

PART C: COMBINED AND CUMULATIVE IMPACTS

Overview

Parts A & B of this Chapter analyze the environmental impacts from the actions proposed in each of the two separate sets of alternatives presented in Chapter 2. The two sets of alternatives address the two separate but related federal actions: 1) management strategies for the Complex for the next 15 years in a CCP and 2) expansion of the refuge boundaries for the four refuges within the Refuge Complex. The USFWS has selected a Preferred Alternative for each action: Refuge Management Alternative D is the Preferred Alternative for management; and, Refuge Boundary Expansion Alternative C is the Preferred Alternative for the expanding the refuge boundaries of the refuges within the Refuge Complex.

This section of Chapter Four, Part C, addresses, first, the environmental impacts resulting from the combined proposed federal actions as described in the two Preferred Alternatives; and, second, the cumulative effects associated with the two combined federal actions. The environmental impacts for the combined actions are organized by resource area in the same way as the impact analysis for the two separate sets of alternatives in Parts A & B. The cumulative effects results from the incremental impact of the combined proposed actions when added to other past, present, and reasonably foreseeable future actions regardless whether undertaken by Federal agency, non-federal agency or private individuals.

The lands to be acquired under Refuge Boundary Expansion Alternative C would be managed in accordance with the management strategies prescribed for the existing Refuge Complex lands under Refuge Management Alternative D. A short summary for each of the Preferred Alternatives is presented in this section. The combined impacts of the preferred alternatives and cumulative impacts are discussed in the remainder of this section.

Refuge Management Alternative D – Preferred Alternative

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

Efforts to address coastal habitat loss and degradation resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW and to restore emergent marshes would be intensified by increasing coordination among agencies and other stakeholders. Goals would include implementing large-scale partnership projects including barrier beach/dune restoration on McFaddin NWR, marsh and shoreline restoration on Texas Point NWR through the beneficial use of dredge material, and structural shoreline protection along the GIWW and East Galveston Bay. Ongoing interior marsh loss would be addressed by working with agencies and other stakeholders on watershed-scale hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion. The USFWS would also implement several smaller hydrologic restoration and shoreline protection projects on the Refuge Complex. Management efforts to control exotic and invasive plant and animal species would be expanded.

Through new partnerships with universities and other agencies, additional research and monitoring would be conducted to better assess impacts of relative sea level rise and to support future conservation planning to address these impacts. Additional monitoring of exotic/invasive plant species, including research to assess the efficacy of ongoing and new control techniques, would be conducted. Additional

baseline data on fish and wildlife populations and habitat use would also be collected, with an emphasis on documenting the status of several sensitive or declining species.

The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. The Refuge Complex would seek to provide additional recreational opportunities and improve the quality of visitor services and of the visitor experience through construction of additional public use facilities, expanding law enforcement efforts to protect public safety and natural resources, providing additional hunting and fishing opportunities, and developing additional educational programs.

Refuge Boundary Expansion Alternative C – Preferred Alternative

Under Refuge Boundary Expansion Alternative C, approximately 64,260 acres are identified for acquisition that would be acquired only from willing sellers, as funding is available, and added to the Refuge Complex. When approved, the refuge boundary expansions would provide USFWS with the authority to acquire interests in lands identified within the acquisition boundaries. This can include acquisition of both fee simple title as well as conservation easements.

Natural habitats within the acquisition area identified under Refuge Boundary Expansion Alternative C include coastal wetlands, low lying coastal prairies, and near coastal woodlands between Trinity Bay to the west and the Sabine River on the east. These habitats provide important and high quality habitat for waterfowl, shorebirds, wading birds and other wetland-dependent migratory birds, neotropical/nearctic migratory songbirds and other resident native fish and wildlife, including three Federally-listed Threatened and Endangered avian species, several State-listed T&E species, and several species of migratory birds which have been identified as needing conservation action under various national and international conservation initiatives. Upland areas under this Alternative including the largest remaining contiguous tracts of native coastal tallgrass prairie on the upper Texas Gulf Coast, an extremely rare but highly diverse habitat type which has been classified by the Nature Conservancy as "Globally Imperiled".

Assumptions

The same assumptions from Part B of this Chapter are used in the analysis of the Combined Impacts in this section.

- 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 within the first year following approval of the refuge boundary expansion. This assumption assures that the maximum possible impacts are addressed even though the proposed "willing seller" acquisition program and the availability of funding would obviously not produce this result.
- The impacts for the Refuge Boundary Expansion Alternatives are analyzed assuming that the lands acquired in the future would be managed according to the strategies contained in the Refuge Management Alternative D, the Preferred Alternative.

I. COMBINED IMPACT ANALYSIS

It is not the purpose of this part of the Chapter to simply repeat the detailed impact analysis for each of the Preferred Alternatives which are contained in the first two parts of the Chapter. Instead, relying on the earlier detailed impacts analyses, this part will discuss the combined impacts which can be expected from implementing these alternatives together and their interactions. These combined impacts could enhance or alter the impacts considered for each individual Preferred Alternative.

A. Natural Resources Section

The biological and ecological impacts that are anticipated to occur from the combination of Refuge Management Alternative D and Refuge Boundary Expansion Alternative C are discussed in this section by resource category.

1. Impacts to Air Quality

The predominant impact to air quality from USFWS management activities on the Refuge Complex and newly acquired lands would be from prescribed burning. Prescribed burning results in temporary, localized decreases in air quality by exposing local residents to low concentrations of smoke for short periods of time

Prescribed burning would be maintained at 12,000 - 15,000 acres annually in emergent marsh habitats on the current Refuge Complex. Burning would be conducted from late September to late November with limited burning in summer. Prescribed burning may slightly increase with the addition of limited summer burning to the current limited spring burning in prairie habitats to control invasive species. Increasing the total Refuge Complex acreage by about 60 percent would add over 29,000 additional acres of marsh, where burning has likely been conducted historically to support grazing and hunting operations, and on about 32,000 acres of prairie, which has been mostly subject to annual burning for grazing unless forage was greatly reduced by grazing. Prescribed burning by the USFWS on newly acquired prairie acreage may initially increase to move vegetation toward desired habitats, but would be greatly reduced on prairies over time as prairie burning would be primarily for maintenance of control invasive and exotic vegetation. Initially, prescribed burning on newly acquired lands may increase in marsh habitats requiring restoration, but the transition from an annual to a 2- or 3-year rotational maintenance schedule after areas are restored would reduce the amount of area burned concurrently and, therefore, annual concentrations of emissions would be reduced in the long-term.

Although temporary, localized decreases in air quality and increases in particulate matter would continue to occur during USFWS prescribed burning events, strict adherence to established prescriptions and monitoring and smoke management protocols by the USFWS would decrease overall adverse impacts to air quality in the project area.

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.

The USFWS has been implementing shoreline protection and restoration activities on the Refuge Complex to address erosion and resulting wetland loss along shorelines and would increase restoration efforts on existing and newly acquired shorelines under the Preferred Alternatives. Approximately 68,000 linear feet of additional Gulf and bay shorelines under Refuge Boundary Expansion Alternative C have been subject to the same influences. The combination of increased shoreline erosion abatement (off-shore rock wavebreaks and breakwaters) in addition to vegetation management over a larger contiguous area would likely reduce shoreline erosion across the newly expanded Refuge Complex.

Under USFWS ownership of contiguous Gulf and bay shoreline, protection and restoration efforts would be more effective and protect larger contiguous areas. The USFWS would construct additional off-shore wavebreaks and shoreline armoring and restore additional dunes. Increasing emergent marsh plantings would further reduce wave erosion and increase sedimentation rates within vegetation stands. Reduction of saltwater intrusion and active management of water levels would benefit emergent marshes in

freshwater to brackish water areas by preventing conversion to open water habitat, reducing organic matter oxidation, and contributing to organic matter accretion that would contribute to a gain of land elevation. Coordination would increase between the USFWS and other agencies to implement large-scale projects to restore barrier beaches and dunes, beneficially use dredge materials, and develop and implement long-term inter-jurisdictional strategies to reduce erosion and wetland loss along the Gulf of Mexico, East Galveston Bay, and the GIWW. Increased dune restoration activities and the use of dredged material would increase contributions to sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994).

USFWS vegetation management activities, such as rotational prescribed burning and water management (including salinity management), would also improve soil stability, and may contribute to soil formation and elevation gain in marsh habitats. Increased monitoring of shoreline erosion, wetland loss, marsh accretion rates and effects of relative sea level rise on a newly expanded Refuge Complex would provide additional information on the effectiveness of various management approaches, allowing for real-time adjustments and evaluation of effectiveness for future applications.

3. Impacts to Hydrology and Water Quality

Modifications to the natural hydrologic regimes of the coastal marshes in the Chenier Plain region have resulted in saltwater intrusion, reduced or restricted freshwater inflows, and altered hydroperiods (wetting and drying cycles), which in some cases contributed to a net loss of emergent wetlands (Moulton *et al.* 1997). Due to the extensive changes to the natural hydrological conditions of the landscape throughout the area, management actions are required to restore and maintain biological integrity and biological diversity.

Under the combined Preferred Alternatives, the USFWS would expand coordination with other state and federal agencies to assess the feasibility of watershed-scale hydrologic restoration projects, which would be aimed at protecting and restoring coastal marsh habitat by reducing saltwater intrusion, increasing freshwater and sediment inflows, and maintaining natural marsh hydroperiods. Across the newly expanded Complex, existing water rights would be amended (and additional rights acquired, if possible) to facilitate increasing freshwater inflows, water management infrastructure would be enhanced and expanded, and barriers would be removed to restore marsh hydrology. Approximately 29,000 acres of newly acquired marsh areas, some of which may not have been managed to protect biological diversity, would receive attention under USFWS management. As a result, improving hydrological conditions over the newly expanded Refuge Complex would considerably improve the overall benefits intended with these management actions.

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Potential Impacts to water quality in the project area include fertilizer and pesticides used in agricultural practices, accidental releases of petroleum and petrochemical products, and non-point source pollution from storm run-off. Under USFWS management of newly acquired lands, herbicide use to control exotic and invasive plant species could increase initially but would decrease over time as sites are restored and IPM strategies combining chemical use with prescribed burning, mechanical removal, and controlled grazing are implemented. The USFWS would limit the types and amounts of herbicides and pesticides used for rice farming and would seek to increase the use of organic farming on newly acquired lands (given there are willing participants). Increased water quality monitoring on the Refuge Complex and in newly acquired areas would help identify and alleviate threats to fish and wildlife from contaminants.

4. Impacts to Vegetation and Habitats

Greater than 500 plant species occur on the Refuge Complex due to the diversity of soil types and ecological communities. Vegetation is heavily influenced by saltwater in the Gulf of Mexico or inland bays. Overbank flooding happens often enough that 77 percent of the Refuge Complex is composed of salt tolerant species. Vegetative habitats of the Refuge Complex primarily consist of marshes, prairie (non-saline and saline); coastal woodlands; and beaches, ridges, and dunes. Emergent marsh is the most prominent vegetative type on the Refuge Complex and within the area under Refuge Boundary Expansion C. Marshes comprise a continuum of wetlands based on salinity gradients from fresh,

intermediate, brackish, and saline marsh. Remnant prairie habitats are generally inland of coastal marsh habitat and located on drier upland sites such as coastal ridge, elevated flats, and short, steep, natural levees. Upland forest habitat or coastal woodlots generally occur on higher elevation uplands. Beach habitat includes dunes that are above mean high tide, although in this region the dune system is not extensive. The complete range of vegetation types is critically important to the region's biological diversity.

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

a. Impacts from Habitat Management / Restoration Activities

USFWS management activities would be expanded on existing acreage and into newly acquired areas, thereby increasing overall benefits to the health of the habitats and dependent wildlife. Habitat management activities (including water management, prescribed burning, and controlled grazing) for waterfowl, shorebirds, and other wetland-dependent migratory birds would be refined and expanded through development of new infrastructure. To the extent feasible and appropriate, many of the management actions would be integrated for maximum benefit to the environment across the expanded Refuge Complex. Importantly, the over 64,000 acres of marsh, prairie, coastal woodlands, and beaches, ridges, and dunes added to the Refuge Complex would be protected from development in perpetuity under USFWS management. In addition, the USFWS would implement an integrated management approach across a larger area. As a result, a continuum of diverse habitats and landscape mosaics would be achieved in the long-term.

(1). Wetland Specific Management and Restoration

(a). Water management

Across the newly expanded Refuge Complex under the two Preferred Alternatives, the USFWS would increase efforts to restore natural hydrology by ensuring adequate freshwater inflows and reducing saltwater intrusion through expanded interagency coordination, enhancing water management infrastructure, and acquiring additional water rights. Water management activities over a larger area would protect and enhance wetland habitats by maintaining diverse and productive emergent and submergent plant communities and a diverse mosaic of these communities. Approximately 39,000 acres of coastal wetlands (or 90 percent of wetlands in the newly acquired areas) recognized to be nationally declining wetland types by the National Wetlands Inventory would be protected in perpetuity.

(b). Moist Soil Management

Moist soil management would be increased on the Refuge Complex and substantially increased on newly acquired lands under the combined Preferred Alternatives.

Expanded moist soil management activities over a larger area would provide important additional freshwater wetland habitat for waterfowl, shorebirds, wading birds and other wetland-dependent fish and wildlife. Expanded moist soil management would increase biological diversity, as moist soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Water management and mechanical soil manipulations in new moist soil units would promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and

purple ammenia. Additional moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime would favor the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus. A substantial number and acreage of natural prairie pothole wetlands that were previously drained would be restored on newly acquired lands. In combination, management efforts would increase the amount of freshwater prairie wetland habitat across existing Refuge Complex lands and newly acquired areas.

(c). Cooperative Rice Farming Program

Conversion of native habitats to rice and livestock production has occurred on most lands that would support these uses in the project area. Rice farming provides an important food source and cover to a diversity of wetland-dependent resident and migratory birds and wildlife. Rice and grain production creates forage for waterfowl, spring habitat for migrating shorebirds, and summer water for breeding and brood-rearing habitat for Mottled Ducks. However, rice production has declined during the last decade in counties surrounding the Refuge Complex.

Under the combined Preferred Alternatives, the USFWS would administer its cooperative rice farming program over a larger area. Areas that are currently cropped and in the USDA farm program would remain in production under the USFWS cooperative farming program (assuming willing participants are available). Other formerly cropped areas would be restored to native prairie or moist soil units over time. Areas acquired would include 3,506 acres currently enrolled as base acreage for rice in the USDA farm program. However, only an average of 421 these acres have been actively cropped in recent years. In addition, USFWS will work with farmers participating in the program to increase the percentage of acreage that is organically farmed. Overall, the USFWS cooperative rice farming program under the two Preferred Alternatives on the expanded Refuge Complex would provide additional freshwater wetlands with high food value for migratory and resident waterfowl and other migratory birds.

(2). Upland Specific Management and Restoration

(a). Native Prairie Management and Restoration

Native coastal prairie is perhaps the most threatened habitat component of the western Gulf of Mexico coastal region. Under the two Preferred Alternatives, prairie management and restoration programs would be expanded on the Refuge Complex and newly acquired areas, with increased monitoring and research to assess management and restoration activities. Approximately 5,744 acres of non-saline prairie habitats on the existing Refuge Complex and over 32,000 acres of prairie habitats on newly acquired lands would be improved under the combined Alternatives over the long-term through application of prescribed burning, controlled grazing, exotic and invasive species management, and restoration using intensive restoration techniques. This would result in restoration of biological diversity and biological integrity in this highly threatened coastal prairie 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. These actions will also help ensure the availability of viable native prairie plant seed sources and sources of plant material necessary to ensure the survival of this habitat.

(b) Woodlot Protection and Restoration

Although comprising a small percentage of the upland habitats on the n the project area, coastal woodlots help support a diverse avian community which includes several sensitive songbird species. Under the combined Preferred Alternatives, 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.

Overall, implementation of the USFWS management actions discussed above on the expanded Refuge Complex would protect and enhance coastal woodlot 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

(a). Fire Management - Prescribed Burning and Wildland Fire Suppression

Natural fire and herbivory by native species now occur less frequently or at reduced levels due to human influences on the ecosystem. Lack of disturbance in this coastal ecosystem typically results in reduced biological diversity and productivity, as plant communities over large areas trend toward climax successional stages. Reduced plant community diversity results in poor quality habitat for migratory birds and other native fish and wildlife. Under the combined Preferred Alternatives, a rotational prescribed burning program would be maintained on the expanded Refuge Complex acreage to maximize the benefits of integrated burning/grazing/water management programs for manipulating wildlife habitat and to provide a mosaic of native plant communities. Suppression of wildfires by the USFWS would continue to consider protection of public and staff safety, property and natural resources.

Short- and long-term ecological fire effects monitoring would be used to guide an adaptive approach to implementing the program, which includes burning to stimulate native warm season grasses or delaying burning to allow seed production. Monitoring and adaptive management would be used to reduce potential negative impacts such as destruction of desirable vegetation and organic matter and wildlife mortality. In addition, ongoing and new research studies would be supported to determine fire effects on marsh accretion, soils, vegetation, and wildlife. Overall, the USFWS prescribed burning program would restore and maintain biological diversity in the long-term on approximately 61,000 acquired acres of marsh and prairie.

(b). Controlled Livestock Grazing

Under the combined Preferred Alternatives, the USFWS would use controlled grazing on the Refuge Complex and 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.

The controlled grazing program would be modified in selected marsh units across the expanded Complex to achieve desired habitat conditions. Grazing units would be reconfigured through additional fencing and development of additional watering sites to increase the effectiveness and efficiency of the controlled grazing program across the newly expanded Complex and protect sensitive habitats, such as woodlots. These modifications in combination with an adaptive management approach are also expected to reduce negative aspects of cattle grazing including excessive vegetation trampling, compaction of soils, reduced percolation rates, deposition of nutrients from feces in areas where livestock concentrate, and overgrazing.

(c). Exotic / Invasive Species Management

Under the combined Preferred Alternatives, the USFWS would expand the scope of exotic and invasive species management activities on the Refuge Complex and 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

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. 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.

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.

(d). Shoreline Protection and Restoration

Under the combined Preferred Alternatives, 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 the expanded Refuge Complex. Along the Gulf shoreline, 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 systems and increased use of dredged material 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 under the combined Preferred Alternatives 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 the combined Preferred Alternatives, the USFWS would continue to utilize mowing and haying in upland grassland habitats.. 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.

b. Impacts from Public Use Programs

Under the combined Preferred Alternatives, the USFWS would provide enhanced public use programs on the existing Refuge Complex and on newly acquired lands. New opportunities for wildlife-dependent uses including hunting, fishing, wildlife observation and photography and environmental education and interpretation would be available to the public at large on the expanded Refuge Complex. Public use activities on the expanded Refuge Complex potentially could impact habitats, but management of these uses by the USFWS will minimize these affects such that the uses remain compatible with refuge establishment purposes and the National Wildlife Refuge System mission.

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

Under the combined Preferred Alternatives, the UFWS would enhance GIS capabilities and other monitoring and research activities to help monitor habitat changes and assess management actions on the expanded Refuge Complex. Enhanced monitoring tools would improve the ability of Refuge Complex staff to track habitat conditions and adapt management strategies to provide the most benefit to this habitat. Working with partners to study the impacts of relative sea level rise and to assist in addressing these impacts would be a focus for the USFWS.

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

Lands on the expanded Refuge Complex would be subject to exploration and development of reserved and outstanding mineral interests. Under the combined Preferred Alternatives, the USFWS would continue to manage oil and gas exploration and development activities 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 to habitats from these activities.

e. Impacts from Community Outreach and Partnerships

Under the combined Preferred Alternatives, the USFWS would continue to work with private landowners in the project area to restore and enhance wetland and upland habitats on their properties. The USFWS would also expand partnerships with local communities, agencies, conservation organization, volunteers and other stakeholders, resulting in enhanced and more effective fish, wildlife and habitat conservation on the expanded Refuge Complex and throughout the project area.

5. Impacts to Fish and Wildlife Resources

The greatest benefit to wildlife populations and habitat under USFWS management is protection from development in perpetuity. Under the combined Preferred Alternatives, an integrated approach to wildlife and wildlife habitat management would be employed across the expanded Refuge Complex to maximize benefits for diverse fish and wildlife communities.

USFWS habitat management activities, wildlife species-specific management activities, and other USFWS programs under the combined Preferred Alternatives would have impacts on the fish and wildlife resources. This section will discuss the impacts from USFWS activities and programs on the following categories of fish and wildlife:

- Migrating and Wintering Waterfowl
- Resident Waterfowl - Mottled Ducks
- Shorebirds, Wading Birds, and other marsh and waterbirds
- Landbirds
- Fisheries Resources
- Threatened and Endangered Species
- Other Fish and Wildlife Species - Mammals, Reptiles, Amphibians, and Invertebrates

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

(a). Wetland Specific Management and Restoration

Wetland management and restoration implemented by the USFWS on the expanded Refuge Complex 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. Increased active management of water levels and salinities (utilizing water control structures, levees, impoundments) in managed marsh units would allow for improved protection of coastal marshes, which would increase abundance of plant species preferred by wintering and migrating waterfowl for food in brackish marshes (Chabreck 1976, Broome *et al.* 1995). Moist soil management acreage would increase across the expanded Refuge Complex, thereby providing additional habitat for wintering and migrating waterfowl. Maintaining rice production (assuming willing participants are available) on existing and acquired areas that are currently cropped and in the USDA farm program would provide valuable habitat for wintering and migrating waterfowl, shorebirds and other wetland-dependent migratory birds (Czech and Parsons 2002).

(b). General Habitat Management and Restoration Activities

Under the combined Preferred Alternatives, the USFWS would apply integrated prescribed burning, grazing and water management programs on the expanded Refuge Complex to promote of growth of target plant communities and overall habitat conditions which provide high quality habitat for waterfowl.

Expanded shoreline protection and restoration activities (i.e., shoreline armoring, plantings, and dune and marsh restoration) across existing and newly acquired shorelines on the Refuge Complex would protect and enhance coastal habitats important to waterfowl.

The USFWS would expand control programs for invasive plant species in marsh habitats on the newly expanded Refuge Complex (e.g., common reed, cattail, and California bulrush), which would allow better growth of submerged aquatics that are valuable food for waterfowl. Exotic/invasive species control activities would be intensified and permanently fallowed rice fields, which have been invaded by Chinese tallow, would also be controlled under USFWS ownership, thereby indirectly benefiting waterfowl.

(2). Impacts to Resident Waterfowl – Mottled Ducks

Mottled Ducks are year-round residents of the Texas Chenier Plain region. This species prefers fresh and slightly brackish marshes (Gosselink *et al.* 1979), although a variety of marsh habitats, prairie, and rice fields are used for nesting. Stutzenbaker (1988) reports that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include agriculture, urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988), as well as increased pollutants (Cain 1988). The recent substantial decline in rice agriculture on the Texas Coast has significantly reduced wetland habitat important to Mottled Ducks. 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).

Under the combined Preferred Alternatives, 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 the expanded Refuge Complex 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 “sennabeen ponds,” as valuable brood rearing habitat.

Under the combined Preferred Alternatives, native prairie restoration and management activities 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 Alternative C (Preferred Alternative) has great potential to provide high quality nesting and brood-rearing habitat for this species. 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 the combined Preferred Alternatives, 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 of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the expanded Refuge Complex 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 the expanded Refuge Complex to 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). 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.

(b). Uplands Management and Restoration

Under the combined Preferred Alternatives, 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 the combined Preferred Alternatives, the USFWS would conduct prescribed burning, controlled grazing, and exotic/invasive species management, and shoreline protection and restoration activities on the expanded Refuge Complex. 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. 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.

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.

(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 the expanded Refuge Complex under the combined Preferred Alternatives 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 and coastal woodlots 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 the expanded Refuge Complex. 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

Under the combined Preferred Alternatives, the USFWS would manage and restore native prairie habitats and adjacent fallowed agricultural lands on the expanded Refuge Complex 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.

The native coastal prairie habitats within the proposed refuge boundary expansion area under Refuge Boundary Expansion Alternative C (Preferred Alternative) has great potential to provide high quality wintering and nesting habitat for several grassland songbird species. 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 Sharp-tailed Sparrow, and nesting habitat for species including Dickcissel 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 Sharp-tailed Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under the combined Preferred Alternatives 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.

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).

Under the combined Preferred Alternatives, 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. Overall, implementation of the USFWS management activities on the expanded Refuge Complex 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. 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 the expanded Refuge Complex. The integrated combination of

water level and salinity management, fire management and controlled livestock grazing would enhance wetland and upland habitats used by many landbird 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.

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

(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 the combined Preferred Alternatives, protection, restoration and management of coastal wetland habitats on the expanded Refuge Complex would benefit the three avian T&E species. Bald eagles 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 the combined

Preferred Alternatives 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

In general, USFWS habitat management and restoration activities on the expanded Refuge Complex which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species, including mammals, reptiles and amphibians, and invertebrates. USFWS management activities 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. Many reptiles and amphibians provide prey for mammalian predators.

b. Impacts from Public Use Programs

Under the combined Preferred Alternatives, the USFWS would provide enhanced public use programs on the existing Refuge Complex and on newly acquired lands. New opportunities for wildlife-dependent uses including hunting, fishing, wildlife observation and photography and environmental education and interpretation would be available to the public at large on the expanded Refuge Complex. Public use activities on the expanded Refuge Complex potentially could impact fish and wildlife resources, but management of these uses by the USFWS will minimize these affects such that the uses remain compatible with refuge establishment purposes and the National Wildlife Refuge System mission.

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

Under the combined Preferred Alternatives, the USFWS would expand biological program activities across the expanded Refuge Complex. New surveys, monitoring and research activities across the expanded Refuge Complex would increase the ability of the USFWS to improve and expand existing management activities for priority fish and wildlife species, such as waterfowl, shorebirds, wading birds and other marsh birds, and landbirds identified as needing conservation action.

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

Lands on the expanded Refuge Complex would be subject to exploration and development of reserved and outstanding mineral interests. Under the combined Preferred Alternatives, the USFWS would continue to manage oil and gas exploration and development activities 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 to fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnerships

Under the combined Preferred Alternatives, the USFWS would continue to work with private landowners in the project area to restore and enhance wetland and upland habitats on their properties. The USFWS would also expand partnerships with local communities, agencies, conservation organization, volunteers and other stakeholders, resulting in enhanced and more effective fish, wildlife and habitat conservation on the expanded Refuge Complex and throughout the project area. .

B. Socioeconomic Resources Section

1. Economic Impacts

a. Impacts from Changes in Land Use

Economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy. These impacts occur as a result of some economic stimulus such as expenditures made by the USFWS to manage operations at the Refuge Complex or expenditures made by recreationalists visiting the area. These direct expenditures create additional economic activity (indirect and induced impacts) as re-spending of the direct expenditures occurs. The combined impacts associated with the management and expansion of the Refuge Complex are discussed in this section. One potential stimulus that could lead to economic impacts associated with expansion and management of the Refuge Complex is a change in land use. The greatest changes in land use will occur in the acquisition area where USFWS will focus management activities that maximize benefits to wildlife. However, land use will also change in minor ways on the existing Refuge Complex as the USFWS adapts management to changing wildlife needs.

The following section discusses the potential socioeconomic impacts associated with changes in the following land uses.

(1). Rice Farming

A number of acres in Refuge Boundary Expansion Alternative C (Preferred Alternative) within Chambers and Jefferson Counties are in the USDA farm program as farm 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 intends to extend their cooperative farming program to acquired acreage that is currently in rice production due to the benefits this management action has for migratory birds. The USFWS will not attempt to convert previously farmed areas to rice production due to the cost associated with restoring water delivery infrastructure and removal of Chinese tallow and other exotic and invasive plant species. The success of this program will depend largely on the availability of farmers willing to work within the guidelines of the cooperative farming program. Overall market conditions will also drive the desire to participate in this program. The USFWS will manage other formerly cropped areas as native prairie or moist soil units. In both areas, the USFWS will use grazing to help achieve wildlife habitat objectives.

(a). Changes in Agricultural Support Programs

Changes in land ownership from private to public could cause economic impacts through a reduction in farm support programs currently available in the study area. This is most relevant for areas historically important for rice production. The USFWS currently manages a cooperative farm program with approximately 1,700 base acres registered with the Farm Service Agency. As such, producers that participate within the cooperative program are eligible for farm support programs. Acquisition of additional acreage by the USFWS, which contains base acreage, would also be eligible for farm support programs through the FSA (USDA 2004). However, while private landowners are able to collect payments even if acreage is not currently in rice production, the same is not true for acreage owned by the USFWS. For these areas, cooperative farmers, contracted by the USFWS, must be producing rice and performing approved maintenance on the allotted base acreage to receive payments.

As discussed earlier, the USFWS would extend the cooperative farming program for acreage that is currently in production. However, base acreage that is not currently in rice production would be restored to native prairie or moist soil units and thus would not be eligible for support payments. It is thus likely that impacts could occur within the study area from a reduction in farm support due to a change in land ownership. Two programs are of most interest in this situation, include: 1) direct payments, and 2) counter cyclical payments.

An estimate of the direct and counter cyclical payments that could be impacted by expanding the Refuge Complex is summarized in Table 4-62. The payments summarized in this table represent an upper bound estimate of the possible losses in direct and counter-cyclical payments if the USFWS were to acquire all historically cropped acreage within the refuge boundary expansion area. It is likely that losses would not approach these upper end estimates because 12 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 to the USFWS.

Table 4-62
Estimated Impacts To Farm Support Programs

Refuge	Impacted Acreage	Direct Payments	Counter-Cyclical Payments
Anahuac NWR	13,730	\$371,435	\$263,652
McFaddin NWR	3,506	\$36,161	\$25,668
Texas Point NWR	0	\$0	\$0
Moody NWR	0	\$0	\$0
		\$407,596	\$289,319

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.

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 spending, total direct payments for the study area were run through the household sector in IMPLAN that corresponds to Jefferson and Chambers counties.

The analysis indicated that the farm support programs provide an additional \$175,000 in income and support seven jobs in the regional economy. It is possible that this additional economic activity could be lost 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 used the maximum payment available for the counter-cyclical program and thus represents the greatest impact if these payments were eliminated. If average prices receive 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 USFWS cooperative farm program and would be eligible for these farm programs.

There may be additional economic impacts that may occur if the USFWS were to acquire croplands within the acquisition boundary. 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. Therefore, it is possible that some acreage could be taken out of production with a change in land ownership. However, declines to the rice industry are likely to continue following recent trends with or without the land acquisition program due to several factors (Childs 2003) including:

- 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 greater impact than those expected to occur due to the Refuge Boundary Expansion and subsequent land acquisition proposed by the USFWS.

(2). Grazing

Much of the acreage within the Refuge Boundary Expansion Preferred Alternative is currently used for grazing operations in natural or improved pastures. This land includes marsh, upland prairies, woodlots, and formerly cropped areas. The USFWS is expected to continue to utilize grazing on the expanded Refuge Complex as a habitat management tool. Stocking rates, duration and season of use may change under USFWS ownership. Grazing permittees would be required to rotate livestock more frequently than is now occurring on private lands.

b. Impacts from USFWS Operations

Current operations at the Refuge Complex provide economic stimulus to the local economy. The largest economic contribution results from the direct expenditures made by the USFWS to support operations. These operations currently support approximately 45 FTEs per year of which 30 positions are directly employed by the USFWS. Current operations generate approximately \$1.2 million in income and nearly \$450,000 in indirect business taxes to local government entities. Agricultural activities managed as compatible refuge economic uses currently supported on the Refuge Complex support approximately 20 FTEs per year, \$859,000 in annual income and \$87,000 in indirect business taxes. Recreational activities also generate economic activity in the regional economy by supporting approximately 25 FTEs, and generating \$883,000 in annual income and \$136,000 in indirect business taxes.

Expanding operations at the Refuge Complex under the combined Preferred Alternatives are expected to cause increases in regional employment and income. This would be the result of an increase in expenditures associated with the Refuge Complex including increased staff levels, new construction projects and increased activities associated with expanding habitat restoration and management. In addition, management activities are expected to increase recreational activities at the Refuge Complex which will have a positive impact on employment and income. Slight increases are also expected to occur as a result of an increase in AUMs for the controlled grazing program.

Expansion and management of the Refuge Complex is expected to have some impacts on local area employment. However, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population. In addition, changes in land ownership are not expected to have significant impacts on population in the study area.

2. Impacts to Hunting and Commercial Hunting Operations

Lands acquired under the Preferred Refuge Boundary Expansion Alternative would most likely be purchased with Federal Migratory Bird Conservation Stamp (Duck Stamp) funds and subject to the regulations of the Migratory Bird Hunting and Conservation Stamp Act, as amended. According to restrictions under the Act, a maximum of 40 percent of the total land area of each refuge could be opened for hunting. The USFWS has traditionally strived to maximize areas open to hunting at or near the 40 percent maximum on the Refuge Complex..

Expansion of the Refuge Complex through 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. There are indications that local commercial hunting operations and their employed 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, the additional

areas opened to hunting on the expanded Refuge Complex would provide additional hunting opportunities for the public at large

3. Fiscal Impacts to Local Governments

Activities at the Refuge Complex could cause impacts to local government services in various ways. For instance, changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). Alternatively, changes in land ownership could impact the tax base in the local area which can affect various taxing districts. It is thus likely that the expansion and management of the Refuge Complex will have some fiscal implications to local government jurisdictions. This includes impacts to revenues as well as expenditures. The activities are expected to impact revenues in two ways. First, activities associated directly or indirectly with Refuge Complex operations are expected to generate over \$9 million in indirect business taxes over the fifteen-year study period, which include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses for government entities (e.g. county and state) (MIG 2000).

In addition, property taxes are expected to decrease if the USFWS expands the Refuge Complex with additional land acquisitions. Removing 67,565 acres from the tax rolls has the potential to reduce tax revenues to all districts by a total of \$99,054, annually. 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. This analysis does not include the fact that annual Refuge Revenue Sharing payments are made by the USFWS to the affected counties. 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. 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.

4. Impacts on Social Conditions

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.

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 expansion and management of the Refuge Complex 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 the expanded Refuge Complex 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 in the Chenier Plain area were identified in Chapter 3, Affected Environment. These stakeholder group categories would continue to adequately describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole.

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

Landowners – Those landowners who would be most directly affected by the combined Preferred Alternatives would be those who have the opportunity and choose to sell their land to the USFWS. There could be some level of animosity or negative feeling against those selling land to the USFWS from those persons not supporting USFWS land expansion actions.

Recreationalists – The lands and waters of the region have a rich heritage of public commercial recreational activity. While recreation plays an important part in the economy of the area, outdoor recreation opportunities are also a traditional and substantial part of the social structure and lifestyles of the area. The USFWS is constantly struggling to balance recreational opportunities with its goal of protecting natural resources. Under the combined Preferred Alternatives, this struggle would continue. There would continue to be major disagreement within the nearby population over the proper amount, locations, and access to recreational resources within the expanded Refuge Complex. Other recreationalists would be highly supportive of USFWS public use programs.

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

Businesspersons and / or Business Owners – As with current conditions, businesspersons and/or business owners would generally have economic development and growth as major future goals that could conflict with USFWS expansion and management of the Refuge Complex. Many persons supporting economic growth as a high priority may continue to be frustrated with USFWS actions that could be perceived as limiting or preventing economic growth. Some business persons/business owners would support expanded USFWS activities in recognition that these activities could bring an expanded visitor base to the area, with the resulting expansion of the ecotourism industry providing economic benefits to at least some portion of local and regional business.

Conservation or Environmental Protection Advocates – Those supporting conservation of natural resources and environmental protection would generally be pleased with an expanded level of USFWS activity and land holdings. For many of these persons, having more land in USFWS control would generally mean a higher level of environmental protection for lands which could be considered “at risk” because of potentially conflicting land uses or misuse of land under private control. However, there would also continue to be instances where conservationists/environmental protection advocates may believe that the USFWS is not doing enough to preserve or protect natural resources within the Refuge Complex.

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 the combined Preferred Alternatives, 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.

C. Combined 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. According to 36 CFR 800, Protection of Historic and Cultural Properties, any undertaking which may result in alteration to features of a property’s location, setting, or use may constitute an impact depending on a property’s significant characteristics. Adverse impacts can occur when prehistoric or historic archaeological sites, structures, or objects listed in or eligible for listing in the National Register for Historic Properties (NRHP) are subjected to the following:

- Physical destruction or alteration of all or part of the property
- Isolation of the property or alteration of the property’s setting when that character contributes to the property’s qualification for the NRHP
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting
- Neglect of a property, resulting in its deterioration or destruction
- Transfer, lease, or sale of the property

Impacts would only be considered adverse if a site is listed, eligible, or potentially eligible for the NHRP. Sites that have not been assigned an NHRP status may experience impacts under the alternatives, but would not experience adverse impacts. In the following discussion, management and land acquisition alternatives are analyzed for adverse impacts to the following sensitive cultural items:

- Six potentially NHRP eligible midden sites on the existing McFaddin, Anahuac, and Moody NWRs.
- One NHRP eligible midden site in the Preferred Refuge Boundary Expansion area near East Bay Bayou.
- The historic shipwreck site in the potential expansion area near Texas Point NWR.

There is a potential for direct and indirect impacts to cultural sites on existing and newly acquired acreage under the combined Preferred Alternatives, however, avoidable impacts would not be considered adverse, but rather minor in nature. Unavoidable adverse impacts are anticipated to continue to occur at potentially eligible sites from natural phenomenon.

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 Alternative C (Preferred Alternative). 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 provide additional protections not afforded to the sites on private lands. Federal acquisition would provide additional protections under NHPA, the Archaeological Resources Protection Act (ARPA), associated regulations, and agency policies for implementing the regulations not afforded to cultural sites on private lands. Section 106 and Section 110 of NHPA set forth the primary consultation requirements for Federal agencies to identify, evaluate, and protect significant cultural resources. ARPA protects archaeological materials on public lands from unauthorized removal or destruction and requires Federal land managers to develop plans and schedules to locate the most scientifically important archaeological sites. ARPA also allows the Federal land managers to issue permits for the excavation or recovery of archaeological resources and sets penalties and fines for destruction, defacement, or unauthorized removal of archaeological resources from Federal lands. Private lands acquired would also be subject to the actions and impacts identified for the management alternatives on existing Complex lands.

Impacts to cultural resources would include the following:

- **Natural Phenomenon** - Natural impacts, including inundation, wind/water/wave erosion, subsidence, tree bioturbation, and animal burrowing, poses the greatest threat to shell middens. Due to the marshy, undeveloped nature of the newly expanded Complex and location of the shell middens along shorelines, full protection of the shell middens is not feasible without completely altering the site or removing the material from its context. Inundation of many of the sites has already occurred and the unavoidable adverse impacts are highly likely to continue. The eligible McFaddin beach site is already inundated by the naturally altered coastline and is subject to water erosion and loss of material. Cultural resource management actions are not proposed for the shell midden sites under the proposed management. Natural impacts would continue to occur to the known cultural sites on existing and acquired areas; however, additional protections may be indirectly afforded to the sites under the combined Preferred Alternatives if water control projects extend to newly acquired lands. The potentially eligible shipwreck that would be acquired 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.
- **Shoreline protection** - Existing and proposed shoreline protection projects and water control structures under the combined Preferred Alternatives would reduce wave fetch and intensity of wave action. Shoreline protection projects under the Section 227 National Shoreline Erosion Demonstration Project may indirectly benefit shoreline sites by reducing wave intensity. Offshore wave breaks may also reduce wave action at the McFaddin Beach site. Maintenance of existing shoreline protection projects and water control infrastructure as well as additional water control projects under the combined Preferred Alternatives may result in the identification of additional cultural resources sites and better protection of the sites from wave action. Because water control and facilities construction and improvements would be expanded, cultural resources may indirectly benefit on existing and newly acquired acreage.
- **Ground disturbing activities** - Ground disturbing activities, including facilities construction, road construction, ditch digging, oil and gas activities, and water control projects (such as levee construction, repair, or removal), would be subject to a ground survey and consultation requirements with the State Historic Preservation Officer (SHPO) under the NHPA Section 106 regulations. Privately initiated oil and gas activities create the most ground disturbance in the Complex with road, pipeline, and well pad construction. Any dredge or fill projects in the Refuge

Complex would be proposed and conducted by the U.S. Army Corps of Engineers. Shoreline protection projects would be subject the Section 106 process and potential impacts to the NHRP eligible sites. All ground-disturbing activities, whether initiated by the USFWS or other entities, would be subject to restrictions imposed on newly expanded Complex lands and consultation with the SHPO under Section 106 regulations. The potential for any ground-disturbing activities to impact known sites or undiscovered sites would be identified and resolved appropriately through the Section 106 process. Known cultural sites on federally acquired lands would be afforded additional protections from ground-disturbing activities through the Section 106 process. 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 Section 106 process may reveal more cultural sites previously undiscovered in private ownership and provide protection as appropriate.

- **Prescribed Burning** - The burn intensity of fires may affect archaeological and historical resources. Low-intensity burns are usually associated with lightly burned grasslands during prescribed burns. Low-intensity burns are not anticipated to affect cultural resources, but may cover the resources in soot. High-intensity burns are typically associated with wildfires in dry areas that have abundant litter accumulation due to unnatural fire suppression. High-intensity fires may char or consume cultural resources leading to a potential impact. There is very little likelihood of a high-intensity fire occurring since the Refuge Complex is primarily wet, has high soil moisture content, and was subject to burning by Native Americans, present-day natural resource managers, and lightning-ignited fires. According to the Refuge Complex Fire Management Plan (USFWS 2001), wildland fires on the Refuge Complex are rarely controlled with suppression tactics, firebreaks, or chemical retardants, which are only used sparingly if necessary to protect life and/or property. Natural wildfires are suppressed when they threaten Refuge Complex facilities, adjacent private property, and/or public health and safety. Rotational prescribed burning considered under the combined Preferred Alternatives would reduce the potential for damage to cultural resources from intense wildfires across the expanded Refuge Complex. The cultural sites on newly acquired lands may be subject to prescribed burning 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, and may reduce fuel loads that produce higher intensity fires that threaten the integrity of cultural items.
- **Cattle grazing** - Cattle grazing may damage cultural resources by inadvertent tromping. Some of the shell midden sites recorded have already experienced damage by cattle.. Cattle on the Refuge Complex typically feed as they disperse in the wet areas and congregate on higher, dry grounds, which typically include manmade dikes or berms. Shell middens are typically associated with undisturbed, wet areas and may be subject to occasional tromping from the dispersed cattle; however, damage by cattle is not likely to be exceeded by damage through natural erosion. The cultural sites on newly acquired lands may be subject to grazing that may or may not have occurred previously in those areas. The potential for inadvertent cattle tromping is likely to remain on acquired lands slated for grazing.
- **Recreation use** - Recreation visitors and activities may inadvertently damage cultural sites; however, recreation access in the Complex is highly limited by the under-developed character of the area. Recreation activities are limited to Anahuac, McFaddin, and Texas Point NWRs. Bird and wildlife observation, fishing, and hunting would continue under proposed management and typically occur in previously disturbed areas. Minor improvements to recreation access, such as trails and boat launches would be constructed under the combined Preferred Alternatives, and would be subject to ground truthing for cultural items before disturbance. Wildlife observation is typically limited to easily accessible areas that comprise a small portion of Refuge Complex lands, where existing shell midden sites are typically not found. Fishing and hunting

recreationalists may reach more remote areas by boat. Most of the recreational boat traffic occurs on the interconnected manmade bayous, ditches, and water delivery systems that have already been modified from their original landforms through straightening and dredging before the Complex was created. Impacts to shell middens from wake action created by smaller fishing boats in the Refuge Complex is likely to be minor since airboats are not allowed and motor sizes are regulated. Continuing and expanding public interpretation and education programs under the combined Preferred Alternatives may indirectly lead to improved public appreciation and awareness of the Complex lands and resources contained therein. The cultural sites on newly acquired lands may be subject to recreation that may or may not have occurred previously in those areas. 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.

D. Summary of Combined Impacts

Overall, positive impacts to the newly expanded Refuge Complex are expected under the combined Preferred Alternatives. In general, the USFWS would maintain a mosaic of native habitat types to support diverse and productive plant and animal communities on the expanded Refuge Complex. Acquired lands would remain undeveloped and would be managed with the existing refuge lands to restore and maintain biological integrity, biological diversity and environmental health

Under the Preferred Alternatives, the USFWS would use water management, prescribed burning, controlled grazing, mowing and haying, prescribed burning, shoreline protection and restoration, prairie management and restoration, exotic/invasive species control as primary habitat management tools on the expanded Refuge Complex. Biological program activities including surveys, monitoring and research would be focused on priority species identified as needing conservation action, and would guide an adaptive management approach for conserving these species. New initiatives would be focused on addressing threats from relative sea level rise, altered hydrological regimes, exotic and invasive species and contaminants. Additional and enhanced opportunities for wildlife-dependent uses including hunting, fishing, wildlife observation and photography, environmental education and interpretation, would be provided on the expanded Refuge Complex.

Under the combined Preferred Alternatives, USFWS management and refuge boundary expansion and subsequent land acquisition would have no major effect on the existence or resolution of current socioeconomic issues. The existence and/or management of the Refuge Complex would continue to be in dispute or unsettled between different parties; people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions; and people would continue to hold mixed opinions about 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. 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 the USFWS’ chosen Preferred Alternatives would depend on individual and group values, beliefs, and goals.

Under the Preferred Alternatives, management philosophies and priorities would change from current conditions, and the amount of USFWS land holdings would increase. While the Preferred Alternatives support different philosophies and priorities, and the differences may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the expanded Complex would generally remain the same as current conditions. For the Refuge Boundary Expansion Preferred Alternatives, the concept of selling only to “willing” parties would lessen potential social and lifestyle concerns because

changes in ownership would be a choice, not a requirement. Overall, impacts to social structures and lifestyles would not be significant as considered in this EIS.

There is a potential for direct and indirect impacts to cultural sites on existing and newly acquired acreage under the preferred alternatives; however, avoidable impacts would not be considered adverse, but rather minor in nature. Unavoidable adverse impacts are anticipated to continue to occur at potentially eligible sites from natural phenomenon. Natural impacts would continue to occur to the known cultural sites on existing and acquired areas; however, additional protections may be indirectly afforded to the sites under the combined Preferred Alternatives if water control projects extend to the acquired lands. 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 provide additional protections not afforded to the sites on private lands. Private lands acquired would also be subject to the actions and impacts identified for the management alternatives on existing Complex lands. Ground disturbing activities, including facilities construction, road construction, ditch digging, oil and gas activities, and water control projects (such as levee construction, repair, or removal), would be subject to a ground survey and consultation requirements with the State Historic Preservation Officer (SHPO) under the NHPA Section 106 regulations. All ground-disturbing activities, whether initiated by the USFWS or other entities, would be subject to restrictions imposed on newly expanded Complex lands and consultation with the SHPO under Section 106 regulations. The ground truthing and Section 106 process may reveal more cultural sites previously undiscovered in private ownership and provide protection as appropriate.

The potential for impacts to cultural resources from prescribed burning, cattle grazing, and recreation use would continue across the expanded Refuge Complex. Regular prescribed burning or use of natural ignited fire on existing and acquired lands would reduce the potential for higher intensity fires under the Preferred Alternatives, and may reduce fuel loads that produce higher intensity fires that threaten the integrity of cultural items. The potential for inadvertent cattle tromping of cultural sites is likely to continue on existing and acquired lands. Recreation visitors and activities may inadvertently damage cultural sites; however, recreation access in the Complex is highly limited by the under-developed character of the area. 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.

II. CUMULATIVE IMPACTS ANALYSIS

Cumulative impact analysis is required by NEPA and CEQ regulations. CEQ's definition of cumulative impacts is as follows:

"... the impact on the environment which results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taken place over a period of time." (40 CFR 1500-1508)

For this analysis, a reasonably foreseeable future action must be a project or activity that has been formerly proposed by a specific project proponent. This cumulative impact analysis has been conducted with the following approach and analytical perspective:

- The focus of analysis is on identification and disclosure of potential cumulative impacts.
- The analysis is primarily qualitative in nature, and no additional quantitative modeling has been conducted.
- Projects included in the cumulative impact analysis are those that have the highest potential for having identifiable cumulative impacts.
- The analysis considered all potential projects and activities (e.g., Federal, other government, and private).

- The analysis considered impacts beyond the primary and secondary EIS study areas where appropriate.
- The analysis is based on the identified preferred management alternative and preferred refuge boundary expansion alternative.

For this cumulative impact analysis, the following projects or activities have been identified as having existing and/or potential future impacts that could collectively add to impacts from the Preferred Refuge Management and Refuge Boundary Expansion Alternatives:

- State Highway 87 Relocation and Reconstruction
- State of Texas Coastal Management
- Fish, Wildlife, and Habitat Management on Non-FWS Lands
- State of Texas Regional Water Planning
- Navigation and Waterway Projects
- U.S. Army Corps of Engineers Activities
- Drainage District Activities
- Big Hill Strategic Petroleum Reserve Site
- Regional Economic Development Activities

Each of these projects is summarized in the following section.

A. Description of Projects and Activities Considered

1. State Highway 87 Relocation

Texas State Highway (SH) 87 between Sabine Pass and High Island, locally known as “the Beach Road,” has existed as a transportation route for more than a century. As far back as 1863, a Civil War map showed a “Road to Galveston” along the shoreline southwest of Sabine Pass. Since that time, ongoing and significant coastal erosion has repeatedly destroyed SH 87, requiring five complete relocations and reconstructions since 1933. Originally located 50 to 100 feet from the Gulf shoreline, this highway was closed in late 1989 due to storm damage from Hurricane Jerry. Currently, large portions of the roadway are damaged and some road sections are within the tidal zone.

In 1997, Jefferson County applied for Clean Water Act (Section 404) and USFWS Right-of Way permits to relocate and reconstruct 16.8 miles of SH 87. The requested permits proposed relocation of the highway to an alignment approximately 300 feet inland of the existing right-of-way.

In 1999, a Notice of Intent was published by the Federal Highway Administration announcing their intent to prepare an EIS for the SH 87 relocation/reconstruction project. The local project sponsors include Jefferson County and the Texas Department of Transportation. Development of the EIS is still ongoing.

Alternatives being evaluated in the SH 87 EIS include alignments along the Gulf of Mexico, close to the highway’s historical location, and an alignment along the south shoreline of the Gulf Intracoastal Waterway. These alignments would cross the McFaddin NWR. One of the alternative alignments along the Gulf of Mexico is being seriously discussed as the likely Preferred Alternative in the EIS process. This alternative will include a shoreline erosion abatement component (potentially the restoration of the dune/beach complex using offshore sand deposits) in addition to rebuilding the highway. This would provide some protection for the highway from tidal surges associated with frequently occurring minor tropical storms and extend the life span of the roadway by slowing rates of Gulf shoreline retreat.

2. State of Texas Coastal Management

The Texas Coastal Coordination Act of 1991 led to the establishment of the Texas Coastal Management Program (CMP). The CMP was designed to meet requirements for participation in the federal Coastal Zone Management Program. Once a state’s program is federally approved, the state received federal

coastal grant funding and may require federal activities in the coastal zone to comply with the program's policies through a process known as consistency review. The Texas program received federal approval in 1997. The CMP's designated coastal zone includes parts of Galveston, Jefferson, and Chambers counties, but excludes federal lands such as National Wildlife Refuges. CMP activities are administered by the Texas General Land Office (TGLO) and include a broad range of programs which include beach and dune management, annual Beach Clean-up, education campaigns, infrastructure improvement projects, and nature trails.

The Texas Coastal Erosion Planning and Response Act (CEPRA) was enacted by the Texas legislature in 1999 to address the erosion of Gulf beaches and bay shorelines through the funding of erosion response projects and through the study of coastal processes. The CEPRA program is also administered by TGLO. The CEPRA program also offers the form for local governments to participate in a long-range, statewide comprehensive response plan to erosion problems. One of the major goals of the program is to take a regional, holistic view of erosion, instead of a piecemeal approach. Erosion control projects under CEPRA are coordinated with other state, local, and federal agencies to maximize efficiency. To date, two CEPRA funding cycles for 68 specific erosion control or study projects have been initiated by TGLO. Approved erosion projects and activities have included the following locations in the Texas Chenier Plain region:

- Rollover Fish Pass and Caplen Beach/Shores on the Bolivar Peninsula in Galveston County
- GIWW - McFaddin NWR Reach in Jefferson County (coordinated with the USFWS)
- Dune Restoration - McFaddin NWR (coordinated with USFWS)
- East Bay in Chambers County (including the entire eight-mile shoreline of the Anahuac NWR (coordinated with the USFWS)

In addition, TGLO is partnering with the U.S. Army Corps of Engineers (USACE) on several of their erosion studies and control projects (see the USACE projects section below for a description of the current and proposed USACE projects in the region).

"Coastal Texas 2020" is a long-term, statewide initiative to unite local, state, and federal efforts to promote the environmental and economic health of the Texas coast. To facilitate the work of Coastal Texas 2020, the coast of Texas was organized into five regions and advisory committees are being created for each region. The program will ultimately produce a strategic plan and report to the Texas legislature to lay out strategies addressing issues and challenges of the Texas coastal areas.

The Galveston Bay Estuary Program (GBEP), administered by the Texas Commission on Environmental Quality (TCEQ) under the U.S. Environmental Protection Agency's National Estuary Program. The GBEP supports habitat restoration and conservation education and research activities throughout the Galveston Bay system.

3. Fish, Wildlife, and Habitat Management on Non-FWS Lands

Much of the land in the area surrounding the Refuge Complex has been retained in fairly natural condition because of the obvious hydrological and vegetation limitations on use of the land for developmental uses. Some of this land is actively managed for fish and wildlife habitat.

Beyond USFWS management of the Refuge Complex, other nearby areas that are actively managed for fish and wildlife habitat/values include the J. D. Murphree, Candy Abshier, and Lower Neches Wildlife Management Areas (WMAs), and the Sea Rim State Park (SP). All of these areas are owned by the State of Texas and managed by the TPWD. Each of these areas is described below:

- **J.D. Murphree WMA** - This WMA is a 24,250-acre tract of fresh, intermediate and brackish water within the prairie-marsh zone. The WMA is highly diverse in coastal wetland vegetation communities. There are several rare/endangered/threatened vegetation species within the WMA and wildlife diversity is also high. The WMA is a key nesting and brooding area for Mottled Ducks, with an increasing amount of nesting by fulvous and black-bellied whistling ducks. A large number

of mammals live and forage in the WMA. The American alligator is the single most important reptile and predator in the WMA, with a dense population estimated at better than one alligator per acre. Alligators have been hunted in recent years by special permit public hunts. The WMA is a principle stopover and staging area for much of the waterfowl of the Central Flyway and provides high quality winter waterfowl habitat. Recreational opportunities include hunting and fishing. The WMA is generally open for wildlife viewing at all times except during hunting seasons. Public access to much of the WMA is restricted to boats due to the lakes, bayous, and marshes associated with this property. Pipelines are common in the WMA. Long-term management of the WMA has been aimed primarily towards winter waterfowl habitat.

- **Candy Abshier WMA** - This 208-acre site is located in southern Chambers County, bordered on the north, east, and west by the community of Smith Point with East Bay to the south. FM 562 provides the only access to the area from Anahuac. The WMA was established in 1990, and consists primarily of coastal prairie habitat with important coastal woodlot or oak mottes. A wide diversity of bird species use Candy Abshier WMA as a stopover during migration in both the spring and fall. Management actions emphasize the habitat needs of neotropical migrant passerine species, while encouraging the utilization of the area for research, demonstration, and recreational uses. In addition to fish/wildlife management and recreation, the WMA contains oil and gas development and grazing as land uses.
- **Lower Neches WMA** - The Lower Neches WMA contains almost 8,000 acres near Bridge City in Orange County. It consists primarily of briny coastal marshland, and was acquired by donation. The low level coastal plains surrounding the rivers, bayous, and shoreline has an environment attractive to many migratory birds, game and non-game, that stop during their migrations to and from South America on the Central Flyway. Hunting for birds and alligators is permitted during scheduled special hunts.
- **Sea Rim SP** - The SP includes 4,141 acres of marshland with 5.2 miles of Gulf beach shoreline in Jefferson County. The land was acquired by purchase from Planet Oil and Mineral Corporation and Horizon Sales Corporation in 1972 and was opened to the public in 1977. The park is named for that portion of the Gulf shoreline where the marsh grasses extend into the surf in a zone termed Sea Rim Marsh. The park's coastline contains a biologically important zone, wherein salt tidal marshlands meet the Gulf waters. The SP is a prime wintering area for a variety of waterfowl, and the area also supports a variety of fish and wildlife. Recreation facilities include campsites with water (and in some cases electricity as well); approximately 2 miles of open beach primitive camping, an overflow camping area; picnic tables, restrooms with and without showers; a store, a visitors' center with exhibits; observation deck; nature trail; 6 miles of open beach for bike riding and hiking; and swimming. Additionally, the Marshlands Unit, which is accessible only by boat, has a boat ramp; observation blinds for bird watching, and airboat tours. While the SP is located on SH 87, the closure of this highway necessitates access to the SP only from the east via Highway 73.

The TPWD, in conjunction with other state agencies, has been especially active in recent years in the area of wetlands conservations and planning. Since the mid-1980s, a number of plans have been developed including the State Wetlands Conservation Plan for State-owned wetlands, the Texas Wetlands Plan, and the Texas Wetlands Conservation Plan. In one form or another, all of these plans address wetlands conservation and planning in the State, including the Texas Chenier Plain region..

In addition to governmental conservation/resource protection efforts, a number of private nonprofit groups have been involved in the stewardship of woodlots and other coastal habitats in the Texas Chenier Plain area. For example, the Texas Ornithological Society has established the Sabine Woods Sanctuary outside Sabine Pass; and the Houston Audubon Society and the Texas Nature Conservancy have been involved in protecting important woodlot habitat on High Island. Both of these efforts serve to protect important woodlots for the benefit of neotropical migratory birds. Houston Audubon also owns land on Bolivar Peninsula (in Bolivar Flats and Horseshoe Marsh) as part of its bird sanctuary program. The Galveston Bay Foundation is involved with coastal marsh restoration and bay shoreline protection in the

Galveston Bay system, and is also involved with regional conservation planning and environmental education. The Legacy Land Trust has acquired some conservation easements on Bolivar Peninsula properties to protect coastal dunes/swales, wetlands, and coastal prairie.

The cumulative impacts study area lies within the Central Flyway, which is a major north-south migratory bird route from the Gulf of Mexico through the central United States into Canada. Birds move from breeding grounds in the north to winter quarters in the south along this route in the fall, and vice versa in the spring. Lanes of heavier migration patterns follow coastlines, mountain ranges and major river valleys. The Texas coastal area is a major viewing site for these migratory birds.

In response to nature tourism opportunities along the Texas coast, the Great Texas Coastal Birding Trail (GTCBT) was established in 1996. The route includes more than 300 birding sites across more than 700 miles of Texas coastline, including Jefferson, Chambers, and Galveston counties. The GTCBT has become world-renowned as a birding/recreational destination. Many GTCBT sites are enhanced with boardwalks, observation platforms, landscaping, and avian species information.

The TPWD and Texas Department of Transportation jointly sponsor the GTCBT. The trail involves private landowners, businesses, conservation groups, and Federal, state, and local governmental agencies, all of which have coordinated to make the GTCBT both a positive economic driver and a sanctuary for birds and bird-watchers. The Houston Audubon Society sponsors bird counting surveys and other activities at its 48-acre Smith Oaks site. It is these efforts from the variety of private stakeholders, in combination with public sector natural resource conservation efforts from agencies such as the TPWD and USFWS, that make the GTCBT an effective public-private partnership.

4. State of Texas Regional Water Planning

The Texas Water Development Board (TWDB) is the state's major water planning and water project financing agency. The TWDB's main responsibilities include:

- Collecting and disseminating water-related data
- Assisting with regional water planning
- Preparing the State Water Plan for the development of the state's water resources (surface water and groundwater)
- Administering cost-effective financial programs for the construction of water supply, wastewater treatment, flood control, and agricultural water conservation projects.

With the signing of Senate Bill 1 in 1997, the TWDB began the process of leading a "bottom up" water planning process designed to ensure all future water needs are met throughout Texas. This effort has led to the development of 16 regional water plans in Texas, which must be updated every five years. Within the regional water planning structure, Chambers and Galveston Counties are in Planning Region H and Jefferson County is in Planning Region I. Water supply and demand data, and other information such as population projections, are kept on both a county and planning region basis. Water demand patterns among these three study area counties are very different, with Chambers County water demand focusing on oil and gas and irrigation purposes, Galveston County water demand focusing on municipal and manufacturing purposes, and Jefferson County water demand focusing on manufacturing, irrigation, and municipal purposes. The TWDB works with the governments and other stakeholders in each region to provide for future water needs; therefore, the TWDB will influence regional water supply projects to meet projected demand.

Also, the TWDB and the TPWD jointly maintain a data collection and analytical study program focused on determining the effects of and needs for freshwater inflows to the state's bays and estuaries. TPWD and the TCEQ jointly evaluate the findings so that TCEQ can appropriately assess the effects of the issuance of water permits within 200 river-miles of the coast.

5. Navigation and Waterway Projects

There are a number of historic waterway, navigation, and drainage infrastructure projects that have affected the areas in and around the Refuge Complex. These include construction of navigation canals, infrastructure and road access for oil and gas activities, channelization and deepening of natural waterways for navigation, and inland drainage. Some of the public works projects that have occurred over the last century and their associated changes to natural conditions include:

- **Gulf Intracoastal Waterway (GIWW)** - The GIWW provides a waterway for transportation of petrochemical products and other goods along Texas and other southern states. It was constructed in 1933. It is connected to the Sabine-Neches Ship Canal allowing access to port facilities in Port Arthur and Beaumont.
- **Sabine-Neches Waterway (SNWW)** - The SNWW is a 79-mile long, deep draft ship channel that extends from the Gulf of Mexico through a jettied channel to Port Arthur and Beaumont via the Neches River Channel, and to Orange via the north part of Sabine Lake and the Sabine River Channel. This navigation channel connects the Gulf of Mexico at Sabine Pass to port facilities in Port Arthur and Beaumont.
- **Houston Ship Channel** - The Houston Ship Channel is a 54-mile long, deep draft waterway connecting the Gulf of Mexico to inland port facilities. It extends from Bolivar Roads near Galveston north through Galveston Bay, the San Jacinto River, and Buffalo Bayou to the Main Turning Basin in Houston, Texas.
- **Keith Lake Fish Pass** - This project, completed in 1977, is a water exchange pass connecting the Keith Lake system of lakes and marshes to the Sabine-Neches Waterway. It was built to enhance fisheries access and recreational fishing in the Keith Lake system.
- **Various levees, roads, cattledwalks, ditches, and canals** - These projects have been associated with the cattle industry, oil and gas development, and access improvements to support commercial and recreational activities throughout the project area.

Generally, these projects were constructed for economic reasons, and have been substantial contributors to the economic growth of the area. Their cumulative modification of regional hydrology has affected ecological and geological processes critical to the long-term integrity of coastal ecosystems in the region. These alterations have contributed to substantial and accelerated coastal land loss from shoreline erosion, and conversion of inland vegetated marshes to open water, and in the conversion of many fresh and intermediate marshes to brackish or saline marshes with a concurrent loss of the natural plant and animal diversity.

6. U.S. Army Corps of Engineers Current Projects

The U.S. Army Corps of Engineers (USACE), Galveston District, exists to fulfill its missions of navigation, flood control and hurricane-flood protection, while its regulatory office works to protect the nation's wetlands and navigation channels. Activities are ongoing with multiple projects and studies within or near the Refuge Complex, including the following:

- **Shoreline Erosion Feasibility Study, Sabine Pass to San Luis Pass** - The study encompasses approximately 90 miles of shoreline to address the severe shoreline erosion occurring along the upper Gulf Coast of Texas between the Sabine-Neches Waterway (Sabine Pass) and the Galveston Entrance Channel (Galveston Bay) and the entire Gulf shoreline of Galveston Island. The study area includes all of the Gulf shoreline within Texas Point and McFaddin NWRs.

- **Section 227, National Shoreline Erosion Control Development and Demonstration Program in Jefferson County** - The primary objectives of the project are to minimize erosion of the exposed cohesive sediment and to minimize sand overwash. The proposed project will be constructed along 2,500 linear feet of severely eroding shoreline at the eastern end of the McFaddin NWR. The Research and Development project will place geotubes to isolate sediment cells. After 3 years of detailed monitoring, the project will be transferred to the TGLO, who will assume responsibilities and decide whether to keep or remove the geotubes.
- **Navigation Improvement Project, Sabine-Neches Waterway Feasibility Study - Channel Improvement to Beaumont** - This project is proposed to widen and deepen the Sabine-Neches Waterway (SNWW) from its entrance in the Gulf of Mexico to Beaumont, Texas. A feasibility study is being conducted to study if the ship channel can be deepened from its present 40 feet to a new depth of 50 feet. The study area includes approximately 65 miles (~13 miles offshore) of waterway along the Sabine River.
- **Section 216 Study, Improvements and Modifications to portions of the Gulf Intracoastal Waterway (GIWW) between High Island and the Brazos River** - The proposed improvements involve channel widening and deepening, construction and expansion of mooring areas, a sediment trap, and bank protection. The project involves approximately 85 miles of the GIWW in Chambers, Galveston, and Brazoria Counties, from High Island to the Brazos River. The improvements are intended to reduce delays and damages and the potential for a hazardous materials spill, providing a more efficient and safer transport artery.
- **Section 1135 Continuing Authority Program (CAP) Studies** - Two Section 1135 (CAP) projects are currently being evaluated in the Refuge Complex area. One project would replace the 1946 salt barrier structure at Taylors Bayou that is now failing. The damage to the existing structure was tied to salinity intrusion from the Sabine Neches Waterway. The second project consists of a proposed natural rock structure that would be located either within the Keith Lake Fish Pass or at the mouth of the Pass. The natural rock structure is intended to act as a reef to control salinity intrusion into Keith Lake and marshes in the eastern portion of the Salt Bayou watershed.
- **Wallisville Project** - Built on the Trinity River, the recently completed Wallisville multipurpose project provides for salinity infusion controls, water supply, recreation, and fish/wildlife habitat enhancement.
- **Navigation Channel Maintenance Dredging** - On-going maintenance and periodic dredging occurs to keep the GIWW, the SNWW, and the Houston Ship Channel clear and safe for navigation. The dredged material is typically stored in leveed dredge containment compartments. In recent years, the Galveston District has worked with other agencies on several beneficial uses of dredge material projects for marsh restoration and shoreline stabilization.
- **Texas DOT Emergency Action Permit For Fill Along the Sabine River** - The Texas DOT holds an emergency permit valid through 2008 to conduct shoreline stabilization activities, as needed, along nine miles east and west of the Port Arthur Ship Channel. The permit is valid for approximately nine miles along the east and west shorelines of the Port Arthur Ship Channel, along SH 87 from south of the GIWW to northeast of Keith Lake, and along SH 82 from east of the GIWW to east of Keith Lake, south of Port Arthur in Jefferson County.

7. Drainage District Activities

There are three Drainage Districts located within Jefferson County. Drainage districts were first authorized by the Texas legislature in 1905. Districts can be established with a two-thirds vote of qualified resident property tax payers in the proposed districts. They have been established to develop, design, and construct canals, drains, ditches, levees, etc. In addition, the Trinity Bay Conservation District (TBCD)

also conducts activities that affect local and regional drainage. Further information on Drainage District 6 and the TBCD is provided below.

a. Drainage District 6 (DD6)

DD 6 was established in 1920, and serves Beaumont, Bevil Oaks, China, Nome, the communities of Fannett, Northwest Forest, Hillebrandt Acres, Cheek, and Labelle, and farm and timber land in between these areas. DD 6 controls storm and floodwaters from rivers, streams and ditches, and drains and reclaims overflowed lands. DD 6 services about 40 percent of northern Jefferson County, including 750 to 900 linear miles of streams, ditches and outfalls. Due to its close proximity to McFaddin NWR, DD 6 activities can have direct interaction with USFWS management activities.

Its activities consist of the design and construction of flood control and drainage facilities, including diversion channels, detention ponds, ditches, etc. Activities are ongoing, and include development of a Master Drainage Plan for the entire district, a Taylors Bayou watershed project/study, a Walker Branch Improvements Project, and the potential for a future passive recreation complex. As part of the Taylors Bayou watershed study, three projects have been recommended in order to substantially lower floodwater surfaces, decrease inundation time, remove 51,000 acres from the 100-year floodplain, and accommodate future upland ditch improvement projects in the upper elevations of the watershed. The three projects proposed in the Taylors Bayou watershed study are:

- **Needmore Diversion Channel** - This channel would consist of a 63,000-foot long, 14-foot deep, 200-foot bottom channel from the North Fork/South Fork Taylors Bayou confluence south to the GIWW.
- **Green Pond Detention Basin** - A 9,000-acre, aboveground detention facility would be constructed, with a maximum water storage capacity of 15,000 acre-feet.
- **Winnie Diversion Channel** - This channel would consist of a 13,000-foot long, 10-foot deep, 50-foot bottom channel from the southernmost "horseshoe" of the South Fork of Mayhaw Bayou south to Spindletop Bayou. (This project is in cooperation with the Trinity Bay Conservation District).

b. Trinity Bay Conservation District

The TBCD provides drinking water, wastewater treatment, and storm drainage for most of east Chambers and part of west Jefferson counties. The District manages stormwater through construction and maintenance of drainage ditches throughout the District. The District constructs such structures as saltwater barriers, bridges, and crossings, and manages about 1,400 miles of ditches in the district. The District is proposing the Winnie Diversion Channel in cooperation with Jefferson County DD6.

8. Big Hill Strategic Petroleum Reserve Site

The U.S. Department of Energy's Strategic Petroleum Reserve (SPR) is an emergency supply of crude oil that was designed to be the nation's first line of defense in the case of petroleum supply interruptions. The SPR oil is stored in four huge underground salt caverns along the coastline of Texas and Louisiana, and includes the Big Hill site about 20 miles southwest of Beaumont in Jefferson County. This region was chosen for the SPR because there are more than 500 salt domes (the preferred storage geological feature) along the coast and many U.S. refineries, pipelines, and ports are located in the area. The Big Hill storage facility is the SPR's newest storage facility, with construction beginning in 1982 and completion in 1991. The site covers about 270 acres and is connected via pipelines with port terminals in Nederland and Port Arthur, Texas. A 48 inch brine disposal line from the Big Hill SPR runs across McFaddin NWR to the Gulf of Mexico. About 160 million barrels of oil are stored at the Big Hill facility out of the SPR's total storage capacity of 700 million barrels. The Department of Energy initiated an Environmental Impact Statement in 2005 for the expansion of existing SPR facilities and the potential

construction of a new SPR facility. Proposed expansion of the Big Hill SPR facility may include modification/expansion of the brine pipeline across McFaddin NWR.

9. Regional Economic Growth and Development

The three-county socioeconomic study area includes Jefferson, Chambers, and Galveston Counties. While each county has different characteristics, conditions, and traditions, each county has sought to expand its economic base by encouraging regional economic growth and development. Major industries in the study area include agriculture (including rice and livestock production), oil and gas production, refineries, petrochemical plants, and recreation. In recent years, major industrial development has included several liquefied natural gas facilities. Trend analysis indicates that agricultural activities are declining, while recreation and tourism activities are on the increase. Oil and gas exploration and production activities have increased recently, and the energy industry will continue to be very important in the regional economy. Recreation will continue to be an increasing focus of land use and governmental activities.

The locations and extent of future growth cannot be stated with any degree of certainty at this time. However, it can be assumed that much of any future economic development would take place with the continuing spread of urban growth. Growth patterns likely include west of Beaumont and Port Arthur in Jefferson County, and urban sprawl from Houston eastward into Chambers County is proceeding rapidly. Extensive residential and commercial development is already occurring in western Chambers County. Each county has governmental and/or quasi-governmental agencies responsible for supporting growth and development initiatives and goals.

10. Summary of Regional Actions Associated with Cumulative Activities

Actions taken by various stakeholders in the area in and around the Complex that affect the land and natural resources upon the land vary among the public (e.g., governmental agency) and private entities involved in projects and activities in the region. Collective action categories affecting land and natural resources in the region include:

- Habitat and fish/wildlife management and enhancement
- Water management
- Cropland management
- Grazing management
- Prescribed burning
- Exotic and Invasive species management
- Erosion control
- Restoration (of habitats, shorelines, etc.)
- Increased recreation/improved visitor experience quality
- Improved access (e.g., SH 87)
- Development of additional navigation/drainage infrastructure
- Repair and maintenance (e.g., dredging) of existing navigation/drainage infrastructure
- Economic development (including tradition oil and gas and agriculture development)
- Land management actions by the USFWS represent a substantial portion of this list of action categories.

While some landowners subscribe to an unmanaged, passive land approach, each governmental agency and many private landowners in the region have generally established land management goals, objectives, and actions. Some of these goals, objectives, and actions serve to make economic gain; others serve for ecological and natural resource preservation/conservation purposes; some are required by law, regulation, or policy; and still others have a mix of purposes and effects. For some land, management practice is non-existent and the result is passive, unfocused land management.

The USFWS, USACE, and State of Texas agencies have engaged in several cooperative programs with various other public and private entities for habitat enhancement and restoration projects, environmental education programs, and expanding public use facilities and services. The benefit of these cooperative programs include the contribution of nonfederal funds to match federal dollars, the contribution of efforts of volunteers on many labor intensive projects such as habitat restoration, the contribution of volunteers to initiate and coordinate environmental education and outreach programs, and the contribution of various groups for materials and labor for improving public use facilities. Because of cumulative cost concerns and the realization that projects cannot be conceptualized and implemented on just an individual basis, use of cooperative programs for a variety of purposes would likely increase in the future.

B. Cumulative Impacts of Regional Projects and Activities with the Combined Preferred Alternatives

This section summarizes the potential impacts of the projects, activities, and management responses to environmental issues and problems identified above accumulated with the potential impacts from implementation of the combined Preferred Management and Refuge Boundary Expansion Alternatives. Impact discussions are somewhat general in nature because of the regional perspective of the cumulative impact analysis.

1. Natural Resources Section

a. Impacts to Air Quality

The major sources of air pollution in the region are oil and gas production, chemical production, shipping, agriculture, and automobile emissions. Jefferson County is within the Beaumont/Port Arthur (BPA) air quality region, while Chambers and Galveston Counties are within the Houston/Galveston (HGA) air quality region. Both of these regions have been designated as non-attainment areas for ground-level ozone. The EPA has classified the BPA non-attainment region as “severe,” while the BPA non-attainment region has been classified as “moderate.” Both regions must attain the one-hour ozone standard by November 15, 2007 according to the State Implementation Plan. To reach this attainment status, the BPA region needs to reduce nitrogen oxides (NO_x) by about 31 percent. Attainment in the HGA area is especially challenging, due to the magnitude of reductions needed for attainment and the shortage of readily available control options – substantial decreases in NO_x and volatile organic compounds must be achieved in the HGA to achieve attainment status.

Prescribed burning is conducted by the USFWS, State of Texas, and some private landowners as part of habitat management efforts. This prescribed burning is conducted by the government agencies only under specific meteorological conditions, and requires permits to burn. Some private landowners also conduct burning under specific meteorological conditions, but private prescribed burning can at times be unpredictable and some private landowners do not go through the proper regulatory processes before burning is conducted. Regional air quality is affected by prescribed burning only when many acres are burned concurrently on the same day. Each individual project or activity in the region that produces air emissions adds to the existing air problem. Through the permitting process, individual project approvals for air emissions are required in the vast majority of cases throughout the cumulative impact area. These permits processes assess the capability of each project to stay within required emission limits and support the terms of the State Implementation Plan.

Automobile traffic and associated emissions will continue to grow throughout the region. Relocation/reconstruction of SH 87 would produce only very localized additional air pollution from the new traffic of less than 1,000 vehicles per day that would use the new highway. Overall, air quality issues are a major regional issue, but air quality varies widely among specific locations in Chambers, Jefferson, and Galveston Counties. The Houston and Beaumont/Port Arthur areas have much more substantial air quality problems than those in and around the Complex.

b. Impacts to Geology and Soils

Major regional geological/physical process issues and concerns include coastal erosion and disposal/use of dredged materials, as summarized below.

(1). Coastal Land Loss

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

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

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

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

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

plant productivity may decrease of the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water. (On McFaddin NWR, coastal erosion and damage from storm tidal surges have also destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Restoration of the historic beach and dune systems along the Gulf would slow erosion, protecting wetlands and infrastructure and restore rare floral and faunal communities. Effective implementation of dune restoration pilot projects and dune protection activities requires extensive coordination among Federal and state governmental agencies, especially related to public education, outreach, signs, and law enforcement. Similarly, additional erosion abatement projects along the GIWW and the shoreline of East Galveston Bay are needed and require interagency coordination.

(2). Soils and Dredged Materials

Spoil banks developed from excavated canals and bayous consist of Made Land soils. The spoil materials of the 15-foot levees along the edge of the GIWW, the saltwater flats that adjoin the waterway, and salty prairie habitats are an example of Made Land soils. Made Land soils are a mixture of clay, sand, and shells. Soils comprising the salty prairie habitats are usually quite variable ranging from generally deep moderately saline clays to stratified clay and loamy materials that have been excavated from canals, ditches, or waterways. These soils are affected by salt spray, storm tides, and salty high water tables restricting the kind and density of plants present.

Dredging of materials from regional waterways and channels is a continuing modification of natural conditions, and has major effects on regional hydrology and habitats. Dredging activities by USACE are a regular occurrence in the region, and will continue into the foreseeable future. The USACE is looking at ways to avoid dredged material placement in waste piles on or near the shorelines of dredged areas, and to use dredged materials to reduce shoreline erosion and for storm damage prevention. For example, dredge spoil from the Sabine-Neches Ship Channel now deposited in offshore disposal areas could be deposited directly on beaches or in near shore littoral systems. The coarse sediment from the spoil would then be available for the natural processes of rebuilding beaches and dunes, reducing erosion rates, and coastal wetland loss. The replenishment of coarse sediments is one of the most critical needs for the restoration and long-term protection of valuable fish and wildlife habitats in this Texas coastal ecosystem, and appropriate use of dredged materials could help in this effort. Regionally, opportunities for beneficial use of dredged material include beach and coastal-wetland nourishment, seagrass restoration, shoreline protection, and mangrove and saltmarsh wetland creation. If dredged material cannot be used beneficially, it should be placed in existing placement areas or on upland sites where levees can be used to contain the material.

c. Impacts to Hydrology and Water Quality

Major regional hydrological issues include the historic and continuing modifications to natural hydrological conditions, water quality, water supply, and flood control. Each is discussed below.

(1). Modifications to Natural Hydrological Conditions

The natural pattern of hydrology in the Texas Chenier Plain has been critical to the building processes that created and maintained the diversity of coastal wetlands and other elements of the ecosystem. Frequent flooding over low bayou banks and large volumes of rainwater flowing slowly across coastal prairies and marshes provided nutrients, sediments, and freshwater to marsh systems. Natural drainage allowed a cyclic pattern of drying and flooding under which wetland plants evolved and adapted. Historically, these ecosystems contained a continuum of coastal marsh types associated with a natural salinity gradient. This continuum of freshwater, intermediate, brackish, and saline wetlands supported a diversity of floral and faunal communities. Diversity of these communities decreased as tidal influence and salinity increased along the gradient.

However, past and continuing modifications of regional hydrology have substantially affected natural ecological and geological processes critical to the long-term integrity of these coastal ecosystems. In general, the primary human induced activities that have affected the Texas coastal ecosystem include construction of navigation canals, infrastructure, and road access for oil and gas activities, channelization and deepening of natural waterways for navigation, and inland drainage. Impacts from the construction and maintenance of these facilities include:

- Saltwater now reaches farther inland into historically freshwater marshes altering the plant species composition and plant productivity. Overall, biological diversity decreased through the conversion of fresh and intermediate marshes to more brackish regimes and salt-tolerant plant and animal communities. Saltwater intrusion also introduced sulphates to these freshwater marshes, which under conditions of high water temperatures during summer are reduced to hydrogen sulphide. Sulphide toxicity can cause plant die-offs and has been implicated in a as a contributing factor in the conversion of vegetated emergent marsh to open water.
- New channels and modifications of natural waterways introduced tidal energies into historically non-tidal or micro-tidal marshes, resulting in decreased plant productivity, plant mortality, peat collapse and erosive loss of organic marsh soils. All have contributed to the conversion of the vegetated emergent marsh to open water. Introduction of tidal influence also altered marsh hydroperiods or wetting and drying cycles. Non-tidal and microtidal marshes whose soil surfaces were exposed only seasonally or during periods of drought became subject to daily tidal fluctuations.
- Increased saltwater intrusion reduces plant productivity in plant communities adapted to fresher hydrological regimes. Plant productivity, especially below-ground biomass in root systems, is an important component of soil formation in the Chenier Plain region's fresher coastal marshes. Reduced plant productivity may reduce soil formation and limit marsh surface elevation gain.
- Alterations to the natural drainage systems in the region have resulted in a rapid transport of freshwater and sediments from inland areas directly to the GIWW, bays and the Gulf, and have generally eliminated the slower historic sheet flow of freshwater from the prairies into the marshes. Historic hydroperiods in the marshes have been altered as rapid drainage of inland flood waters has increased the frequency and depth of precipitation-driven flood events in downstream marshes. Conversely, drainage improvements in and adjacent to the marshes has promoted more rapid drainage and drying during normal or low precipitation cycles.
- Natural and human-caused subsidence has resulted in submergence or "drowning" of emergent wetlands and conversion to deeper, open water. Natural subsidence is the compaction of recent geologic sediments. Human-induced subsidence in the region occurs primarily from groundwater withdrawal and oil and gas extraction. Oil and gas extraction is believed to induce movement of near-surface geologic faults, causing a rapid drop in marsh elevation (White and Tremblay 1995). Subsidence also contributes to saltwater intrusion and is a causative factor in shoreline erosion/retreat and resultant coastal land loss along the Gulf, bays and larger waterbodies. The mean sea level trend for Sabine Pass, Texas is 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps suggests that current projections of relative sea level rise are underestimating future conditions.

Land subsidence is an induced movement of geologic faults at the surface causing a rapid drop in marsh elevation. Subsidence has resulted in submergence or "drowning" of emergent wetlands and conversion to deeper, open water ponds. Much of the subsidence in this part of Texas is human induced, from groundwater withdrawal and oil and gas extraction. Subsidence is also attributed to natural compaction of geologic sediments. Subsidence contributes to saltwater intrusion (White and Tremblay 1995).

Conversion of vegetated marshes to open water has occurred throughout the region in areas where rapid land subsidence resulted in submergence of wetlands. Relative sea level rise is resulting in increased saltwater intrusion further inland into both surface waters and underground freshwater aquifers. Increased saltwater intrusion due to relative sea level rise may decrease plant productivity and impact soil formation and marsh surface elevation gain, and future relative sea level rise threatens existing vegetated marshes with submergence and conversion to open water. Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation and drainage channels have caused plant mortality, peat collapse and erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. It is likely that these impacts have been and will be the most severe in areas subject to both saltwater intrusion and rapid subsidence. These human induced processes have resulted in various ecological responses, some of which are directly responsible for the onset of others (Stutzenbaker 1990, White and Tremblay 1995). This fact illustrates the interdependent relationship of natural resources and ecological processes in this complex ecosystem.

Water that is rich in nutrients, particularly nitrogen and phosphorous, enter East Bay via the GIWW from Sabine Basin. Groundwater withdrawal has impacted artesian well pressure, groundwater quality (saltwater intrusion), and caused land subsidence. The largest wetland losses in this basin resulted from fill placed in wetlands for the construction of impoundment levees and roads, disposal of dredged material from the GIWW, and construction of drainage canals for housing developments on Bolivar Peninsula. The construction of the GIWW, the Sabine-Neches Waterway, and Keith Lake Fish Pass (connecting Keith Lake to the ship canal), dramatically affected the lower 65,000 acres of Salt Bayou with a significant loss of intermediate and freshwater marsh and associated plant and animal communities (Stutzenbaker 1990). The Sabine-Neches ship channel, along the western edge of Sabine Lake, has had a strong influence on the tidal action and saltwater intrusion into the basin. Approximately 80% of the freshwater flows that historically moved into Sabine Lake from the two rivers now bypass Sabine Lake and flow into the ship canal directly to the Gulf. Some portion of the freshwater also flows through the GIWW toward East Bay. Freshwater and intermediate marshes had become brackish as far inland and westward as Clam Lake (13 miles from Sabine Pass). Direct tidal action now occurs at the south end of Sabine Lake. From these examples, it is clear that the cumulative effects from hydrological change are substantial and extensive. Furthermore, ecological responses to hydrological and other natural resource modifications are ongoing (e.g., changes are still occurring in response to alternations of natural conditions).

(2). Water Quality

Surface water quality is influenced by agricultural practices and saltwater intrusion. Saltwater intrusion is probably the water quality parameter of the greatest concern to the Federal and state land management agencies as it is a contributing factor to wetland loss through the conversion of vegetated wetlands to open water. The movement of saltwater from the Texas Gulf inland through the bayou and marsh systems varies depending upon tidal action, storms, and storm runoff. The GIWW, the Keith Lake Fish Pass, channelization of natural waterways, and the many canals associated with oil and gas development have facilitated the movement of saltwater further inland than what occurred historically or what would occur under natural conditions. The level and impacts of saltwater intrusion vary by area and requires site-specific investigations to evaluate the habitat conditions.

Agricultural lands supporting rice cultivation contribute nutrients and toxins to surface waters within coastal watersheds. The application of herbicides is used in the farming of rice, soybeans, sorghum, and hay. Concentrations of herbicides are generally greatest during May, June, and July with the lowest concentrations occurring in the fall and winter. Other potential sources of contaminants affecting regional lands and waters include oil spills, leaks, and contamination from oil production and transport areas (pipelines, barges, etc.), aerial deposits of airborne contaminants from refineries located at Port Arthur, malfunctions of waste water treatment plants, and developments of landfill sites. Water runoff after heavy rainfalls could contain point source and nonpoint source contaminants. A relocated/reconstructed SH 87 and increasing urbanization would add to regional stormwater runoff on a localized basis.

(3). Water Supply

Most drainage ditches and agricultural water delivery systems are owned and maintained by county navigation and drainage districts, or similar agencies. Lands that receive irrigation water either have water rights and pump from the creeks and bayous or purchase water from the above mentioned water purveyors. Wetland management generally requires less water per acre (approximately one-third the water) than what is required for rice farming. The non-urban demand for water has declined dramatically with the decrease in rice farming in the area, increasing the availability of irrigation water under average hydrologic conditions.

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

Water supply will continue to be a driving force of water management practices and further development of the region. The State of Texas' regional water planning processes currently underway by the TWDB will continue to match water supplies with water needs on regional bases. The regional water planning processes will also continue to drive some portion of water development projects such as water storage, drainage, or flood control.

(4). Flood Control

The average annual precipitation in the area is approximately 55 inches which includes many high and intense individual storm events. As a result, flooding is common in the region. Erosional scouring and saltwater intrusion associated with storms result in the loss of freshwater emergent and aquatic vegetation and an increase in open water habitat, particularly in areas subjected to long-term inundation with saltwater. The positive aspects of this type of flooding include the deposition of sediment into the coastal marshes, a necessity for marsh accretion. However, alterations of the natural topography, primarily to promote drainage (GIWW, levees, canals, and channeling) of the inland portions of several watersheds have exacerbated flooding in the downstream portions of the watershed.

Inland flooding can damage existing infrastructure (buildings, roads, levees, power poles, oil/gas wells, and storage tanks) depending on the level and extent of flood stage. However, freshwater infusion from flooding can be beneficial to the natural resources by recharging the freshwater wetlands and providing nutrient and sediment to these areas. The lands directly along the Gulf Coast are most susceptible to flooding from tidal surges.

In response to the adverse effects of flooding, flood control projects have been initiated throughout the region by local governments or drainage districts. The existing flood control infrastructure requires extensive repair and maintenance on a regular basis, and also after flooding and storm-caused erosion damage. The proposed Needmore Diversion Channel, sponsored by DD6 in Jefferson County, would continue the trend of large flood control projects in the region. The Needmore Diversion Channel has the potential to further impact regional hydrology, habitats and fish and wildlife resources.

d. Impacts to Vegetation / Habitats

Vegetation issues in the region around the Texas Chenier Plain Refuge Complex are similar to those faced by the USFWS. The major issues, concerns, and impact trends relevant to vegetation include habitat loss/fragmentation, and the increasing ecological harm from invasive plant species.

(1). Habitat Loss / Fragmentation

The vegetation communities within the Refuge Complex are representative of the region as a whole. Vegetation communities compromise the habitat that provide the food and forage for numerous fish and wildlife species in the region. If habitat is lost or fragmented, the direct impacts are not only to vegetation, but to fish and wildlife as well.

A major threat to the primarily freshwater and intermediate wetland habitats is saltwater intrusion. Freshwater and intermediate marshes are important for a variety of plants and for invertebrate diversity. Both plant and invertebrate diversity are essential elements for many species of wildlife. The alterations of hydrology have resulted in increased saltwater intrusion. Saltwater intrusion, in combination with other factors, has resulted in the conversion and loss of emergent marsh to open water. The intrusion of saltwater into primarily fresh and intermediate marshes has gradually converted these productive wetlands into saline marshes decreasing the diversity of wetland habitats. With the loss of the freshwater component from the gradient of wetland types present in the coastal areas historically, the biological diversity has decreased and many resident and migratory species have been forced into fewer and smaller productive areas.

In addition to saltwater intrusion, habitat loss occurs from land use conversions, urbanization, invasive species, and hydrological modifications. Habitat fragmentation in the region occurs from projects such as pipelines, canals, ditches, and waterways. Habitat fragmentation breaks discrete habitat units into smaller pieces, and often cuts off or blocks freshwater inflows needed for habitat health. Regional water planning processes coordinated by the TWDB in the study area (Regions H and I) both identified maintenance of freshwater inflows into the bays and estuaries of the coastal areas as major regional concerns.

The management of regional habitats among the various public and private landowners ranges from active management (high intensity) such as that conducted by the USFWS and State of Texas, to haphazard or passive management (low intensity). The high intensity management practices of the USFWS and State of Texas are consistent with one another, and these management actions are directly intended to avoid or mitigate existing environmental or natural resource management problems.

While there are cooperative efforts among some of the other landowners in some instances, habitat management is often inconsistent and sometimes conflicting with other goals in the region. Some examples of regional habitat management issues are provided below.

- In most cases forested wetlands in the region receive minimal stewardship. These lands are generally not managed intensively for timber production or wildlife. Trees of commercial size are occasionally harvested and processed at mills approximately 30 miles inland. Typically, forested wetlands in the area have been cleared for farming and grazing. Disturbed sites are susceptible to invasion by Chinese tallow. Remnant forest wetland usually consist of narrow strips of habitat along a river or bayou corridor; relatively large, undisturbed blocks of this mixed deciduous forest habitat occur along the Trinity River and in the Taylors Bayou watershed in the northern portion of the project area.
- The USACE owns a substantial area of forested wetlands along the Trinity River within the northwestern portion of Chambers County near Wallisville. Approximately 5,700 acres were purchased by the Corps for the Wallisville Project in the 1970's (south of Interstate 10). The Wallisville Project was initially established primarily for water storage and supply. The project is currently designed to prevent saltwater inflow into the Trinity River floodplain during the River's low-flow periods. Much of the land above the saltwater barrier will be unaffected by the Project and is likely to remain in a natural state.
- Stewardship of coastal marshes varies greatly across the region. In addition to the USFWS and Texas state agencies, certain private landowners are involved in stewardship activities to

maximize fish and wildlife benefits and production. Many of these landowners are enrolled in one or more of the cooperative programs currently available to private landowners with governmental agencies. These lands are generally leased for waterfowl hunting by both commercial and private interests, and waterfowl management is a primary focus of management activities on these lands. By default, many other migratory and resident species benefit from these management activities. In contrast, other private lands in the region are managed for other purposes, or receive no management. In general, this has resulted in loss or degradation of coastal marshes, especially in the freshwater marsh components. Reduced benefits to wildlife and negative impacts to natural biological diversity have resulted.

A few of the undeveloped woodland habitats are under some form of stewardship. If the structure and species composition of these habitats are maintained, they will continue to provide substantial benefits to wildlife, especially to neotropical migrants during spring and fall.

The USFWS, State of Texas, the USACE, and some private landowners have developed and implemented efforts to restore natural habitats in some areas of the region. These efforts, however, are often piecemeal and do not necessarily achieve the larger habitat restoration goals and achievements necessary to reverse existing trends or extensive habitat loss or degradation.

Restoring degraded marshes and maintaining adequate marsh building processes involve the reintroduction of freshwater and sediment, restoring adequate drainage to alleviate flooding stress, and restricting saltwater intrusion. Factors resulting in marsh loss are often complex in nature and differ between locations. In order to develop corrective measures and restore wetlands, factors impacting the marshes must first be analyzed through pre-project monitoring. Post-project monitoring is just as essential to evaluate restoration activities. Government roles in pre- and post-project monitoring of corrective measures are important in the region, and involve the USFWS, State of Texas, and USACE. An increasingly important restoration tool involves the use of dredged materials to augment sediment supply in sediment poor marshes. Methodologies such as terracing, which use dredged materials to artificially augment marsh elevation, may restore emergent marshes in areas which have been converted to open water. Other means of increasing accretion involve sediment diversions, water level, and salinity management. Backfilling submerged wetlands with fill from excavated areas are also options for directly restoring emergent wetlands lost through land subsidence. The use of wave barriers, installation of water control structures and low level dikes, and transplanting root stock has been used effectively to create emergent marsh along the East Galveston Bay and the GIWW.

The major step involved in restoration of native tallgrass coastal prairie habitat is restoring the natural hydrology of the area. This involves removing old levees and restoring the natural contour of the land. The next step is the introduction of native prairie plant seeds or plant materials. Many commercially available seed sources are not suitable and most of the seeds collected locally have the best survival. Prescribed fire and rotational grazing are used to maintain restored prairie areas.

(2). Exotic / Invasive Species Management

Many non-native species exist in apparent harmony in environments where they were introduced. However, an invasive species is one that displays rapid growth and spread, establishes over large areas, persists, and often conflicts with or replaces native species of vegetation. Invasive species, sometimes also referred to as noxious weeds, is a major regional problem.

Lack of invasive species management on much of the land in the region makes regional invasive species control difficult. Without disturbance, both marsh and prairie habitats are subject to invasion by several woody plants. Public agency (e.g., State of Texas and USFWS) invasive vegetation species control efforts are directed towards the following species: Chinese tallow, deep-rooted sedge, baccharis, willow red rice, coffee bean, barnyard grass, Johnson grass, broadleaf weeds, and other grasses. Aquatic pest plants within the region include water hyacinth, alligator weed, common reedgrass, salvinia, and cattail.

These plants can choke inland waters, canals, reservoirs, and bayous throughout the area. Regional invasive plant control strategies include:

- Prescribed fire
- Mechanical
- Chemical
- Controlled saltwater inflows

e. Impacts to Fish and Wildlife Resources

Regional impacts to wildlife are primarily dependent upon the health and availability of wildlife habitat, and associated management of land and vegetation. Habitats provide the wintering, migrational, and breeding habitat for numerous migratory birds and other wildlife. Habitat serves as a source of food and shelter for fish and wildlife.

Wildlife protection and wildlife habitat protection is the highest priority of the USFWS, and is also a major priority of several other Federal and state agencies and conservation organizations. Habitat loss and fragmentation lead indirectly to decreasing wildlife health and to decreasing biological diversity.

Overall, wildlife is vulnerable on a regional basis to environmental and resource changes such as land use conversions, habitat loss/fragmentation, modifications of hydrology, etc. This vulnerability and potential direct, indirect, and cumulative impact to wildlife is mitigated to some extent through land and habitat management efforts by the USFWS, State of Texas, USACE, other agencies, private groups, and individuals. Without the land and habitat management efforts, impacts to wildlife would be more substantial.

f. Impacts to Land Uses and Land Conditions

Land use concerns from a regional perspective are generally the same as those faced by the USFWS at the Texas Chenier Plain Refuge Complex. Land uses and conditions have evolved substantially from natural conditions, and changes in access and land uses have resulted in substantial loss and/or fragmentation of natural habitats.

Major regional land uses are the same as those uses found in and around the Refuge Complex:

- Land conservation and wildlife/wildlife habitat protection use
- Agricultural use
- Recreational resource use
- Oil and gas use
- Developmental (residential/commercial/industrial) use

Intentional and unintentional land use and land condition changes are very evident throughout the region. In addition to the changes resulting from the construction and maintenance of navigation canals and other water-related infrastructure (discussed in detail within the Hydrology section below), examples of other land use/condition changes include:

- Larger areas of upland pine/hardwood habitats in the region have often been managed for timber production. Over the last several years a substantial acreage of this habitat in Chambers and Jefferson Counties has been harvested. Remnant native stands that are not managed as pine monocultures provide important benefits to a diversity of upland species.
- Conversion of natural habitats to agricultural uses in the area has occurred on most lands that would support these activities over the last century.

- Almost all of the historic native tallgrass coastal prairie in western Gulf Coast region has been lost. Agriculture, urbanization, and industrialization have directly replaced much of the native prairie. Extensive drainage impacted much of the remaining area. Naturally occurring wildfires were suppressed, native grasslands were overstocked with domestic cattle, and non-native plants and animals were introduced.
- Coastal land loss threatens extensive acreage of inland brackish and intermediate marshes as Gulf and bay shorelines retreat. Shoreline restoration/stabilization efforts in the region have been ongoing for the last 25 years.
- Substantial acreages of wetlands have been lost to both natural and human induced factors over a recent 25-year period.
- Regional navigation, flood control and drainage projects have changed natural hydrologic regimes, which subsequently changes land conditions and potential land uses.
- Oil and gas exploration on the Texas Gulf Coast has occurred since the early 1900's. Oil, gas, and mineral exploration, with intensive 3-D seismic survey activity, is continuing along the Texas Gulf Coast, both on-shore and off-shore.

Various land uses can conflict and compete in certain locations in the region. In response to these conflicts, management agencies such as the USFWS, USACE, and State of Texas often cooperate on resolution or study of natural resource problems. However, because of budget constraints and the scope and extent of regional environmental problems, these agencies are often only able to react to the “hot spots” requiring the most immediate attention. Proactive management efforts are difficult in these circumstances.

(1). Access

In addition to the general land use and condition changes identified above, access within the region is another major land use issue and concern. One of the major regional access issues is the potential relocation of SH 87. The USFWS has a dual role in SH 87 issues in that it is an affected landowner and is a cooperative governmental partner in resolving environmental issues related to the road relocation/reconstruction. Completion of the highway project would bring more visitors to the region, providing an opportunity for the USFWS and the State of Texas to reach a diverse audience with information on the coastal resources through interpretive displays, kiosks, and other educational facilities. A relocated/reconstructed highway would provide additional access for recreation in the area, particularly on the McFaddin NWR and at Sea Rim SP.

Other access issues include access to oil and gas resources, and access to recreational opportunities. For example, new roads and access infrastructure will continue to be a major part of oil and gas development in the region. Recreational access concerns center around the need to strike a balance between recreational use/visitation and conservation of natural resources.

2. Socio-Economic Resources Section

a. Recreational Impacts

Recreational uses of regional land occurs because of both economic and social/lifestyle reasons. The growth in ecotourism (e.g., wildlife viewing and photography) in the area supplements the traditional uses of land for hunting and fishing. Regional hunting opportunities for waterfowl are extensive, and involve large amounts of both private and public lands. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3 to 4.5 million birds, or 30-71 percent of the total flyway population. The area also winters 90 percent of the snow, Canada, and greater white-fronted geese in the Central Flyway. Additionally, the coastal marshes, prairies and prairie wetlands of the Texas

Chenier Plain region serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central/South America. The government land management agencies and many private landowners understand this link from habitats to recreation, and therefore recognize the need to protect natural resources and natural ecological processes to protect their economic, cultural, and social ties to recreation. Recreational land use will continue to be important in both economic and social terms to those who live and work in the region; however, there are many ecological threats to these recreational uses, including habitat loss/fragmentation, hydrological modifications, and developmental/urbanization pressures.

b. Economic and Social Impacts

Economic and social life in the region has had a long history of ties to the land and water of the Texas Chenier Plain region. The land and water have a rich heritage of relationships with lifestyles and commercial activity. Regional economy activity is driven by agriculture, recreation, and oil and gas development. In addition, commercial transportation activity along waterways, such as the GIWW, provides substantial economic benefit.

Agricultural activity is still an important regional activity and land use, but is generally on the decline in regional economic importance. Many remaining farmers recognize the benefits of implementing farming practices that benefit waterfowl primarily through the gain of additional income through the lease of their lands for hunting purposes. Grazing management on private lands in the region is conducted for the economic gain associated with livestock production, often without the purposeful consideration of the habitat enhancement benefits of grazing.

Outdoor recreation plays a major role in contributing to the regional economy. Activities such as hunting and fishing and bird watching are major regional activities on both private and public lands, including refuge lands. Increasing and enhancing recreational facilities and opportunities in the region generally encourage more frequent visitation and attract more diverse groups of users.

Ecotourism has already become a substantial economic contributor to the communities along the Texas Gulf Coast. While the actual amount of economic impact from bird-watching in the area is difficult to estimate, it is clear that the GTCBT and other birding opportunities in the region are drawing a substantial number of visitors to the area, and this recreational opportunity is now recognized as an important regional economic force. Communities near the GTCBT generally take an active role in providing goods and services to birders, such as hotels/motels/B&Bs, campgrounds, restaurants, gift shops, etc. Birders will continue to seek “natural” recreational experiences. Therefore, effective land management and conservation efforts will continue to be important to the growth of ecotourism in the region. In recognition of this, and in keeping with their required policies and goals, the USFWS and other agencies have initiated cooperative efforts to provide high-quality recreational opportunities, which in turn help support the local economy.

Texas remains a leader in the oil and gas industry in terms of production, refining, and petrochemicals. There is extensive oil and gas activity in the region in terms of active wells, closed wells, oil and gas infrastructure including pipelines, and refineries. According to U.S. Census data, the petroleum and chemical manufacturing industries in Chambers County accounted for 37 percent of total private industry employment and 60 percent of total private industry annual payroll in 2000. In Jefferson County, 10 percent of the employment was in the petroleum or petrochemical industry with an annual payroll that represented 20 percent of the total private sector payroll in 2000. Generally, oil and gas production has shown increase trends in recent years, and even with the cyclic nature of the industry, oil and gas production will continue to be a major regional force.

The GIWW and associated navigation/transportation channels are a major source of economic activity and revenue in the region. The GIWW is credited with contributing billions of dollars of direct and indirect annual economic impact from port revenues, payrolls, and revenues of the water transportation industries and maintenance expenditures on the canal system by the USACE. Indirectly, the GIWW is linked to

additional revenues generated by recreation, tourism, sports, and commercial fishing. Barge transportation along the GIWW is viewed as being economical, efficient, and safe.

Unlike other multiple-use agencies, economic uses of land and natural resources are secondary to the USFWS in their management of national wildlife refuges. The protection and enhancement of a refuge's natural resources always remain as a priority in decisions to permit or regulate activities. All economic uses on a refuge must be compatible with the purposes of the refuge and should support the goals of the refuge. USFWS management of the Refuge Complex has and will continue to support cooperative economic ventures only under the above conditions. Environmental protection/conservation management priorities of the USFWS, the State of Texas, and other public and private parties can conflict with other regional economic interests in some areas.

As growth and development occurs in the region, there will always be issues and concerns with public infrastructure and services matching increasing demand. Budgets for certain local governments will be difficult to balance under some situations, and it will be up to these local governments to take appropriate steps in providing adequate infrastructure and services to their citizens.

From a social and lifestyle perspective, opinions about regional environmental, natural resource management, and economic issues would continue to vary among different people and groups. Federal and/or state of Texas governmental management of land in the region would continue to be controversial, and different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to use and control of the land. Resolution of regional issues and concerns will continue to be difficult into the future.

c. Environmental Justice

While there are low-income and minority populations in the region, there is no evidence of environmental justice issues or concerns associated with specific projects or with cumulative development. Any affected populations would generally be affected in the same ways as the regional population as a whole. As noted above, different people and groups will perceive the magnitude and scope of impacts in different ways, and the importance of any specific impacts will depend primarily on individual and group values, goals, and beliefs.

3. Cumulative Impacts to Cultural Resources

Less than one percent of the region has been systematically studied; therefore, the full extent of the cultural resources in the area has not been determined. Many potential sites occur along the Trinity River and along Galveston Bay and larger inland lakes in the area (USFWS 1994, Texas Historical Commission 1996). Several archaeological sites in Chambers County have been impacted from past mining and excavation. Future protection of cultural resources is enhanced because many proposed actions (especially those projects in which a governmental agency is the proponent) are required to undergo a cultural resource survey and/or clearance as part of permitting or approval processes before lands are disturbed. This serves to mitigate potential impacts associated with disturbance of unknown cultural resource sites.

4. Summary of Cumulative Impacts

Regional environmental and natural resource management issues in the Texas Chenier Plain Refuge Complex are substantial and complicated. Issues and concerns throughout the region are generally the same as those faced by USFWS, although the regional perspective to issues and concerns is broader in geographic scale:

- The coastal area of Texas is home to over four million people and this number continues to grow.
- Houston is the nation's fourth largest city and Harris County is the nation's second most populated county.

- The world's largest petrochemical complex and some of the nation's busiest port facilities are located along the Texas Gulf coast.
- Regional land uses can compete and may be incompatible in certain locations because of different economic and natural resource management goals.
- Urbanization, industrial development, and public works projects have eliminated or fragmented habitats in many areas, thereby adversely affecting vegetation, wildlife, and the general ecological processes of the region.
- Intentional and unintentional hydrological modifications to natural conditions are substantial in the region, exacerbating coastal erosion, habitat loss/fragmentation, and subsidence problems.
- Freshwater inflows have been reduced, saltwater intrusion has increased, and the GIWW and other dredging, navigation, irrigation, and flood control projects have had a major regional impact on historical hydrological regimes and associated natural habitats.

The activities and projects in the cumulative impact area have caused substantial harm to natural conditions, but have also provided substantial economic opportunity and growth. Environmentally, the Federal and state management agencies often can only respond to "hot spot" problems; e.g., those problems that are of greatest concern at any specific point in time. This approach is necessitated by the realities of budgets and ecological/economic tradeoffs. It is this delicate balance between regional ecology and regional economy that will continue be the major challenge for the future. Even with extensive rehabilitation and management efforts, the lands and waters of the region will never be returned to natural conditions, and any further alteration must be carefully considered from a cumulative impact perspective.

Overall, the issues and problems on the expanded Refuge Complex are also clearly evident on a regional, or cumulative basis. Public parties struggle on a regular basis to achieve environmental protection and natural resource management goals while balancing other, sometimes conflicting, goals and objectives. It is clear that balancing economic benefits with environmental change is, and will continue to be, a major challenge for all stakeholders in the 21st century.