions for waterfowl and increased waterfowl utilization of grazed areas (assuming proper water levels and salinities).

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

- Reduces rank vegetation which enables migratory birds access to 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.

Although grazing operations on private lands in the project area often provide enhanced wetland habitats for waterfowl and other migratory birds, they are not always compatible with maintaining the overall diversity of the region's native plant and animal communities. Typically, marsh pastures used during the cool season on private lands are grazed year after year. Upland pastures are often used year-round. Overall plant species diversity in both wetland and upland habitats will decrease over time in areas which are heavily grazed year after year. On areas used for summer pasture that include fallowed rice, wet prairies or fresh marsh, heavy grazing limits the production of seeds of annual grasses such as the millets and sprangletop. Inhibiting seed production decreases the amount of vital food sources available in these habitats for waterfowl the following fall and winter. Native plant species diversity, productivity and reproduction in remnant native prairie habitats are also reduced by perennial heavy grazing. In areas which are repeatedly overgrazed, potential detrimental impacts include excessive trampling of vegetation, compaction of soils, reduction of percolation rates, increased soil erosion, and reduced water quality from fecal coliform bacteria and excessive nutrients.

(c). Exotic / Invasive Species Management

Many private landowners in the project area actively control exotic/invasive plant species, particularly Chinese tallow, primarily to improve range conditions for livestock. A broad array of pesticides is used in support of rice farming operations to control various agricultural pests including noxious weeds, insects and fungal diseases.

Typically, broad spectrum herbicides and mechanical removal are used for Chinese tallow control on private lands. Aerial application is used for most pesticide applications on rice and for control operations on larger stands of Chinese tallow. While control of Chinese tallow enhances grassland habitats, wide-scale use of broad spectrum herbicides in the project area has contributed to loss of native plant species diversity.

Feral pigs occur in substantial numbers throughout the project area. Rooting and wallowing by feral hogs 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 of habitat. Feral hogs are prolific and are able to exploit wetland and upland habitats. Hunting and trapping of feral hogs would continue to occur on private lands in the project area. Effectiveness in controlling populations and reducing impacts to native vegetation and habitats would depend on the intensity of removal operations.

(d). Shoreline Protection and Restoration

As previously discussed, erosion along the Gulf of Mexico and Galveston Bay shorelines is a major issue in the project area. It is likely that most private landowners in the project area will not engage in significant efforts to restore or protect shorelines due to lack of economic incentives.

(e). Mowing and Haying

Many privately-owned pastures (improved and natural) in the project area are hayed. Haying results in invigorating growth of grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis.

5. Impacts to Fish and Wildlife Resources

Under Refuge Boundary Expansion Alternative A, land management practices on private lands described in *Impacts on Vegetation and Habitats* would continue to impact 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

Some land owners in the project area are intensively and very successfully managing properties to enhance habitats for wintering waterfowl, and many agricultural practices provide substantial benefits to waterfowl and other migratory birds. In general, however, economic considerations other than fish and wildlife benefits dictate land uses and land management practices on private lands in the project area. This would continue under Refuge Boundary Expansion Alternative A.

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 increases 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.[18] 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.

Under Refuge Boundary Expansion A, the following land uses and management practices on private lands would have the greatest impacts on waterfowl populations.

18 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).

(a). Wetlands Management and Restoration

Under Refuge Boundary Expansion Alternative A, some privately-owned marshes would continue to be structurally managed to improve habitat for wintering and migrating 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.

A small number of landowners would continue to use moist soil management 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.

Under Refuge Boundary Expansion A, rice farming operations in the project area which are concurrently managed for waterfowl would continue to provide important freshwater wetland habitat and high quality food resources for wintering and migrating waterfowl. Fall and winter flooding of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Rice production in the project area has declined significantly in recent years, and only a relatively small amount of base acreage currently in the USDA farm program is being actively farmed. Former rice fields are either left fallow or are being converted to improved pasture. Much of this acreage is supporting livestock operations. Permanently fallowed rice fields which are not being managed for grazing are rapidly being invaded by Chinese tallow and deep-rooted sedge. These exotic plant species are so invasive that they quickly replace native plants and provide few benefits for wildlife. The decline in rice production in the project area has significantly reduced the amount of farmed wetland acreage available to waterfowl and other migratory birds. It has undoubtedly contributed to reduced numbers of waterfowl wintering in the area. Any future declines in rice production would further exacerbate these impacts.

On properties in the project area being managed for livestock grazing as a primary economic use, marshes and flooded rice fields and moist soil impoundments are usually drained immediately following the hunting season. This is done to increase availability of forage for livestock and increase the amount of dry ground available for calving. These wetland habitats are typically “drawn down” as quickly as possible beginning in late January. This practice reduces wetland habitat available during late winter and spring for migrating waterfowl and other migratory birds.

Utilization of broad spectrum herbicides and pesticides in rice farming and pasture management in the project area may reduce abundance and diversity of invertebrates important as a food sources for waterfowl and other migratory birds.

(b). General Habitat Management and Restoration Activities

The integrated combination of burning, livestock grazing and water management in wetland habitats on private lands being managed specifically for waterfowl in the project area would continue to provide optimum habitat conditions for wintering waterfowl and many additional migratory bird species. 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. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields also enhances waterfowl habitat.

On a year to year basis, overall habitat quality for waterfowl in the project area 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 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.

(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 in the project area 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 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 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 Boundary Expansion Alternative A, the following would continue to be the primary land management activities on private lands impacting Mottled Ducks in the project area. 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 activities on private lands in the project area being managed for waterfowl would 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 this species. Rice farming and moist soil management would continue to provide critical shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round.

On properties in the project area being managed for livestock grazing as a primary economic use, marshes and flooded rice fields and moist soil impoundments are usually drained immediately following the hunting season. This is done to increase availability of forage for livestock and increase the amount

of dry ground available for calving. These wetland habitats are typically "drawn down" as quickly as possible beginning in late January. This practice reduces wetland habitat available for Mottled Duck nesting and brood-rearing during late winter, spring and summer.

(b). Uplands Management and Restoration

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. Conversion of most native coastal prairie habitats to agricultural uses in the project area has removed these habitat features.

Some agricultural practices on privately-owned uplands within the project area undertaken to improve forage conditions for cattle may also benefit Mottled Ducks. Controlling brush encroachment in grasslands using burning, livestock grazing, herbicide application and mowing/haying in salty and non-saline prairies (and on levees and along fence lines) would be expected to improve nesting success of Mottled Ducks.

Conversion of fallowed rice fields and other grassland habitats to "improved pasture" and invasion of Chinese tallow and other exotic plants in unmanaged fallowed rice fields would likely have negative impacts on Mottled Ducks by reducing suitable nesting habitat.

(c). General Habitat Management Activities

The integrated combination of burning, livestock grazing and water management in wetland habitats on private lands being managed specifically for waterfowl in the project area which provide optimum habitat conditions for wintering waterfowl also benefit Mottled Ducks during all phases of their life cycle. 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 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 Mottled Ducks and other migratory birds. Control of Chinese tallow on private lands in and adjacent to freshwater marshes, moist soil units and rice fields also enhances habitat values for Mottled Ducks.

Agricultural management practices also have the potential to negatively impact Mottled Ducks in the project area. For example, 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). Salt prairies occur as a broad zone between coastal prairies and marshes, and commonly 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). 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. Annual burning of salt prairies would reduce nesting habitat. Overgrazing by cattle may

reduce desirable nesting habitat in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988).

(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 and the Least Tern. 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 and Wood Stork.

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 migrant, including Wood Stork, White Ibis, and Forster's Tern.

(a). Wetlands Management and Restoration

Marsh habitats actively managed for waterfowl on some private lands in the project area (utilizing water control structures, levees, impoundments, etc.) include a wide variety of habitat types used by shorebirds, wading birds and marsh and waterbirds. In general, shorebirds and wading birds would also continue to benefit from rice farming and moist soil management on private lands. Both provide shallow freshwater wetland habitat, which provide 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).

On properties in the project area being managed for livestock grazing as a primary economic use, marshes and flooded rice fields and moist soil impoundments are usually drained immediately following the hunting season. This is done to increase availability of forage for livestock and increase the amount of dry ground available for calving. These wetland habitats are typically "drawn down" as quickly as possible beginning in late January. This practice reduces wetland habitat available for migrating shorebirds and other wetland-dependent avian species during spring and summer.

(b) Uplands Management

Some agricultural practices on privately-owned uplands within the project area undertaken to improve forage conditions for cattle may also benefit some shorebirds. For example, heavily grazed wetter prairies are used by Golden Plovers and Black-necked Stilts. Conversion of fallowed rice fields and other grassland habitats to "improved pasture" and invasion by Chinese tallow and other exotic plants in unmanaged fallowed rice fields would likely have negative impacts on shorebirds by reducing suitable nesting, migration and wintering habitat.

(c). General Land Management Activities

The integrated combination of burning, livestock grazing and water management in wetland habitats on private lands being managed specifically for waterfowl in the project area also benefit shorebirds, wading birds and other marsh and waterbirds. Water management activities in coastal marshes which maximize the annual production of 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

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 delicate*), (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 rails 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. Ignition methods and patterns for agricultural burning in the project area likely are not influenced by issues such as potential wildlife mortality.

Other land uses and land management activities in the project area could negatively impact some species of shorebirds, wading birds, marsh and water birds, dependent on intensity and timing. 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).

Utilization of broad spectrum herbicides and pesticides in pasture management and rice farming in the project area may reduce abundance and diversity of invertebrates, an important food source for shorebirds and wading birds.

(4). Impacts to Landbirds

Landbird species found in the project area 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 wildlife species.

(a). Wetlands Management and Restoration

Water management activities on private lands in the project area aimed at enhancing habitats for wintering waterfowl in coastal marshes would continue to indirectly benefit several land bird species which utilize these habitats.

(b). Uplands Management and Restoration

Some agricultural practices on privately-owned uplands within the project area undertaken to improve forage conditions for cattle may also benefit some landbird species. Controlling brush encroachment to enhance grasslands using burning, livestock grazing, herbicide application and mowing/haying in salty and non-saline prairies (and on levees and along fence lines) would benefit certain species of grassland songbirds.

Conversion of fallowed rice fields and other grassland habitats to "improved pasture" and invasion by Chinese tallow and other exotic plants in unmanaged fallowed rice fields would likely have negative impacts on grassland songbirds by reducing suitable nesting, migration and wintering habitat.

Coastal woodlots and near-coastal bottomland forests support a diverse avian community, which includes several species of neotropical migratory birds. Coastal woodlots and bottomland forests found on private lands in the project area are typically part of the overall land area used for livestock grazing. Coastal woodlots are typically found on higher elevation sites, and cattle will typically congregate on these sites for shade. Grazing typically reduces or eliminates understory shrubs and may preclude natural reproduction of woody plant species. Where this occurs, habitat quality for migrating and resident landbirds is negatively impacted.

(c). General Habitat Management Activities

The integrated combination of burning, grazing and water management occurring on some private lands in the project area to provide optimal habitat conditions for waterfowl also enhances wetland and upland habitats used by many land bird species. Chinese tallow control would also enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats.

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.

Heavy grazing could adversely affect some ground-nesting birds by reducing suitable nesting habitat, trampling and by disturbing nesting pairs (Whyte and Cain 1979). Utilization of broad spectrum herbicides and pesticides in pasture management and rice farming in the project area may reduce abundance and diversity of invertebrates, an important food source for many land bird 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).

Some private landowners in the project area utilize structural marsh management to reduce saltwater intrusion which negatively impacts livestock and rice farming operations and to enhance habitat quality for waterfowl. Burning, grazing, and Chinese tallow control on private lands also enhance estuarine wetlands, and help create wetland habitat diversity and productivity important to a variety of fish and shellfish species.

Managing water levels and salinities (e.g., using water control structures, levees, impoundments, etc.) in managed marsh units may restrict access of some finfish and invertebrate fisheries species to managed areas. Actively managing water levels may impede access 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.

(6). Impacts to Threatened and Endangered Species

Three Federally-listed Threatened or Endangered avian species occur in the project area: Bald Eagle, Piping Plover, and Brown Pelican. Water management activities on private lands in the project area aimed at enhancing habitats for wintering waterfowl in coastal marshes would continue to indirectly benefit these avian T&E species.

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

Mammals typically found in the project area 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, land uses and management practices on private lands which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of mammal species.

Land uses on private lands which create or maintain freshwater wetland habitats (structural management of marshes, rice farming, and moist soil management) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibian and reptiles, including frogs,

salamanders, aquatic snakes (e.g., western cottonmouth), 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.

Many landowners in the project area control coyote populations as a means of reducing losses of domestic livestock. 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. Overgrazing by livestock can destroy swamp rabbit and cottontail rabbit habitat (Gosselink *et al*. 1979). Large, intense and fast-moving fires may result in direct mortality f less mobile species such as small mammals, amphibians, 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).

B. Socioeconomics Resource Section

The socioeconomic impacts for Refuge Boundary Expansion Alternative A (No Action) are the same as the socioeconomic impacts analyzed for Refuge Management Alternative D, the Preferred Alternative, in Part A. of this Chapter. This is because they both address the present set of conditions at the Refuge Complex and in the project area. The Refuge Complex would remain the same size as present, as no refuge boundary expansion would occur under this Alternative, and the management strategies from Refuge Management Alternative D (Preferred Alternative) would be implemented on the existing refuges. **For socioeconomic impact analysis information, please refer to Refuge Management Alternative D (Preferred Alternative) in the set of Refuge Management Alternatives in Part A of this Chapter. For comparative purposes, socioeconomic impacts under Refuge Boundary Expansion Alternative A (No Action) are compared to those under Refuge Boundary Expansion Alternatives B, C and D in Section II of Part B of this chapter, beginning on the following page.**

II. IMPACT ANALYSIS FOR REFUGE BOUNDARY EXPANSION ALTERNATIVES B, C, AND D

Overview

Refuge Boundary Expansion Alternatives B, C, and D would establish new boundaries for the Moody, Anahuac, McFaddin, and Texas Point NWRs. The USFWS would then be authorized to purchase lands, or interests in lands such as conservation easements, from private landowners within the newly established refuge boundaries. Lands would be acquired from private landowners only on a willing-seller basis and at fair market value, subject to availability of funds. Lands so acquired would become part of the National Wildlife Refuge System, and refuge management programs to be implemented on the existing refuges (as described under Refuge Management Alternative D) would also be implemented on newly acquired lands.

Management of newly acquired lands would be focused specifically on meeting the establishment purpose(s) of the refuges and the mission of the National Wildlife Refuge System. All lands becoming part of the National Wildlife Refuge System would remain undeveloped in perpetuity. Management programs on newly acquired lands would include habitat management and restoration activities in coastal wetlands, prairies and woodlands which emphasize conservation and management of migratory birds, consistent with restoring and maintaining biological integrity and biological diversity. Habitat management activities in wetland habitats would include managing water levels and salinities in coastal marshes and moist soil management to restore shallow freshwater wetlands. Management of uplands would focus on restoration of native coastal prairie and increasing native plant species diversity in coastal woodlots. Economic uses which serve as important management tools in meeting conservation objectives, such as rice farming and livestock grazing, would also be used. A cooperative rice farming program would use fall and winter flooding of second crop rice and first- year fallow fields to provide high quality habitat for migrating and wintering waterfowl, shorebirds and other migratory birds. Grazing would employ techniques such as grazing unit rotations, prescribed stocking levels, and timing and duration of use.

The USFWS would also focus on addressing threats to coastal habitats and fish and wildlife resources on newly acquired lands posed by relative sea level rise, altered hydrological regimes, exotic/invasive plants and animals, and environmental contaminants. Increased coordination with local, State and Federal agencies would be aimed at implementing major coastal habitat restoration projects. An integrated pest management program would be used to manage exotic/invasive plants and animals, with an overall goal of reducing use of chemical herbicides and pesticides over time. Management of oil and gas exploration and development activities would focus on minimizing impacts to habitats and fish and wildlife, including implementing strict pollution controls. Expanded field surveys and scientific monitoring and research would support an adaptive approach for conservation of native habitats and fish and wildlife resources.

Recreational and educational public uses of newly acquired lands would include the National Wildlife Refuge System's six priority wildlife-dependent uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. Development of visitor facilities similar to those found on the Refuge Complex would occur and could include trails, boardwalks and observation decks, fishing piers, boat ramps and photography blinds. The USFWS would also continue and expand outreach efforts and development of community-based partnerships.

Refuge Boundary Expansion Alternative B includes approximately 22,479 acres of coastal wetlands (primarily estuarine marshes) and 9,233 acres of upland habitats. Refuge Boundary Expansion Alternative C includes 29,308 acres of coastal wetlands (primarily estuarine and palustrine marshes) and 32,197 acres of upland habitats, including significant acreage of native coastal prairie. Refuge Boundary Expansion Alternative D includes 40,600 acres of coastal wetlands, including palustrine forested wetlands (bottomland hardwoods), and 55,617 acres of upland habitats.

A. Natural Resources Section

1. Impacts to Air Quality

The USFWS fire management program has the greatest potential of all refuge management activities to impact the region's air quality. Fire management activities on any newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would include both the suppression of unplanned wildland fires and prescribed burning.

Suppression of wildland fires on newly acquired lands would continue as prescribed in the USFWS Texas Chenier Plain 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 Refuge lands.

The USFWS would use prescribed burning on newly acquired lands 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 from September to late November, in order to maximize the benefits of integrated burning/grazing/water management programs and strictly adhere to management prescriptions. Limited prescribed burning during summer would be conducted if needed to control invasive woody vegetation. Prescribed burning in upland prairie habitats would occur primarily during late winter and early spring, with summer burns conducted as needed to control woody vegetation. Annual burning may occur in newly acquired areas initially if needed to control brush, however, burning frequency on prairies would be reduced over the long-term as grasslands are restored.

Although prescribed burning conducted by the USFWS would continue to be beneficial to habitats and wildlife (as discussed under *Section II.A.4.* and *II.A.5* below); this management action could also negatively impact local air quality, primarily through the production of smoke. Smoke from unplanned wildland fires and from planned prescribed burning could 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. However, because prescribed burning is conducted by the USFWS under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality will be minimal. Prescription parameters which must be met prior to ignition and for the predicted duration of a prescribed burn 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 prescribed burn; and these conditions are regularly monitored for the duration of the burn as a further safeguard.

Prescribed burning by the USFWS under these controlled conditions would also reduce 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.

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. 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)). 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).

Although shoreline erosion and retreat and along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as 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.

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.

Under Refuge Expansion Alternatives B, C and D, 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 on newly acquired lands. On McFaddin NWR and Texas Point NWRs, these partnerships would continue to focus on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Coordination with other agencies and conservation organizations would be expanded, with a goal of implementing a major project to restore the entire barrier beach/dune system on McFaddin NWR. Major structural erosion abatement projects would also been implemented, including breakwater construction along the GIWW and East Galveston Bay shorelines.

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 newly acquired lands Refuge Boundary Expansion Alternatives B, C and D 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). 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 newly acquired lands would reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. These management activities therefore would benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils.

Prescribed burning on newly acquired lands 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 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

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 the GIWW and numerous smaller canals and ditches, upstream dams and reservoirs, 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).

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 4.B.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 have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

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)). 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 Boundary Expansion Alternatives B, C and D, the USFWS would conduct wetland management and restoration activities on newly acquired lands aimed at minimizing or mitigating impacts

of altered hydrological regimes on plant, fish and wildlife resources. These would include structural marsh management, moist soil management, a cooperative rice farming program, and restoration of coastal wetlands. Water management activities in marsh habitats would include water level and salinity management and establishment of freshwater inflows using management infrastructure comprised of water control structures, levees, and water delivery systems (including pumps, ditches and canals). Water levels which mimic natural marsh hydroperiods (wetting and drying cycles) as closely as possible would be maintained. Specifically, management of water levels would be aimed at preventing too rapid drainage and excessive drying or artificially high water levels and/or prolonged periods of inundation. Similar water management infrastructure would be used to intensively manage moist soil units and rice fields. Marsh hydrology would also be restored by removing abandoned roads, levees, and well pads remaining from past oil and gas development.

The wetland management and hydrologic restoration activities implemented by the USFWS on newly acquired lands would help maintain or restore the 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 and nutrient/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, promote plant productivity and contribute to marsh surface elevation gain.

b. Water Quality

Potential sources of contaminants affecting water quality in the project area include accidental releases from oil and gas exploration and production activities, including spills and leaks from wells, production facilities, and pipelines. Oil and gas exploration and development activities have increased in the project area in recent years. A high volume of petrochemicals is transported through the project area 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 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. Some studies have indicated that rice tail waters entering the Galveston Bay system are relatively free of pollutants.

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would periodically monitor water quality on newly acquired lands through its Environmental Contaminants program, and would work with local, state and federal agencies to address water quality issues. Oil and gas exploration and production activities would 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 a high level of preparedness and to effectively respond to accidental spills affecting water quality (and fish, wildlife and habitats). 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 newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would include the following habitat management and restoration activities in wetland and upland habitats: 1) structural water management in coastal marshes,

2) wetland restoration, 3) prairie grassland management and restoration, and 4) coastal woodlot and near-coastal bottomland forest restoration and protection. Other habitat management and restoration activities with impacts to vegetation and habitats would include prescribed burning, controlled grazing, exotic/invasive plant and animal control, shoreline restoration and protection, and mowing/haying.

The USFWS would administer public uses on newly acquired lands, including the six priority wildlife-dependent uses of the National Wildlife Refuge System: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses would have direct and indirect impacts to vegetation and habitats.

Systematic monitoring of vegetation and habitats under the USFWS Refuge Biological Program would be conducted, allowing for ongoing assessment and refinement of management activities.

The USFWS would manage oil and gas activities on newly acquired lands through issuance of Special Use Permits. Stipulations in the SUPs would serve to minimize and mitigate for 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

Wetlands management and restoration activities on the Refuge Complex impact hydrologic regimes. Such activities also strongly influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetlands 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, 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.

The USFWS would use structural water management on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D to control salinities and water levels within marsh habitats. Managed marsh units within the project area are under varying degrees of structural control, and may best be described as marsh semi-impoundments. Some 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. Most existing water control structures on private lands in the project area are designed to actively control the amount of saltwater or freshwater entering or leaving the managed unit.

The typical water management regime for managed marshes on newly acquired lands would involve maintaining salinities within the range of the particular marsh type being targeted by controlling the volume and timing of inputs of freshwater and saltwater. In general, salinity management promotes the establishment of the aquatic plant communities associated with brackish, intermediate and fresh marshes. Saltwater inputs would sometimes be increased to higher than target levels if required to control certain aquatic invasive species such as cattail. Water levels would be maintained at target elevations to maintain plant productivity and diversity and to provide optimal wildlife habitat. The general water level management regime across most managed marsh habitats would involve maintaining pre-determined water levels which provide favorable conditions for dabbling ducks and geese during fall and

winter. Following the wintering migratory bird season, managed marsh units would be drawn down gradually to create soil conditions favorable for the germination of a variety of seed producing annual plants in emergent marshes and water levels conducive to the germination and establishment of submerged and floating aquatic plants in ponds and other open water habitats. Summer water levels and salinities would be maintained to promote the growth of these plant species and subsequent seed and tuber production. Overall, water levels which mimic natural marsh hydroperiods (wetting and drying cycles) as closely as possible would be maintained. Specifically, management of water levels would be aimed at preventing too rapid drainage and excessive drying or artificially high water levels and/or prolonged periods of inundation.

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 factor controlling hydrologic regimes and the response of vegetative communities in these coastal marshes.

This management activity would help 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. This would include the establishment of diverse and productive submerged and floating aquatic plant communities in open water habitats. 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 newly acquired lands would also help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, this management activity may also contribute to marsh soil formation and surface elevation gain (marsh accretion).

(b). Marsh Restoration

Under Refuge Boundary Expansion Alternatives B, C, and D the USFWS would expand the level and scope of wetland restoration activities on newly acquired lands. Coordination with the U.S. Army Corps of Engineers and other state and federal agencies would be expanded to develop additional projects which beneficially use dredge material to restore coastal marshes.

Impacts of marsh restoration efforts would be to increase the amount of vegetated marsh in areas which have converted to open water, in turn providing more productive habitats 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 Refuge Boundary Expansion Alternatives B, C and D, the USFWS would implement moist soil management on newly acquired lands to provide and enhance shallow freshwater wetland habitat for migratory birds and other wetland-dependent wildlife.

Water management and mechanical soil manipulations on new moist soil units would be 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. Some 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.

Moist soil management increases 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).

(d). Cooperative Rice Farming Program

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would implement a cooperative rice farming program on newly acquired lands where feasible. Primary objectives of the program would be to provide shallow freshwater wetland habitat with high value food resources for wintering and migrating waterfowl, shorebirds, wading birds and other migratory birds. The program would use Cooperative agreements with local farmers. Preference would be given to those farmers proposing to grow rice organically in order to reduce overall use of chemical herbicides and pesticides on Refuge lands.

Cooperative rice farming on newly acquired lands would provide shallow freshwater wetland habitat and serve several outcomes for migratory bird management: 1) providing habitat and nutritious forage for migrating and wintering waterfowl, 2) creating habitat for migrating shorebirds, and 3) providing fresh water habitat for during spring and summer 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 available to 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 would 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 would also help to offset waterfowl consumption of crops on adjacent privately-owned croplands.

(e). General Habitat Management Activities

The USFWS would also utilize fire management, controlled livestock grazing, and exotic/invasive species control as integrated management tools in wetland habitats. The impacts of these activities on vegetation and habitats are discussed below under *General Habitat Management Activities.*

(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, 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).

Coastal prairie habitats are important for prairie-dependent avian and wildlife. Currently, nine of the 13 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas are present in coastal prairie grasslands on the Refuge Complex. The USFWS has listed seven avian species occurring in prairie habitats on the Refuge Complex as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005).

Refuge Boundary Expansion Alternatives C and D include the largest contiguous native coastal prairie remnants on the upper Texas Coast. Under Refuge Boundary Expansion Alternatives B, C and D, the following prairie habitat restoration and management activities would be used on newly acquired lands: 1) protect and manage existing native prairies and restore prairie on suitable upland sites; 2) restore shallow depressional "prairie wetlands"; 3) conduct a rotational prescribed burning program on existing and restored prairies; 4) conduct a rotational livestock grazing program; 5) utilize an integrated pest management program, consisting of herbicide application, mechanical removal, prescribed burning and controlled livestock grazing to manage exotic/invasive plant species such as Chinese tallow and deep-rooted sedge which are negatively impacting prairie habitats; and 6) mow or hay to control weed and woody species infestations..

Overall, prairie restoration and management activities on newly acquired lands would increase the abundance of native prairie grasses and forbs, including the increasingly rare little bluestem/brownseed paspalum and eastern gamma grass/switchgrass prairie plant communities. The USFWS would use integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing/haying to restore the historic mosaic of prairie plant communities and the different structural characteristics of these habitats. Brush encroachment by exotic and native plant species would be reduced. Previously-drained shallow depressional "prairie wetlands" within extant stands of native prairie would be restored. Additional native prairie and freshwater wetlands would be restored on adjacent fallowed agricultural fields. Management and restoration of native prairie habitats on newly acquired lands would help conserve an important and increasingly rare component of the western Gulf Coast ecosystem. The long-term protection and management of the remaining largest contiguous tracts of native prairie on the Upper Texas Coast will provide functional habitats to support many declining native plant and wildlife species, including plant associations classified as Globally Imperiled and many Avian Species of Conservation Concern.

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. Prairie plants on the upper Texas Coast evolved under relatively unique climatic conditions of high annual rainfall and hydric soils. Conservation of existing coastal prairie remnants in the project area under Refuge Boundary Expansion Alternatives B, C and D would protect important reservoirs of genetic material and extremely valuable sources of viable local seed and plant materials. Future restoration of native coastal prairie in the region would greatly benefit by the protection of these existing viable local seed and plant material sources.

(b). Woodlot Restoration and Protection

Although comprising a small percentage of the upland habitats in the project area, coastal woodlots help support a diverse avian community which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in woodland habitats in the project area. Migratory birds depend on coastal woodlots for cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier Plain 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).

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would protect and manage coastal woodlots and near-coastal forests on newly acquired lands by: 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. Under Refuge Boundary Expansion Alternative D, an important near-coastal bottomland hardwood forest (Taylors Bayou bottomlands) would be protected.

Overall, implementation of the USFWS management actions discussed above on newly acquired lands would improve coastal woodlot and bottomland forest habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodland 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 Boundary Expansion Alternatives B, C, and D, the USFWS would use fire management, controlled livestock grazing, exotic/invasive species management, and mowing/haying on newly acquired lands to enhance habitats for migratory birds and other native fish wildlife. Shoreline restoration and protection activities would be implemented 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 would be used to conserve, enhance and restore both wetland and upland habitats on newly acquired lands.

(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.

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 human caused changes in historic isohaline lines and hydroperiods, much of the vegetation that dominated these fresher marshes (i.e. Sawgrass (*Cladium mariscus* subsp. *jamaicence*), maidencain (*Panicum hemitomon*), giant cutgrass (*Zizaniopsis miliacea*), and bullwhip (*Schoenoplectus californicus*)) were 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 would carefully consider these parameters in implementing its fire management program on newly acquired lands.

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). 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.

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would use its fire management program on newly acquired lands to manage prescribed burning and to suppress wildfires in a manner beneficial to native plant and animal communities and ecological functions, while providing for public and employee safety and minimizing negative impacts to the surrounding communities (USFWS 2001). In wetland habitats, prescribed burning would be implemented in combination with controlled livestock grazing and water level and salinity management with of primary goal of providing diverse high-quality

wintering habitats for waterfowl, shorebirds and other marsh and water birds. In upland habitats, prescribed burning and controlled grazing would be used to control encroachment by woody species and to enhance germination and growth of native prairie grasses and forbs, benefiting many grassland avian species.

Prescribed burning would generally occur on a three-year rotation; however, the actual condition of vegetation and fuel loading would dictate the need for a burn (USWS 2001). The majority of the prescribed burning in marsh habitat would be conducted from September to late November. Prescribed burning of upland grassland habitat would occur primarily in late winter and early spring to stimulate native warm season grasses. Summer burning would occur in wetland and upland habitats when necessary to control invasive woody vegetation.

The USFWS fire management program would be conducted on newly acquired lands to achieve the following benefits:

- Hazardous fuels reduction 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.

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 annual grasses 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).

USFWS fire management practices in non-saline coastal prairies on newly acquired lands would include prescribed burning in late winter prior to green-up of the warm season grasses. This is the most common type of prescribed burn currently conducted on remnant native prairies and restored coastal prairie sites

on the Refuge Complex, and it is used to promote the growth of these native grasses. Burning would be 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 non-saline uplands on the Refuge Complex.

One of the primary objectives of burning non-saline upland grasslands on newly acquired lands would be 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.

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 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 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.

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.

While this valuable habitat management tool has many positive effects, prescribed burning can have detrimental impacts ranging from an undesirable change in vegetative 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 Expansion Alternatives B, C and D, the USFWS prescribed burning program on newly acquired land would 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. In addition, the USFWS would use short and long-term ecological fire effects monitoring on newly acquired lands to guide an adaptive approach to implementing its fire management program. Additional research studies to determine fire effects on marsh soils and vertical accretion, vegetation, and wildlife would be conducted through new and expanded partnerships with the U.S. Geological Survey and academic institutions.

(b). Controlled Livestock Grazing

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would use controlled grazing on newly acquired lands (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.

Grazing strategies would include variations in stocking rates, timing (cool vs. warm season) and duration. Smaller grazing units would be grazed on a rotational basis, providing "rest" as needed to maintain plant diversity and productivity. Stocking rates and rotations would be determined annually according to management objectives for the various grazing units and the quantity and condition of forage and availability of fresh water in those units. Cool season and summer cattle grazing on various marsh and upland units would be used. The USFWS would expand the use of high intensity, short duration grazing on upland prairie habitats to mimic historic patterns of herbivory.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. 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 newly acquired lands would be managed to 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 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. Moderate grazing following burns in marshes would result in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al*. 1979). Grazing would also help 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 would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Specifically, the beneficial effects of the USFWS controlled grazing program in wetland habitats would include:

- Reduction of rank vegetation which enables migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Reduction of 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.
- Creation of open water which provides loafing spots for birds and allows them to access aquatic invertebrates.
- Complimenting marsh burning by prolonging the time that browse is available for goose use.
- Increased plant vigor, increased plant productivity, enhanced nutrient recycling, and prevention of excessive build-up of residual plant material.

- Reduction of hazardous fuel loading, reducing the amount and intensity of wildfires.

- Breaking up of capped soils through hoof action, which assists in seedling establishment.

- Maintenance of 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 (and prescribed burning) in coastal prairie habitats increases vigor of many native prairie grasses, and increases overall plant species and structural 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 Estuary Program 1992). Overgrazing in prairie habitats reduces native prairie plant diversity, as native grasses and some native forbs 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. The USFWS would continue to monitor grazing programs and adjust grazing strategies so as to avoid detrimental impacts.

(c). Exotic / Invasive Species Management

Under Refuge Boundary Expansion Alternatives B, C, and D, the USFWS would expand the scope of exotic and invasive species management activities on newly acquired lands. An Integrated Pest Management (IPM) program would be implemented to control the following exotic and invasive plant species:

- Chinese tallow, Eastern baccharis, willow, deep-rooted sedge and King Ranch bluestem 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 fields

- Invasive broadleaf weeds in restored prairies

Integrated pest management would be implemented using a combination of treatments including herbicide application, mechanical control, prescribed burning, controlled grazing and water level and salinity management. The overall goal of the USFWS IPM program would be to achieve results while decreasing dependence on and use of chemical herbicides to control and manage invasive plant species. Spot treatments using target-specific herbicides would be used in wetland and upland habitats when target stands are small enough to treat by hand. In wetland habitats, this would include treatment of invasive plant species including cattail, common reed, and California bulrush where these plants have formed dense, homogeneous stands which result in pond closure and loss of open water. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats. Aerial herbicide application would be required to initiate control on large mature stands of Chinese tallow. Mowing/haying and burning would be used on upland grassland habitats, and burning, controlled grazing and salinity management would be primary tools used in marsh habitats. Discing or roller chopping would be used in rice fields and moist soil units.

The USFWS would also expand monitoring programs for exotic/invasive species on newly acquired lands using GIS and GPS technologies to document and track infestations and evaluate the effectiveness of treatments. Additional research would also be supported through new and expanded partnerships with the U.S. Geological Survey and academic institutions.

Control of invasive emergent and floating plants in ponds would promote 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 would result in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance would likely increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

The USFWS would also continue to control exotic animal species to conserve biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral pigs are the primary species currently impacting habitats in the project area. Rooting and wallowing by feral pigs causes significant habitat and infrastructure damage. These soil disturbances in marsh and upland sites allow invasive plants to establish and reduce the value of the habitats to wildlife. Feral pigs are particularly damaging to water management infrastructure. They wallow and root extensively on levees and within rice fields and moist soil units affecting the management of thousands of acres habitat. Feral hogs are prolific and are able to exploit wetland and upland habitats. 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.

Although nutria have not reached population levels capable of damaging habitats in recent years in the project area, 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 as necessary on newly acquired lands.

(d). Shoreline Protection and Restoration

As discussed under Part B in *Section II.A.2. Impacts to Geology and Soils*, 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 beach 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.

Under Refuge Expansion Alternatives B, C and D, 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 on newly acquired lands. On McFaddin NWR and Texas Point NWRs, these partnerships would continue to focus on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Coordination with other agencies and conservation organizations would be expanded, with a goal of implementing a major project to restore the entire barrier beach/dune system on McFaddin NWR. Structural erosion abatement projects would also be implemented, including breakwater construction along the GIWW and East Galveston Bay shorelines.

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.

Shoreline protection and restoration activities on newly acquired lands would continue to positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier dunes 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 in the project area Use of dredged material along existing shorelines would protect existing marshes by reducing shoreline retreat and direct loss of these habitats, provide a substrate for reestablishment of marsh vegetation and restoration, and increase net sediment supply to marshes which provides nutrients and increases plant productivity (Chabreck 1976, 1994). Breakwaters would 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 would also provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

(e). Mowing and Haying

Under Refuge Boundary Alternatives B, C and D, the USFWS would continue to utilize mowing and haying in upland grassland habitats on newly acquired lands. Mowing and haying would invigorate growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants. Reduction of herbaceous and woody cover often results in the “release” of native prairie plants. Mowing and haying would be 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. Mowing and haying would also reduce use of chemical herbicides.

b. Impacts from Public Use Programs

The greatest potential for impacts to vegetation resources and habitats on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would likely be from motorized boating activities. Motor boats, vehicles and walking would be the primary means of access to areas opened to the public for wildlife-dependent recreational uses including hunting, fishing, wildlife observation and photography and environmental education and interpretation. 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 could lead to vegetation trampling, and in heavy use areas, cause plant mortality. The more extreme impacts would 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 be localized and minimal. Regulations, including horsepower restrictions and area closures to motorized boating would be used to protect wetland habitats and public safety. Access for other recreational and educational uses would be restricted to established roads. The

USFWS would also construct trails, boardwalks, and observation platforms and fishing piers on newly acquired lands to support recreational uses while reducing trailing impacts.

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

No direct impacts to vegetation and habitats would occur as a result of implementation of the USFWS Biological Program on newly acquired lands. Habitat and vegetation monitoring activities and research studies would support an adaptive management approach by providing information which helps refine and improve exiting management practices.

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

Lands acquired under Refuge Boundary Expansion Alternatives B, C and D would be acquired subject to exploration and development of reserved and outstanding mineral interests. The USFWS would manage oil and gas exploration and development activities on newly acquired lands through the issuance of Special Use Permits. Stipulations in the Special Use Permit would 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 would 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 newly acquired lands would be to reduce impacts on vegetation and habitats from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Boundary Expansion Alternatives B, C and D, 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. It is anticipated that continuation of outreach and partnership efforts would result in additional habitat restoration and enhancement.

5. Impacts to Fish and Wildlife Resources

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS habitat management and restoration and biological program activities on newly acquired lands would be focused on 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 manage the six priority wildlife-dependent uses on newly acquired lands. These uses would have impacts to fish and wildlife.

USFWS management of oil and gas exploration and development and community outreach and partnership programs would also impact these 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 increases 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 due to 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.[19] 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.

Under Refuge Boundary Expansion Alternatives B, C and D, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations in the project area.

(a). Wetlands Management and Restoration

Under Refuge Boundary Expansion Alternatives B, C and D, marsh habitats on newly acquired lands would be structurally managed to enhance habitat for wintering waterfowl and other migratory birds. This management activity would utilize existing 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.

The USFWS would use moist soil management on newly acquired lands to provide shallow freshwater wetland habitat for wintering and migrating waterfowl. Existing rice farming infrastructure on permanently fallowed fields would be adapted to provide this capability. 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.

19 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).

The USFWS would use a cooperative rice farming program on newly acquired lands, also to provide shallow freshwater wetlands with high quality forage for wintering and migrating waterfowl. Management of first year fallowed rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

The USFWS would implement marsh and wetland restoration activities on newly acquired lands. Restoration would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

Wetland management and restoration implemented by the USFWS on newly acquired lands would likely increase use by wintering and migrating waterfowl. Management and restoration of newly acquired lands would benefit three wintering waterfowl species listed by the USFWS as Game Birds Below Desired Condition: Northern Pintail, Lesser Scaup and Ring-necked Duck. On a year-to-year basis, overall habitat quality for waterfowl on Refuge lands and in the project area as a whole 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 in the project area would 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. Recent decreases in rice production have reduced available habitat and subsequently wintering waterfowl numbers in the project area, and any future declines in rice production would further exacerbate these impacts.

(b). General Habitat Management and Restoration Activities

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would use an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats to create optimal habitat conditions for wintering waterfowl and other migratory bird species. Prescribed burning and controlled 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 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 plant communities with low growth habits 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 newly acquired lands would be enhanced through the control of undesirable invasive vegetation such as common reed, cattail, and California bulrush in areas where these plants have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic and 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. 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.

The USFWS would implement shoreline protection and restoration activities on newly acquired lands, which would enhance wintering waterfowl habitat by decreasing saltwater intrusion into inland marshes and addressing threats of additional saltwater intrusion. If successfully implemented, large-scale

restoration of the barrier beach/dune system on newly acquired land within McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR would significantly enhance wetland habitats for wintering waterfowl on these refuges. Offshore rock breakwaters and shoreline armoring on East Galveston Bay and the GIWW would protect habitats of high importance to wintering waterfowl.

(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 a*l. 1979), although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled ducks in the project area 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 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 Expansion Alternatives B, C and D, the following habitat management and restoration activities would continue to be the primary management activities impacting Mottled Ducks on newly acquired lands. 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.

(a). Wetlands Management and Restoration

Wetland management and restoration activities on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D 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 would provide critical shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. The USFWS would manage selected moist soil units each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

(b). Uplands Management and Restoration

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 native 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.

Under Refuge Boundary Expansion Alternatives B, C and D, native prairie restoration and management activities on newly acquired lands would benefit Mottled Ducks primarily by protecting, restoring and enhancing nesting and brood-rearing habitats.

The native coastal prairie habitats within the proposed refuge boundary expansion areas under Refuge Boundary Expansion Alternatives C and D have great potential to provide high quality nesting and brood-rearing habitat for this species. USFWS management activities in native prairie habitats and adjacent fallowed agricultural lands would be aimed at increasing native plant species diversity and productivity. The USFWS would use integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing/haying to restore the historic mosaic of prairie plant communities and the different structural characteristics of these habitats. Brush encroachment by exotic and native plant species would be reduced. Previously-drained shallow depressional "prairie wetlands" within extant stands of native prairie would be restored. Additional native prairie and freshwater wetlands (using moist soil management) would be restored on adjacent fallowed agricultural fields. Restored and enhanced prairie habitats and prairie wetland habitats would likely increase overall reproductive success of Mottled Ducks in the project area.

(c). General Habitat Management Activities

Under Refuge Expansion Alternatives B, C and D, the USFWS would use prescribed burning, grazing, and exotic/invasive species management, and shoreline protection and restoration activities on newly acquired lands. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats would enhance 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. If successfully implemented, large-scale restoration of the barrier beach/dune system on newly acquired lands within McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR would significantly enhance wetland habitats for Mottled Ducks on these refuges. Offshore rock breakwaters and shoreline armoring on East Galveston Bay and the GIWW would protect habitats of high importance 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 migrant, 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 newly acquired lands which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) would positively impact shorebird, wading bird, marsh and waterbird species found in the project area.

(a). Wetlands Management and Restoration

The USFWS would manage water levels and salinities (by utilizing water control structures, levees, impoundments, etc.) in structurally managed marshes on newly acquired lands, which would protect and enhance habitats used by many avian species in this group. In general, shorebirds and wading birds would benefit from moist soil management and rice farming activities on newly acquired lands that would 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).

The USFWS would manage some moist soil units on newly acquired lands specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species would include several species identified as Avian Species of Conservation Concern and/or as needing conservation action under the U.S. Shorebird Conservation Plan, Gulf Coast Joint Venture All-bird Conservation Initiative and North American Waterbird Conservation Plan: 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. Wading and marsh bird species using moist soil habitats would 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 Boundary Expansion Alternatives B, C and D, restoration and enhancement of native prairie habitats on newly acquired lands 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) (also listed as needing conservation action under the U.S. Shorebird Conservation and North American Waterbird Conservation plans) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would conduct prescribed burning, controlled grazing, and exotic/invasive species management, and shoreline protection and restoration activities on newly acquired lands. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats would enhance 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 would 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.

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 a*l. 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 a*l. 2001) and Wilson's Snipe (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 would use these techniques in prescribed burning operations on newly acquired lands.

Some USFWS management activities on newly acquired lands 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. 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. The USFWS strategy of management to maintain a mosaic of available habitats and resources should provide an adequate range of habitats for this group of avian species.

Other habitat management activities could negatively impact some species of shorebirds, wading birds, marsh and water birds, 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).

(d). Management of Oil and Gas Exploration and Development

Lands acquired under Refuge Boundary Expansion Alternatives B, C and D would be acquired subject to exploration and development of reserved and outstanding mineral interests. Under Refuge Boundary Expansion Alternatives B, C, D, the USFWS would continue to manage oil and gas exploration and development activities on newly acquired lands through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to shorebirds, wading birds, marsh and other waterbirds, including timing of activities to avoid major periods of utilization, offsets to avoid nests and concentrations of birds, 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 would be to reduce impacts on fish and wildlife resources, including avian species in this group, from these activities.

(4). Impacts to Landbirds

Land bird species found in the project area 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 by the USFWS on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats within the project area, restoration, management and protection of native prairies, coastal woodlots and near-coastal forested wetlands (bottomland hardwoods) are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory birds.

(a). Wetlands Management and Restoration

The USFWS would implement wetland management and restoration activities on newly acquired lands. Managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and cooperative rice farming program would benefit resident and migratory land birds which depend on wetland habitats. Several landbird 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

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 Boundary Expansion Alternatives B, C and D 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.

The native coastal prairie habitats within the proposed refuge boundary expansion areas under Refuge Boundary Expansion Alternatives C and D have great potential to provide high quality wintering and nesting habitat for several grassland songbird species. The USFWS would manage and restore native prairie habitats and adjacent fallowed agricultural lands on newly acquired lands to increase native plant species diversity and productivity. The USFWS would use integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing/haying to restore the historic mosaic of prairie plant communities and the different structural characteristics of these habitats. This habitat diversity would in turn support many species of grassland songbirds. Native prairie and other upland grassland habitats on newly acquired lands would provide enhanced 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. Landbirds listed as Avian Species of Conservation Concern utilizing prairie habitats and which would benefit from conservation and management of native coastal prairie in the project area include LeConte's Sparrow, Nelson's Sharptailed Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk.

Woodlot Restoration and Management

Although comprising a small percentage of the upland habitats in the project area, coastal woodlots help support a diverse avian community, which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in the project area'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 Plain region 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.

Under Refuge Boundary Expansion Alternatives B, C and D the following USFWS management actions on newly acquired lands would 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.

Under Alternative D, the USFWS would protect bottomland hardwoods along Taylors Bayou in Jefferson County, an important near-coastal forest that is heavily utilized by neotropical migratory birds, especially during spring migration. Radar studies have identified this area as an important annual "fall-out" area, where large numbers of songbirds stop to rest and renew energy reserves following their trans-Gulf migration (Dr. Sidney Gauthreaux, Clemson University, personal communication).

Overall, implementation of the USFWS management activities on newly acquired lands would 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 coastal woodlots would provide quality habitat for neotropical migratory birds and resident songbirds that require native trees or understory for cover and foraging. Protecting a riparian bottomland hardwood forest under Refuge Boundary Expansion Alternative D would ensure conservation of a near-coastal forest which is especially valuable to neotropical migratory birds. Species to benefit would include three neotropical migratory birds considered to be Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler. Since acreage of woodland habitat in the project area is small relative to its importance to migrating neotropical migratory birds and resident landbirds, such positive impacts for each acre protected are proportionately significant.

(c). General Habitat Management Activities

The USFWS would use prescribed burning, controlled grazing, exotic/invasive species management, and shoreline protection and restoration on newly acquired lands. The integrated combination of water level and salinity management, fire management and controlled livestock grazing would enhance 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 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.

The USFWS fire management program on newly acquired lands would incorporate known habitat needs of the diverse avian communities found on the refuges.

(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 Boundary Expansion Alternatives B, C and D, 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 in the project area support highly diverse aquatic vertebrate and invertebrate communities.

Managing water levels and salinities (using water control structures, levees, impoundments, etc.) in managed marsh units may restrict access of some finfish and invertebrate fisheries species to managed areas. Actively managing water levels may impede access 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 would be reduced by the USFWS on newly acquired lands 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.

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 also use these techniques on newly acquired lands to enhance fisheries utilization of managed marsh units.

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. Target salinity ranges typical of structurally managed marshes 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.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring in the project area 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 Boundary Expansion Alternatives B, C and 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 Boundary Expansion Alternatives B, C, and D would benefit Threatened and

Endangered species and many other sensitive or declining native fish and wildlife species, including several State-listed T&E species.

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

Mammals typically found in the project area include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species. 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 fish, shellfish and small animals.

In general, USFWS habitat management and restoration activities on newly acquired lands under Refuge Expansion Alternatives B, C and D which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under 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.

Control of exotic and/or invasive woody species in wetland and upland habitats on newly acquired lands 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 an unburned habitats is maintained.

b. Impacts from Public Use Programs

The USFWS would administer priority wildlife-dependent uses, including hunting, fishing, wildlife observation and photography and environmental education and photography on newly acquired lands identified under Refuge Boundary Expansion Alternatives B, C and D. This would make new recreational and educational opportunities available to the general public.

The USFWS would open specific areas within newly acquired lands to the public for these uses. Facilities similar to those currently found on the Refuge Complex including trails, boardwalks, observation decks, boat ramps and fishing piers would be developed over time to support these uses. Regulations similar to those currently governing public uses on the Refuge Complex would be in place to protect natural resources and public safety. The USFWS would maintain closed areas on portions of newly acquired lands to provide undisturbed habitats for migratory birds and other wildlife.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

The most direct effect of hunting on newly acquired lands would be 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, waterfowl hunting program on newly acquired Refuge lands 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 new hunt areas would include motorized boating, non-motorized boating, motorized vehicles, and walking and bicycling. 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.

The USFWS would establish sanctuary areas on newly acquired lands to ensure that wintering populations of waterfowl maintain sound nutritional and physiological status in advance of migration and nesting. 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.

Refuge-specific hunting regulations for new hunt areas on newly acquired lands would help mitigate the impacts of hunting activity-related disturbance to waterfowl. Waterfowl hunting in hunt areas would be allowed three days per week, and all hunting activity would be curtailed each day at noon. The non-hunted days and afternoon and evening closures would provide undisturbed periods within the hunt areas, facilitating waterfowl utilization of hunt area habitats for foraging and resting. Regulations would also 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 would be in place primarily to protect habitats and public safety, they would 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 newly acquired lands for fishing and wildlife observation and photography would include motorized and non-motorized boating and motorized vehicles on roads open to the public. Motorized vehicles and walking would be used to access areas used for environmental education and interpretation. The USFWS would develop trails, boardwalks, observation platforms and fishing piers and boat ramps on newly acquired lands.

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 would likely 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 would be 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 on newly acquired land to 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

Primary means of access to areas on newly acquired lands opened for fishing, wildlife observation and photography would be motorized and non-motorized boating and motorized vehicles on roads open to the public. The USFWS may also develop walking trails, boardwalks and observation platforms, boat ramps and fishing piers to support access for these uses on newly acquired lands. Motorized vehicles and walking would be used to access areas used for environmental education and interpretation.

Disturbance of migratory birds by visitors would 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 areas opened for this use on newly acquired lands would be the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing would 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 and crabbing 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 administration of these public uses on newly acquired lands opened for these uses.

(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 newly acquired lands would be subject to the some level of disturbance by public use activities. 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 within areas identified under Refuge Boundary Expansion Alternatives B, C or D, 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 lands newly acquired under Refuge Boundary Expansion Alternatives B, C or 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

It is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on newly acquired lands, but 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

The USFWS may administer an adult alligator harvest program as an economic use on newly acquired lands. This program would be administered under regulations promulgated by Texas Parks and Wildlife Department. State regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS would regulate the alligator harvest program through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations would be in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure in the alligator population. Expanding the commercial alligator harvest program currently being administered by the USFWS on the Refuge Complex to newly acquired lands would not have any measurable effect on the long-term viability of alligator populations.

(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, land subsidence or other factors contributing to marsh loss. The USFWS would control muskrat populations on newly acquired lands in specific locations as deemed necessary to protect wetland habitats 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

The USFWS would implement a variety of field surveys and new and expanded scientific monitoring and research on newly acquired lands.

Surveys, monitoring and research activities for waterfowl would include: 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 would include: 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 the U.S. Geological Survey Biological Resources Division and academic institutions.

Surveys, monitoring and research activities for resident and migratory land birds would include: 1) periodic surveys of selected land birds 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 would include: 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 would include: 1) participation in the annual coast-wide wintering Piping Plover survey 2) coordination of research studies on sensitive and/or declining species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Aerial basking surveys and nighttime spotlight surveys to monitor alligator population trends would be expanded to include newly acquired lands. Data collection from harvested alligators and coordination and information sharing with the Texas Parks and Wildlife Department on alligator harvest management, population monitoring, and research would occur.

Information on species composition and relative abundance of invertebrates would be 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 be expanded. These monitoring activities would provide baseline information on invertebrate populations.

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 would facilitate implementation of an adaptive management approach which allows continual refinement and improvement of management activities.

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

Lands acquired under Refuge Boundary Expansion Alternatives B, C and D would be acquired subject to exploration and development of reserved and outstanding mineral interests. The USFWS would manage oil and gas exploration and development activities on newly acquired lands within the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit would 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 newly acquired lands would be reduced impacts to fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands in the project area 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.

It is anticipated that continuation of outreach and partnership efforts would result in benefits to fish and wildlife resources as important habitats are restored and enhanced on private lands. 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.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from Refuge Boundary Expansion Alternatives B, C and D can be associated with changes in land use which would occur with the transfer of land from private to federal ownership. The changes in land use would occur in the following segments of the local economy:

- Rice farming on acreage within the USDA farm program
- Cattle grazing
- Commercial hunting operations
- Reduction in potential development for areas near Taylors Bayou.

a. Rice Farming - Reduction in Agricultural Support Programs

A large number of acres in the proposed refuge boundary expansion areas within Chambers and Jefferson counties are in the USDA farm program as base acreage for rice. However, a large percentage of this acreage is no longer used for rice production and is either being converted to improved pasture or is fallow. The USFWS would expand its their cooperative farming program on acquired acreage that is currently in rice production due to the habitat benefits rice provides for migratory birds and other wildlife. However, the USFWS would generally not attempt to convert fallowed areas to rice production due to the cost associated with restoring water delivery infrastructure and removal of exotic plant species (e.g. Chinese Tallow). The USFWS will manage some formerly cropped areas as native prairie or moist soil units and use grazing to help achieve wildlife habitat objectives. The success of this cooperative farming program will largely depend on the availability of farmers willing to work within the guidelines of the program including: 1) limits on harvest of the second ratoon crop of rice, 2) restrictions on herbicide and pesticide use, and 3) prohibition of some rotational crops. Overall, market conditions affecting rice production throughout the project area will likely be the primary factor affecting the USFWS' ability to expand the cooperative rice farming program on any newly acquired lands.

FWS currently manages a cooperative farming program with approximately 1,700 base acres registered with the USDA Farm Service Agency (FSA). Rice producers in the cooperative farming program are eligible for farm support programs. As discussed earlier, the USFWS would try to extend the cooperative farming program for additional acquired acreage that is currently in rice production so that it would also be eligible for farm support programs through the FSA. However, base acreage that is not currently in rice production would be converted to natural prairies or moist soil units and thus would not be eligible for support payments. Because, although private landowners are able to collect payments even if acreage is not currently in rice production, the same is not true for federal acreage within the Refuge Complex. For these areas, cooperative farmers, contracted by USFWS, must actually be producing rice or conducting approved maintenance on the allotted base acreage to receive payments. Thus, it is likely that economic impacts could occur within the study area from a reduction in farm support due to a change in land ownership.

To help ensure viable and strong rice production in the United States, the Farm Security and Rural Investment Act of 2002 provides direct payments and counter-cyclical payments to producers for rice

crops. Eligibility for direct and counter-cyclical payments requires producers to sign an agreement with the Farm Service Agency (FSA), which administers this USDA farm program. Producers must also report annually all crop acreage and comply with conservation and planting requirements to establish eligible base acreage payments.

(1). Direct Economic Impacts from Reduction in Agricultural Support Programs

(a). Loss of "Direct Payments"

Direct payments are similar to production flexibility contract payments as they help absorb market shocks that affect production and prices. **The direct payment for rice is calculated as follows**:[20]

Direct Payment Rate X 0.85[Base Acreage] X [Direct Payment Yield]

The direct payment rate for rice within the years 2002-2007 is set at $2.35 per hundredweight (cwt). Producers are limited to direct payments not exceeding $40,000 per crop year and payments are decoupled from both current production and prices on eligible acres.

This information was used to estimate the average direct payment rate per acre for eligible farms in Jefferson and Chambers counties. For Texas, 591,649 acres of rice acreage are enrolled in the program.[21] Of this amount, 85 percent (502,900 acres) are eligible to receive direct payments. The specific yield per acre for Texas as estimated by FSA is 4.947 hundredweight (cwt). Multiplying the direct payment yield by the number of base acres eligible for the program and the direct payment rate of $2.35 per cwt resulted in total direct payments to producers in Texas of $58.4 million. Dividing the total direct payments in Texas by the number of eligible acres resulted in an average payment per base acre of $116 per acre.

An estimate of the base acreage within the Refuge Boundary Expansion Alternatives was made with information from the FSA. FSA provided maps and acreage figures for cropland, base acreage and production acreage within the acquisition boundaries. Using this data and GIS software, base acreage and acreage in current production was estimated by alternative and is summarized in Table 4-42. There are only a relative few rice producers left in the acquisition area. This finding is expected, as the majority of rice production is located in northern parts of Jefferson and Chambers counties.

Table 4-42
Estimated Rice Acreage by Alternative

	Refuge Boundary Expansion Alternative			
Acreage Type	No Action	Alternative B	Alternative C	Alternative D
Crop Acreage	0	5,965	13,730	30,874
Eligible Base Acreage	0	3,026	3,506	13,290
Average Annual Production Acreage (2000 – 2004)	**0**	**197**	**421**	**2,457**

20 U.S. Farm Service Agency Online, Fact Sheet Electronic Edition, Rice Summary of 2002-2007 Program, April 2003, http: //www.fsa.usda.gov/pas/publications/facts/html/rice03.htm
21 Personal communication with Nathan Childs of the U.S. Department of Agriculture, (202)-694-5292.

Using the average direct payment per acre and the estimated base acreage, Booz Allen then estimated the total annual direct payments received by producers for rice acreage within the acquisition boundary for each alternative as summarized in Table 4-43.

Table 4-43
Estimate of Losses of Direct Payment for Rice by Alternative

	Refuge Boundary Expansion Alternative			
Refuge	No Action	Alternative B	Alternative C	Alternative D
Moody	$0	$0	$0	$0
Anahuac	$0	$315,647	$371,435	$1,171,163
McFaddin	$0	$36,161	$36,161	$374,133
Texas Point	$0	$0	$0	$0
Total	**$0**	**$351,808**	**$407,596**	**$1,545,295**

The direct payments summarized in Table 4-43 represent an upper bound estimate of the possible losses in direct payments if the USFWS were to acquire all historically cropped acreage within the boundary expansion area. It is likely that losses would not approach these upper end estimates because 7 to 20 percent of the base acreage is currently in production and would remain in production under USFWS ownership, and thus eligible for payments. Additionally, it is likely that current landowners would retain a certain percentage of the base acreage when farms are reconfigured after a portion of the farm is sold and included in the Refuge Complex.

(b). Loss of Counter Cyclical Payments

Counter-cyclical payments also are decoupled from current production. However, they are negatively correlated to current prices as the payments increase when market prices decline. **For rice, the counter-cyclical payment is calculated as follows.**[22]

Counter-Cyclical Payment Rate X 0.85[Base Acreage] X [Counter-Cyclical Payment Yield]

Counter-cyclical payments for rice are made when the target price for rice is above the effective price. The effective price is formulated from the direct payment price ($2.35) plus the higher of either the seasonal average farm price or the national loan rate[23]. For years 2002-2003 the rice crop target price is $10.50 per cwt and the rice loan rate is $6.50 per cwt. The counter-cyclical payment rate for 2003 was calculated by the FSA as follows because the seasonal average farm price ($3.85 per cwt) was below the loan rate.[24]

$10.50-[2.35+6.50] = $10.35-$8.85 = $1.65

Producers are limited to counter-cyclical payments not exceeding $65,000 per crop year. If the effective price is below the target price then producers receive counter-cyclical payments in addition to direct payments.

The information presented above was used to estimate a counter-cyclical payment that may occur on rice acreage in the areas under Refuge Boundary Expansion Alternatives B, C and D. The maximum payment would occur when farm prices are below the established rice loan rate of $6.50. If rice prices are above this rate, producers receive a smaller counter-cyclical payment. Therefore, a conservative estimate

22 U.S. Farm Service Agency Online, Fact Sheet Electronic Edition, Rice Summary of 2002-2007 Program, April 2003, http: //www.fsa.usda.gov/pas/publications/facts/html/rice03.htm.
23 The National Agricultural Statistics Sevice determines the season average farm price.
24 U.S. Farm Service Agency Online, Fact Sheet Electronic Edition, Rice Summary of 2002-2007 Program, April 2003, http: //www.fsa.usda.gov/pas/publications/facts/html/rice03.htm.

was used for this analysis and assumed that producers would receive the maximum counter-cyclical payment of $1.65 cwt produced on eligible acreage within acquisition boundaries.

The counter-cyclical payments were estimated by multiplying the counter-cyclical rate by the number base acres and the counter-cyclical payment yield (4.947 cwt). An estimate of the counter-cyclical payments that could be eliminated if USFWS were to acquire all rice acreage within the boundaries is summarized in Table 4-44.

Table 4-44
Estimate of Losses of Counter-Cyclical Payments for Rice by Alternative

	Refuge Boundary Expansion Alternative			
Refuge	No Action	Alternative B	Alternative C	Alternative D
Moody	$0	$0	$0	$0
Anahuac	$0	$224,052	$263,652	$831,314
McFaddin	$0	$25,668	$25,668	$265,566
Texas Point	$0	$0	$0	$0
Total	**$0**	**$249,720**	**$289,319**	**$1,096,880**

This is an upper bound estimate of the losses of counter-cyclical payments that could occur. However, like the direct payments discussed earlier, it is likely that only a percentage of these payments would be lost because some acreage would remain in production under the USFWS cooperative farming program and some of the base acreage would be retained by current landowners as farms are reconfigured.

(2). Indirect and Induced Economic Impacts of Reduction in Agricultural Support Programs

Farm support programs, such as direct payments and counter cyclical payments, have additional benefits beyond those realized by the individual producer. These programs provide income to producers that generate additional economic activity in the area, as this income is re-spent. IMPLAN was used to estimate the additional economic activity associated with the farm support programs for rice that could be lost if USFWS were to acquire all lands within the acquisition boundaries.

Additional economic activity that is generated by these particular programs will depend on how the additional income earned by producers is re-spent in the local economy. Because direct payments and counter-cyclical payments are decoupled from actual production, eligible producers are free to spend this additional income as they see fit. Therefore it was assumed that producers would re-spend this additional income in a similar fashion to other forms of income. To estimate economic impacts of this re-spending, total direct payments for the study area were run through the household income models in IMPLAN that correspond to Jefferson and Chambers counties.

Table 4-45 summarizes the additional economic activity that is estimated to occur due to the farm support programs associated with eligible acreage within the acquisition boundaries. The impacts to employment and income presented in this table represent upper bound estimates of losses in farm support programs if the USFWS were to acquire all acreage within the acquisition boundary. However, impacts are not likely to approach this upper bound due to a number of factors. First, this analysis uses the maximum payment available for the counter-cyclical program and thus represents the greatest impact if these payments were eliminated. If average prices received were to exceed the loan rate in future years, the payment would not be as great and thus the impact would not be as large as presented in this table. In addition, the direct payments are tied to farms instead of actual rice acreage. Therefore, it is possible for base acres to remain eligible after a farm is reconfigured upon the sale of certain acreage. Finally, a percentage of the base acreage would remain in rice production under the cooperative farm program and would be eligible for these farm programs.

Table 4-45

Indirect and Induced Economic Impacts of the Reduction in Farm Support Programs by Alternative

	Refuge Boundary Expansion Alternative			
	Alternative A	Alternative B	Alternative C	Alternative D
Labor Income	$0	$151,661	$175,710	$ 666,160
Employment	0	6	7	25

There may be additional economic impacts if the USFWS were to acquire croplands within the boundary expansion area. This is due to the fact that rice production may decline with a change in ownership. While the USFWS plans on continuing their cooperative farming program in areas that are historically important for rice production, the program's success is dependent on individuals' willingness to meet the requirements of the program. It is possible that some acreage could be taken out of production with a change in land ownership if producers lack interest in the USFWS cooperative farming program.

However, declines to the rice industry are likely to continue in the study area following recent trends with or without the USFWS Refuge Boundary Expansion and subsequent land acquisition program due to several factors including:[25]

- Texas producers have higher cost of production than other states
- unfavorable climatic conditions (e.g. high average temperature and late season hurricanes),
- difficulty in growing rotational crops in south Texas
- impacts from waterfowl migration
- problems with red rice
- development encroachment

All these factors will continue to affect the viability of the rice industry in Texas and will have a substantially larger impact than those expected to occur due to the refuge boundary expansion proposed by the USFWS.

b. Cattle Grazing Operations

Changes in land ownership may also cause impacts to grazing operations within the study area. While USFWS will continue to use controlled grazing for habitat management, it is likely that grazing operations on acreage managed by the USFWS will differ from those on private lands. Differences between grazing practices on USFWS lands and on private lands result from differing land use objectives. Grazing on the refuges is used as a tool to enhance wetland and upland habitats for wildlife, while economic objectives generally dictate grazing programs on private lands. In general, stocking rates and duration of use will be less on refuge lands than private lands. . The difference in management techniques will affect the productivity of the acreage for cattle production. In addition, it is anticipated that grazing activities on lands managed by the USFWS will be more costly due to more frequent rotations. Although changes in grazing operations under USFWS management in upland prairie areas are expected to be notable; changes in marsh areas are expected to be relatively minor. Therefore, it is not expected that expansion of refuge boundaries and subsequent land acquisition will cause significant changes in the cattle industry in the study area though some local impacts may be expected.

c. Commercial Hunting Operations

(1). Commercial Hunting Operators

Waterfowl and dove hunting are widely available, usually through a lease, on private lands in the study area. Several commercial guiding outfitters operate in the study area with services for waterfowl hunting,

25 Personal communication with Nathan Childs of the U.S. Department of Agriculture, 202-694-5292.

charter fishing, alligator harvest, and birding. The project area is probably best known in the community for waterfowl hunting, which also provides a source of revenue in the local community for two weeks during the September teal season and from November to January for waterfowl. Approximately six outfitter-guiding services and three landowners who leased their property to outfitters or hunt clubs were identified within the areas identified under the Refuge Boundary Expansion Alternatives. In addition, many rice farmers are currently transitioning from rice to cattle, hunting or a combination of these activities. In general, most outfitters that were contacted operate near current refuge boundaries.

Pricing and packages for guide services vary by outfitter. However, on average waterfowl hunting varies between $50 a day to $150 a day. Many outfitters also provide meals and lodging, which may average around $35 a night for lodging and $50 a day for meals. Outfitters noted that many clients also visit the local establishments while they are in town.

Most outfitters have operated in the area for decades and are either from the local community or are seasonal residents from in-state metropolitan areas. Outfitters contacted during this study employ an average of 13 guides seasonally from the local communities and average between 700 to 2,500 clients annually. The client base mostly includes people from outside the project area. According to the interviews, guided hunting is not a high priority for most local residents, with only a few interested in outfitter services from the Beaumont area. Depending on the marketing of the hunting outfitter, most clientele are from either out-of-state or metropolitan areas within Texas (such as Houston, Dallas, or San Antonio). Some international clientele was also noted. Many clients are repeat customers.

Some outfitters noted that they have a good relationship with the USFWS and that the proximity of the refuges benefits their hunting business. In addition, many outfitters believe that USFWS programs provide support in making habitat improvements that increases hunting profitability. Private lands used for hunting are generally well maintained, including wetland projects, which provides high quality neighboring habitat to the refuges. Some outfitters noted that converting land from private to public ownership has already adversely affected their businesses and more land acquisition would further impair their business or cause their operations to cease. In addition, outfitters stated that hunting on refuges is generally less accessible due to the restrictions on mechanized transportation. Others noted that if the USFWS acquires remnants of private lands as they become available, established guiding services may benefit from the additional habitat protection. In general, most outfitters expressed interest in guided trips on refuges and noted that conservation easements are more desirable because they provide more flexibility.

(2). Hunting on Refuge Complex

There are approximately 37,300 acres currently designated for hunting on the Refuge Complex. Hunting of geese, ducks, and coots is permitted during the waterfowl and September teal seasons on designated areas of the Anahuac, McFaddin, and Texas Point NWRs. Hunting is permitted three days per week until noon with a valid permit (50 CFR 32.63). Moody NWR is privately owned property upon which USFWS holds a perpetual non-development conservation easement. Moody NWR is not open for hunting to the general public, but this privately-owned property is hunted through a commercial guide/outfitter service.

If additional lands were acquired for the Refuge Complex, designated hunting areas would be opened considering conservation objectives, access issues and the quality of hunting to be supported. A consideration for lands acquired with Migratory Bird Conservation Stamp (Duck Stamp) funds is the 40% statutory limitation on the maximum amount of lands which can be opened for hunting. For those lands, management at the Refuge Complex has traditionally strived to maintain areas open to hunting at or near the 40 percent maximum. Migratory waterfowl use of wetland habitats is generally related to the quality of habitat (presence of food resources, proper water levels, etc.) and is influenced by factors such as disturbance. Establishment of sanctuary areas on any newly acquired lands would occur in areas of high quality habitat and low susceptibility to disturbance, which would ensure benefits to wintering and migrating waterfowl and other migratory birds, consistent with Refuge establishment purposes.

(3). Impacts to Commercial Hunting Operations - Acquisition of Private Land

The expansion of Refuge boundaries and subsequent land acquisition by the USFWS is likely to result in some impact on hunting activities within the study area. However, it is unclear at this point if the impact will be positive or negative on the local community. Some commercial hunting operations and local hunting guides may be negatively impacted if the USFWS purchases lands where current hunting leases are held. If the terms of these purchases restrict hunting guides from operating, then it is likely that individual operators would realize a reduction in business. However, areas opened to hunting by the USFWS on newly acquired lands would increase the amount of land available to the general public for hunting, and may actually increase hunting opportunities in the project area. The following section discusses these potential impacts in more detail.

General information on hunting activity was obtained through interviews with local stakeholders; however, there is a lack of detailed information on private activities and exactly where these activities may occur in relation to areas within the Refuge Boundary Expansion Alternatives. Since some private hunting activities may occur through informal agreements with private landowners, the information regarding the extent of these activities and income generated is unknown. Therefore, this analysis is primarily qualitative and based on interviews and maps of the acquisition alternatives. Two local hunting guide services and three landowners who provide hunting leases were interviewed in May 2003.

For the purposes of this analysis, it is assumed that all lands would be acquired in fee simple title. It was also assumed that hunt areas on refuges would be designated at or near the 40 percent maximum and will primarily include desirable and historically hunted areas. Open water areas and impoundments as well as rice acreage were considered desirable hunting areas for waterfowl. These desirable areas were also based on vegetation habitat maps prepared by the USFWS. Desirable hunting areas slated for acquisition are primarily located near McFaddin and Anahuac NWRs, with some acreage near Moody NWR and no acreage near Texas Point NWR. Although lands will be acquired over time from willing sellers as funding becomes available, this analysis focuses on the greatest possible impact scenario to define potential long-term impacts. Estimates of the number of acres within desirable hunting areas that may be converted from private to public ownership if the USFWS were to buy all properties at once within any of the Refuge Boundary Expansion Alternative are shown in Table 4-46.

Table 4-46
Estimate of Desirable Hunting Acreage within Refuge Boundary Expansion Alternatives

	Refuge Boundary Expansion Alternative			
Acreage	No Action	Alternative B	Alternative C	Alternative D
Desirable Hunting Acreage	0*	4,265	6,423	17,071
Total Acreage	**0**	**33,590**	**64,260**	**104,120**

*Alternative A would result in no land acquisition and would not affect current hunting operations. However, indirect impacts may occur over time such as decreased hunt quality from lack of adequate sanctuary areas.

Most outfitters are reliant on the leases provided by the private landowners for locations where they can provide hunting opportunities. If landowners sell to the USFWS rather than provide hunting leases, the quantity of prime areas where guide services operate will decline. Since most outfitters identified operate near Refuge boundaries, lands acquired near refuge areas would directly impact those hunting outfitters. Some outfitter services that depend on leases may cease to operate as a result. As commercial outfitters cease to operate, the limited employment offered by the business will no longer be available and the surrounding community may be indirectly affected. However, those outfitters that operate on land they already own would benefit if they retain their land. Those remaining establishments would have less competition for commercial guide services and the quality of the hunting opportunities may improve.

It is important to note that other factors may have important impacts on hunting outfitters regardless of any actions implemented by the USFWS under Refuge Boundary Expansion Alternatives B, C or D. This includes such things as natural phenomenon, stricter hunting regulations, changing land uses and land ownerships, or decreased interest in hunting. Natural phenomenon, including climatic conditions (e.g. drought in nesting areas), disease, and predation, may reduce continental waterfowl populations. . Lowered continental waterfowl populations would result in implementation of more restrictive harvest regulations. Reduced bag limits and shortened seasons would negatively impact commercial hunting operations. Changes in habitat quality and quantity (for example, the recent decline in rice production) in the project area can greatly impact local waterfowl numbers. Changing land uses such as the conversion of former rice fields to pasture or improved pasture or to residential development and changes in land ownership will also impact the waterfowl outfitter businesses in the project area. Finally, human factors, such as poor economic conditions or reduced hunting interest, may result in fewer hunters and less business for outfitter services.

d. Potential Development

For most of the area within the Refuge Boundary Expansion Alternatives B, C and D, future potential development appears low, at least in the immediate future. However, urban sprawl from the greater Houston area is already resulting in rapid development in western Chambers County, and ultimately development pressures are expected to increase in the relatively undeveloped portions of mid and eastern Chambers County.

Some lands within the expanded refuge boundaries proposed in Refuge Boundary Alternative D were found to have some development potential based on current activity. The area in question is commonly known as Taylors Bayou and is located north of Highway 73 in Jefferson County. Much of the acreage in and around the bayou was formally used for rice production with the remaining acreage comprised of bottomland hardwoods. There is already some residential development near the boundary expansion area. This includes a well established country club and residential neighborhood to the east of Taylors Bayou. Adjacent to the country club is a new development, which consists of single-family residential properties. Additionally, scattered residential development is also occurring to the south of the refuge expansion boundary.

Evaluation was conducted to determine the development potential of the Taylors Bayou area. This included interviews with the Jefferson County Tax Appraisal office[26] and review of tax assessment records on properties in this area. Tax records contain information on market values of individual properties. These market values will reflect the value of the parcel in its highest and best use even if it is not being used for this purpose. For instance, agricultural lands, which have high potential for development, will show a higher market value compared to other agricultural areas. The market values associated with a select sample of properties in and around Taylors Bayou were examined to determine if development potential is being reflected in market values obtained by the Tax Appraisal Office. The results are summarized in Table 4-47 on the following page.

The most significant development in the area is the Lake Estates residential development just south of Taylors Bayou overlooking the Belle Oaks Golf Course on Country Club Road (east of Labelle Road). The development consists of 60 home sites on 80 acres of land, 23 of which are wetlands and unusable for development. Pre-construction lots begin at $70,000 and finished lots begin at $300,000. Lot sizes range from one-half to one-acre in size.[27]

Market values of parcels in and around Taylors Bayou do reflect that development is possible in this area and is occurring. However, further interviews with the Tax Appraisal District and the Southeast Economic

26 Personal communication with Larry Harrington of Jefferson County Tax Appraisal District, Beaumont, Texas 409-840-9944.
27 Personal communication with Jerry Braxton of Excavators & Constructors, Inc., Beaumont, Texas, 409-721-6030.

Table 4-47
Estimated Market Values of Parcels near Taylors Bayou

Location of Parcel	Market Value ($ / acre)[1]	Comments
Fishcamp Area - Subdivision East of Jap Road	$1,200 - $1,500	Lots are available in this area but values reflect lands values only. This area is low in elevation and would require any structures to be built on stilts.
Fishcamp Area - West of Jap Road	$300	This area is very low in elevation and marshy; little potential for development.
West of Jap Road and North of Taylors Bayou	$500	Area is a bit higher in elevation which is reflected in market value.
Rice acreage south of Highway 73	$500	Low elevation; marshy.
Acreage south of new development to the east of boundary expansion area	$500	Low elevation; these areas will need a fair amount of work before development can take place.
New development area; east of current country club	$70,000 per lot[2]	Higher elevation but still requires a fair amount of work before development can take place

[1] Market values were obtained from the Jefferson County Tax Appraisal District.
[2] Lot sizes range from one-half to one-acre in size.

Development Association[28] indicate that the development is limited due to certain challenges. First, much of this area is low in elevation and would require development modifications, which increase the cost of construction. Additionally, this area is located some distance from urban areas (Port Arthur) which limits the demand for development due to the long commuting distance. Officials interviewed felt that while this area does have development potential, it is still quite speculative at this point and will remain so in the future unless significant changes were to occur.[29]

At this time, if the USFWS were to acquire acreage in the Taylors Bayou area, there is potential that it could limit some future development. The likelihood of this impact is dependent on the development potential. For instance, development potential in the low-lying floodplain adjacent to Taylors Bayou itself appears low, thus potential impacts to development would be low as well. However, areas that are somewhat higher in elevation do appear to have development potential which could be lost if these areas were acquired by the USFWS.

2. Fiscal Impacts to Local Governments

Fiscal impacts to local government jurisdictions may occur if the USFWS acquires land within the study area that is currently owned by private parties. Impacts arise since the federal government would not pay property taxes on acquired acreage; therefore, the property taxes that are currently paid by private landowners would no longer accrue to the affected local government jurisdictions. To gain an understanding of how local government entities may be impacted, a model was developed to evaluate changes in tax revenues if lands were acquired by the USFWS. The model is based on several assumptions as follows.

- Changes in tax revenues are estimated for acquisition of all acreage in fee simple title under each Refuge Boundary Expansion Alternative.
- Only taxing jurisdictions within Galveston, Jefferson and Chambers Counties would be impacted by the acquisition actions of the USFWS.
- Lands to be acquired are assumed to be in agricultural production and are currently taxed at a reduced rate from other types of property (e.g. industrial and commercial).

28 Personal communication with Mike Foster of the Southeast Texas Regional Planning Commission, Beaumont, Texas 409-899-8444.
29 Development potential for this area could increase with the completion of a large drainage project which is planned by Drainage District #6.

The following steps were used to develop the model in detail:

Step 1: Identify Acreage by Taxing District and Land Use Category

The first step in implementing the model was to estimate the acquisition acreage by taxing jurisdiction. For each county where lands may be acquired, all districts that were likely to be impacted were identified using maps provided by the tax assessors' offices and interviews with county officials. The jurisdiction maps were compared with maps of the Refuge Boundary Expansion areas prepared by the USFWS to identify which districts may be impacted. Table 4-48 summarizes these districts.

Table 4-48
Taxing Districts with Jurisdiction in Acquisition Areas

Chambers	Jefferson	Galveston
Chambers County, East Chambers ISD*, Anahuac ISD*, Chambers-Liberty Navigational District, Hospital District, Trinity Bay Conservation District	Jefferson County, Sabine Pass ISD*, Hampshire-Fannett ISD*, Drainage District 3, Drainage District 6, Port of Sabine Pass, Jefferson County Waterways & Navigational District	Galveston County, High Island ISD*, Galveston County Road and Flood District

* ISD – Independent School District

Next, USFWS vegetation maps, in a GIS format, were overlaid on the acreage within each of the impacted districts. The vegetation types in the acquisition areas were then converted to land use categories utilized for tax assessment purposes. The conversion used for this analysis is summarized in Table 4-49.

Table 4-49
Vegetative Type to Tax Category Conversion

Vegetation Types	**Land Use Category for Tax Assessment Purposes**
Non-Saline Prairie/Agricultural	Rice Acreage/Natural Pasture/Improved Pasture
Salty Prairie	Natural Pasture/Marsh Pasture
Fresh Marsh	Natural Pasture/Marsh Pasture
Intermediate Marsh	Natural Pasture/Marsh Pasture
Brackish Marsh	Natural Pasture/Marsh Pasture
Saline Marsh	Natural Pasture/Marsh Pasture
GIWW Spoil Areas	Barren
Contained Spoil	Barren
Forested Wetland	Rice Acreage/Natural Pasture
Inland open water	Natural Pasture/Marsh Pasture
Natural Lake - brackish marsh	Natural Pasture/Marsh Pasture
Natural Lake - intermediate marsh	Natural Pasture/Marsh Pasture
Prairie Grassland	Natural Pasture
Unclassified	Barren

Finally, the land use categories were overlaid on the Refuge Boundary Expansion Alternatives and the jurisdiction maps. From this information, we were able to estimate the acreage within each taxing district by land use category for all three of the expansion alternatives. Simplified summaries of the estimated acreage by land use category for each of the expansion alternatives are shown in Tables 4-50 through 4-52. (Note very small differences in acreage totals for each Alternative because of unrectified information on GIS maps).

Table 4-50
Land Use Categories by acres in Refuge Boundary Expansion Alternative B

Land Use Category	**Chambers Co.**	**Jefferson Co.**	**Galveston Co.**
Irrigated Agriculture	2,702	311	
Improved Pasture	6,570		
Natural Pasture	16,425	1,871	415
Natural Pasture/Marsh		5,007	48
Barren Land	106	42	
Total Acreage	25,803	7,231	463

Table 4-51
Land Use Categories by acres in Refuge Boundary Expansion Alternative C

Land Use Category	**Chambers Co.**	**Jefferson Co.**	**Galveston Co.**
Irrigated Agriculture	3,195	311	
Improved Pasture	16,794		
Natural Pasture	29,305	1,915	6,923
Natural Pasture/Marsh		5,546	334
Barren Land	106	42	
Total Acreage	49,400	7,814	7,257

Table 4-52
Land Use Categories by acres in Refuge Boundary Expansion Alternative D

Land Use Category	**Chambers Co.**	**Jefferson Co.**	**Galveston Co.**
Irrigated Agriculture	10,073	3,218	
Improved Pasture	25,867		
Natural Pasture	30,376	6,221	6,923
Natural Pasture/Marsh		21,040	334
Barren Land	243	42	
Total Acreage	66,559	30,521	7,257

Step 2: Estimate Assessed Values of Acquisition Acreage

Once the acreages and land use categories were estimated for each district under each Refuge Boundary Expansion Alternative, it was then necessary to determine how the local tax assessor values these acreages for tax purposes. Given the location and rural nature of the lands that would be acquired by the USFWS, it was assumed that all lands that could be purchased by the USFWS are now in agriculture production. This assumption is important because agricultural lands in Texas are appraised differently than other land uses. An agricultural appraisal considers the capacity of the land to produce crops, livestock, qualified wildlife or timber instead of its value on the real estate market.[30] Land must be principally devoted to agricultural use for five of the last seven years to qualify for this assessment. An agricultural appraisal is based on an estimate of the typical annual income during the five-year period proceeding the year before appraisal.

Table 4-53
Chambers County Land Assessments

Land Use Category	Value per acre
Irrigated Agriculture	$223
Barren Land	$36
Natural Pasture	$56

Source: Chambers County Appraisal District, 2003 Chambers County Ag & Timber Values, Anahuac, Texas.

Table 4-54
Jefferson County Land Assessments

Land Use Category	Value per acre
Irrigated Agriculture	$194
Natural Pasture	$34
Marsh Pasture	$9

Source: Jefferson County Appraisal District, 2003 Ag Schedule, Beaumont, Texas.

Table 4-55
Galveston County Land Assessments

Land Use Category	Value per acre
Natural Pasture and Hunting	$40
Natural Pasture, Marshy	$15

Source: Galveston Central Appraisal District, 2004 Agricultural Productivity Values, Galveston, Texas

The Texas Comptroller's Office was contacted for information on agricultural assessments for each of the three counties where acquisition would occur. Mr. Jesus Longoria of the Texas Comptroller's Office was able to provide data on total acreage and agricultural productivity values by agricultural land categories for the affected school districts in Chambers, Jefferson and Galveston Counties. This data was taken from the annual Property Value Study, conducted by the Comptroller's Office. This report summarizes information provided by the counties each year and is used to certify tax assessments for school districts across the state. Mr. Longoria provided data for 1998-2001.

The data on agricultural productivity values as well as information from the county appraisal districts was used to estimate an annual average value per acre for each of the land classifications. A summary of these estimates for each county is provided in Tables 4-53 through 4-55.

30 Texas Comptroller of Public Accounts, "Texas Property Taxes," January, 2003, Austin, Texas.

Step 3: Determine Property Tax Rates by District

The applicable tax rate for each impacted district was obtained from the counties as summarized in Tables 4-56 through 4-58. The tax rate will be applied to the total assessed value of lands per district to estimate total property tax revenues generated in the acquisition areas under current conditions.

Table 4-56
Chambers County Property Tax Rates by District

Code	Tax District	Tax Rate Per $100/Value
01	Chambers County	0.528645
33	East Chambers Cons. ISD	1.65
30	Anahuac ISD	1.5
60	Chambers-Liberty Navigational District	0.0285
49	Drainage District #6	0.200039
65	Hospital District	0.75
79	Trinity Bay Conservation District	0.4827

Source: Chambers County

Table 4-57
Jefferson County Property Tax Rates by District

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

Source: Jefferson County

Table 4-58
Galveston County Property Tax Rates by District

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

Source: Galveston County

a. Estimated Reduction in Tax Revenues

The model was then used to calculate the potential decrease in tax revenues that would occur if the USFWS were to acquire all lands within the proposed expanded boundary in fee simple title.

Refuge Boundary Expansion Alternative B

For Refuge Boundary Expansion Alternative B, the estimated loss in property tax revenues from removing lands from the tax rolls was estimated to be $47,278 as summarized in Table 4-59. Most of this reduction in tax revenues would occur in Chambers County based on the distribution of acquisition acreage. Within Chambers County, the largest impact would occur to the Anahuac ISD, which is estimated to lose $19,721. The next largest impact to Chambers County jurisdictions would accrue to the County and the Hospital District, with each losing an estimated $10,357 and $9,245 respectively. The largest impact in

Jefferson County would occur to the Hampshire-Fannett ISD, which would lose an estimated $2,470 in property tax revenues.

Table 4-59
Estimated Reduction in Property Taxes on Lands
in Acquisition Areas – Refuge Boundary Expansion Alternative B

Refuge Acquisition Areas	County		
	Chambers	Galveston	Jefferson
Anahuac NWR	$35,644	$15	
Moody NWR	$7,550		
McFaddin NWR	$277	$346	$3,237
Texas Point NWR			$189
Total	$43,471	$361	$3,426

Refuge Boundary Expansion Alternative C

Table 4-60 summarizes the tax implications for Refuge Boundary Expansion Alternative C. Removing 64,471 acres from the tax rolls has the potential to reduce tax revenues to all districts by a total of $99,054. As with Refuge Boundary Expansion Alternative B, the largest impact would occur in Chambers County with a reduction of $89,568 in tax revenues. Within Chambers County, the largest impact would occur to the Anahuac ISD, which is estimated to lose $43,850, while the Hospital District would lose $21,925, and the County would lose $18,177. Districts within Jefferson County are estimated to lose over $3,500 with the largest impact occurring to the Hampshire-Fannett ISD, which is estimated to lose over $2,470.

Table 4-60
Estimated Reduction in Property Taxes on Lands
in Acquisition Areas – Refuge Boundary Expansion Alternative C

Refuge Acquisition Areas	County		
	Chambers	Galveston	Jefferson
Anahuac NWR	$79,592	$5,590	
Moody NWR	$9,508		
McFaddin NWR	$468	$348	$3,237
Texas Point NWR			$311
Total	$89,568	$5,938	$3,548

Refuge Boundary Expansion Alternative D

Refuge Boundary Expansion Alternative D, the largest acquisition alternative, has the potential to reduce property tax revenues to all districts by an estimated $184,304 as summarized in Table 4-61. As with the other two alternatives, the largest impact would occur to taxing districts in Chambers County. Within Chambers County, the largest impact would occur to the Anahuac ISD, which is estimated to lose $76,890, while the Hospital District would lose $38,445 and the County would lose $30,409. The districts within Jefferson County are estimated to lose $21,485 with the largest impact occurring to Hampshire Fannett ISD ($15,567) and Jefferson County ($3,701).

Table 4-61
Estimated Reduction in Property Taxes on Lands in Acquisition Areas – Refuge Management Alternative D

Refuge Acquisition Areas	County		
	Chambers	Galveston	Jefferson
Anahuac	$146,944	$5,590	
Moody	$69,508		
McFaddin	$428	$348	$21,180
Texas Point			$305
Total	$156,880	$5,938	$21,485

A comparison of the estimated tax revenues that could potentially be lost due to a change in land ownership with current tax revenues earned by impacted districts in the study area indicates that no district would incur a loss greater than one percent of their current annual tax revenues.[31] Total estimated property tax losses for each alternative by government jurisdiction for the three counties are provided in Appendix A.

b. Offset from Refuge Revenue Sharing Payments

This analysis has not considered the annual Refuge Revenue Sharing payments that would be distributed to the counties from the USFWS if acquisition were to occur. The most recent data on these payments indicated that the USFWS has paid a minimum of $43,000 to Chambers County and $58,000 to Jefferson County in annual revenue sharing payments for lands currently owned. The dollar amount of past Refuge Revenue Sharing payments is substantial and significantly offsets the local tax losses. In some instances, largely for lands subject to the agricultural exemption, the past Refuge Revenue Sharing payments have been equal to or even greater than the amount paid in taxes while in private ownership. Future Refuge Revenue Sharing payments would be adjusted for any newly acquired lands using calculations described in Chapter 2, Part B, *Issues Common to all Refuge Boundary Expansion Alternatives*. It can be anticipated that these payments would offset at least a portion of the lost tax revenues estimated above and thus decrease potential negative impacts to the taxing districts.

3. 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, the Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

31 Annual revenues for the Hospital District were not available.

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), and
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others).

Overall, most people's lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Any social and/or lifestyle effects from implementation of Refuge Boundary Expansion Alternatives B, C or D on individuals and groups would be lessened because the USFWS would only acquire lands from "willing" sellers; it must be assumed that a willing seller has individually determined that any associated impacts from this land transfer to the USFWS is acceptable, or the transaction would not be made. Issues would also arise when USFWS management activities on any newly acquired lands are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and may 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 description of the potential relationships between the USFWS and stakeholder groups is contained in the impact analysis for Refuge Boundary Expansion Alternative A, the "No Action" Alternative. 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 refuge boundary expansion.

- 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 on newly acquired lands may conflict in some cases with some of the goals, beliefs, and objectives of many of the local stakeholders. Some members of a stakeholder group may support refuge boundary expansion and future USFWS management of those lands, while other members oppose it. Different stakeholder groups may agree or disagree with the size or location of a particular refuge boundary expansion alternative; or, even the need for refuge boundary expansion. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and address their concerns. 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. With new actions such as those proposed in Refuge Boundary Expansion Alternatives B, C and D, USFWS public outreach efforts would continue and may expand.

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 proposed USFWS refuge boundary expansion actions would have no major effect on the existence or resolution of current socioeconomic issues associated with USFWS activities at the Texas Chenier Plain Refuge Complex. Under any of the Refuge Boundary Expansion 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 the Refuge Boundary Expansion Alternative A (No Action), existing conditions and trends would generally remain the same. The management of the Refuge Complex land and the extent of land holdings would not change in substantive ways.

Under Refuge Boundary Expansion Alternatives B, C and D, management philosophies and priorities would change from current conditions, and the amount of USFWS land holdings would increase. The USFWS management of newly acquired lands would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values which may differ from current private land management actions. 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 the action alternatives for refuge boundary expansion, 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 Refuge Boundary Expansion Alternatives B, C and D support different conservation priorities, and the differences among alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the project area would generally remain the same as current conditions. Because the USFWS would work only with willing sellers, the potential social and lifestyle concerns would lessen because changes in ownership would be a choice, not a requirement. Overall,

impacts to social structures and lifestyles would not be significant from any alternative considered in this EIS. No matter which Refuge Boundary Expansion Alternative was implemented, most socioeconomic issues would remain unresolved.

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 Boundary Expansion Alternatives would be in compliance with EO 12898.

III. IMPACTS ON CULTURAL RESOURCES FROM REFUGE BOUNDARY EXPANSION 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.

Impacts on Cultural Resources from Refuge Boundary Expansion Alternatives

No additional lands would be identified for acquisition and the Refuge Complex would remain its current size under Refuge Boundary Expansion Alternative A. Seventeen known shell middens, one of which is NHRP eligible, and a potentially NHRP eligible historic shipwreck would be slated for acquisition as lands become available under Refuge Boundary Expansion Alternatives B and C. A total of 25 known shell middens, two of which are NHRP eligible, and the potentially NHRP eligible shipwreck would be slated for acquisition as lands become available under Refuge Boundary Expansion Alternative D. There is a potential for additional protection as well as impacts to federally acquired cultural sites under all of the acquisition alternatives; however, these impacts would not be considered adverse and most of the impacts would be considered minor in nature, unavoidable, or beneficial.

The transfer of lands with known cultural sites from private to federal ownership are not anticipated to impact known cultural sites, but would rather preserve the setting of the sites and may provide additional protections not afforded to the sites on private lands. Federal acquisition would provide additional protections under NHPA and associated regulations not afforded to cultural sites on private lands. Private lands acquired would also be subject to the actions and impacts identified for the preferred management alternative on existing Refuge Complex lands.

Natural impacts would continue to occur to the known cultural sites on acquired areas; however, additional protections may be afforded to the sites under Management Alternative D if water control projects extend to the acquired lands. The potentially eligible shipwreck has already experienced damage from waves and previous disturbance from U.S. Army Corps of Engineers jetty construction and repair; USFWS ownership would likely not result in any changes to the shipwreck site from its current condition.

Known cultural sites on federally acquired lands would be afforded additional protections from ground-disturbing activities through the Section 106 process. Any ground-altering projects proposed by the USFWS would have a new site-specific Section 106 consultation. Cultural sites on private lands may not experience ground disturbance as often as federal lands, but in some cases may be subject to more. The presence of cultural sites on private lands are typically unknown by the landowner and the sites have been subject to clearing, grading, or borrowed material that modified the condition of the original site. On occasion, private landowners may also collect and remove cultural materials from the sites for a personal hobby, which removes the cultural material from the benefit and knowledge of the greater public. The ground-truthing and the Section 106 consultation process may reveal more cultural sites previously undiscovered in private ownership and provide protection as appropriate.

The cultural sites on newly acquired lands may be subject to prescribed burning, cattle grazing, and recreation that may or may not have occurred previously in those areas. Regular prescribed burning or use of natural ignited fire on acquired lands would reduce the potential for higher intensity fires under Management Alternative D, and may reduce fuel loads that produce higher intensity fires that threaten the integrity of cultural items. The potential for inadvertent cattle tromping is likely to occur on acquired lands slated for grazing under Refuge Management Alternative D. Cultural sites on newly acquired private lands

may experience an increase in visitation as opposed to that occurred in private ownership. However, recreational activities typically occur in previously developed areas and access can be controlled as needed to protect sensitive cultural items. Boating restrictions on Refuge Complex lands would impose restrictions that may reduce the potential for damage to shoreline cultural sites from wake erosion.

IV. IMPACTS COMPARISON TABLE FOR REFUGE BOUNDARY EXPANSION ALTERNATIVES

The impacts discussed in detail in the preceding section, *Part B: Impact Analysis for the Four Refuge Boundary Expansion 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 three "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
RBE Alternative A	**RBE Alternatives B, C, & D**
Impacts to Air Quality	
Smoke impacts to air quality from agricultural burning on private lands to improve forage for livestock and wildlife and control brush.	Smoke impacts to air quality from USFWS prescribed burning on newly acquired lands mitigated by strict adherence to prescription parameters.
Impacts to Geology and Soils	
Coastal land loss continues at existing or accelerated rates on private lands.	USFWS would expand interagency coordination to address threats from coastal land loss on newly acquired lands, with goal of implementing major structural erosion abatement projects implemented along Gulf, GIWW and East Galveston Bay shorelines. USFWS water management and prescribed burning on newly acquired lands may benefit soil formation and vertical accretion in marshes.
Impacts to Hydrology and Water Quality	
Economic considerations dictate type & scope of activities affecting large-scale hydrology on private lands. Less management of marshes resulting from trend to smaller ownerships.	Wetland management & hydrologic restoration by USFWS on newly acquired lands would help restore historic continuum of fresh, intermediate, brackish and saline marshes which support a natural diversity of native plant, fish, and animal communities. USFWS would increase efforts to improve water quality.

RBE Alternative A	RBE Alternatives B, C, & D
Impacts to Vegetation / Habitats	
Impacts from Habitat Management and Restoration Activities	
Water management on private lands primarily supports agricultural uses, primarily livestock grazing. Rice production is declining with former rice fields fallowed or converted to improved pasture. Burning, grazing and water management on some private lands enhance wetland habitats for waterfowl and other migratory birds. Many private landowners actively control invasive plant species, particularly Chinese tallow.	USFWS would use structural water management on newly acquired lands to control salinities and water levels within marsh habitats to mimic natural marsh hydroperiods and provide more productive habitats for fish & wildlife. Moist soil management would be expanded and cooperative rice farming would be maintained where possible on newly acquired lands to provide freshwater habitat for waterfowl and other migratory birds. Prairie restoration & management on newly acquired lands would increase the abundance of native prairie grasses & forbs, protecting Globally Imperiled plant communities. USFWS would increase protection and enhancement of woodlot habitats. USFWS would use prescribed burning, controlled grazing and exotic/invasive species control to enhance native habitats on newly acquired lands. Shoreline protection/restoration and marsh restoration on newly acquired lands would positively impact nationally-declining wetland habitats.
Impacts from USFWS Programs (Public Use, Biological, Oil and Gas Management, and Community Outreach / Partnerships)	
Some private landowners participate in USFWS and other agency conservation initiatives, particularly to restore wetland habitats. Oil and gas development would continue as currently administered on private lands.	Motorized boating for fishing and hunting can impact wetland vegetation; impacts from other public uses are localized & minimal. Biological program supports adaptive management approach and oil & gas management reduce impacts to vegetation/habitats. Continuation of outreach and partnership efforts would result in additional habitat restoration & enhancement on Refuge Complex and private lands throughout the project area.
Impacts to Fish and Wildlife Resources	
Impacts from Habitat Management and Restoration Activities	
On private lands, economic considerations dictate land uses & management practices and resulting benefits to fish & wildlife. Agricultural practices provide substantial benefits to waterfowl but may reduce wetland habitat available for other wetland-dependent avian species. Combinations of burning, grazing, & water management on private lands which provide benefits to waterfowl also benefit other species.	Marsh habitats on newly acquired lands would be managed to enhance habitat for waterfowl, shorebirds, wading birds & other wetland-dependent migratory birds. Moist soil management would be expanded and cooperative rice farming continued on newly acquired lands providing additional high quality wetland habitat for wintering and resident waterfowl and other migratory birds. USFWS would provide and enhance habitats specifically needed by Mottled Ducks. USFWS would focus management/restoration activities to obtain a mosaic of diverse habitat types benefiting a wide variety of avian species, including several Avian Species of Conservation Concern. Restoration and enhanced management of native prairie habitats would benefit many declining landbird species. Integrated burning, grazing, & exotic/invasive species control on newly acquired lands would maintain naturally diverse and productive wetland and upland habitats benefiting avian species, T&E species, and a wide variety of other wildlife species. USFWS management of water control structures on newly acquired lands would benefit fisheries by increasing fish passage.

RBE Alternative A	RBE Alternatives B, C, & D
Impacts from Public Use Program	
Dove and waterfowl hunting would continue as currently managed on private lands.	USFWS would open specific areas within newly acquired lands for public wildlife-dependent recreational uses. Waterfowl and dove harvest would not affect overall populations and their long-term viability. Sanctuary areas would be established on newly acquired lands to maintain local waterfowl populations & mitigate hunting pressure. Motorized boating does affect distribution & habitat use of waterfowl & other wildlife species. Impacts from other recreational activities are localized & minimal as to most species. No impacts to T&E species or long-term viability of fisheries resources.
Impacts from Biological Program, Oil and Gas Management, and Community Outreach / Partnerships	
Some private landowners allow wildlife surveys and studies (waterfowl banding), and participate in USFWS and other agency conservation initiatives which benefit wildlife, especially waterfowl. Oil and gas development would continue as currently administered on private lands.	USFWS would implement a variety of new/expanded surveys, monitoring, & research on newly acquired lands to facilitate adaptive management approach allowing continual refinement and improvement of management activities. Biological program would focus on priority wildlife species needing conservation action. Net effect of oil & gas management is reduction of impacts to fish & wildlife resources from these activities. Expanded outreach/partnership efforts would result in benefits to fish & wildlife resources as important habitats are restored and enhanced on private lands.
Economic Impacts	
There are direct, indirect and induced impacts from existing Refuge Complex operations, agriculture, and recreation **(same as impacts analyzed for Refuge Management Alternative. D in Part A of Chapter 4).**	New land acquisition results in losses of agricultural support programs for rice farming by Alt.: Direct Payments, B) $351,808 C) $407,596 D) $1,545,295; Counter-Cyclical Payments, B) $249,720 C) $289,319 D) $1,096,880; Indirect/Induced, B) $151,661 C) $175,710 D) $666,160. Represents maximum possible loss, more likely only a percentage of this because some acreage would be included in coop rice farming and some base acreage would be retained by current landowners as farms are reconfigured. New land acquisition not expected to cause significant impacts in cattle grazing industry or commercial hunting operations. Some loss of development potential in and around Taylors Bayou by new land acquisition under Alt. D.
Fiscal Impacts to Local Governments	
Refuge Revenue Sharing Payments made to local governments based on already acquired lands.	New land acquisition results in losses of tax revenues to local governments by Alternative: B) $47,258, C) $99,054, D) $184,303. Represents maximum possible loss if all lands were acquired within an expansion boundary. Refuge Revenue Sharing Payments on newly acquired lands would offset portion of loss in tax revenues.
Impact on Population and Social Impacts	
No impact on population or environmental justice. Social conditions remain generally the same with some unresolved issues.	Same as Refuge Boundary Expansion Alternative A.
Impacts on Cultural Resources	
Unavoidable adverse impacts from natural phenomenon are anticipated to continue to occur at cultural resource sites under all of the Refuge Boundary Expansion Alternatives. Acquisition of these sites would preserve the setting of these sites and provide additional protection through the Section 106 process from ground-disturbing activities.	