

TEXAS CHENIER PLAIN REFUGE COMPLEX

Moody National Wildlife Refuge
Anahuac National Wildlife Refuge
McFaddin National Wildlife Refuge
Texas Point National Wildlife Refuge

***Final Environmental Impact Statement,
Comprehensive Conservation Plan, and
Land Protection Plan
(Volume 1 of 2)***

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Comprehensive Conservation Plans provide long-term guidance for management decisions; set forth goals, objectives, and strategies needed to accomplish refuge purposes; and identify the U.S. Fish and Wildlife Service's best estimate of future needs. These plans detail planning program levels that are sometimes substantially above current budget allocations and, as such, are primarily for USFWS strategic planning and program prioritization purposes. The plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

Executive Summary

EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service (USFWS) has developed this Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA) of 1969 to develop alternatives for a Comprehensive Conservation Plan (CCP) and Land Protection Plan for the Texas Chenier Plain National Wildlife Refuge Complex (Refuge Complex), and disclose the impacts associated with the alternatives. The Texas Chenier Plain Refuge Complex consists of four separate units of the National Wildlife Refuge System administered by the USFWS as one Refuge Complex. The four units are: Anahuac National Wildlife Refuge (NWR), McFaddin NWR, Texas Point NWR, and Moody NWR. These Refuge units are located along the upper Texas Gulf Coast in Chambers County, Jefferson County, and Galveston County (see map on next page).

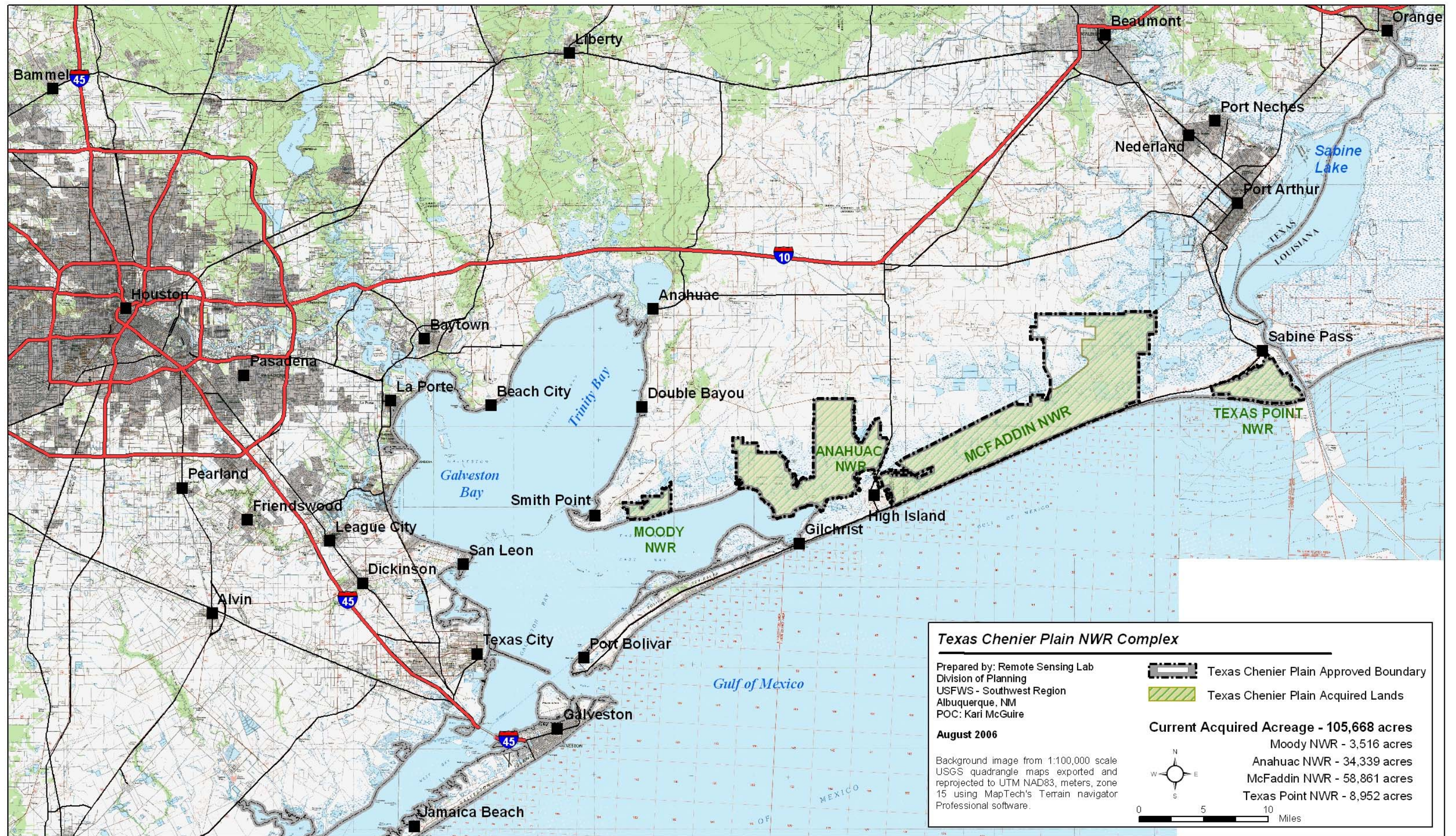
A CCP for the Texas Chenier Plain Refuge Complex is required by the National Wildlife Refuge System Improvement Act (Refuge System Improvement Act) of 1997 (Public Law 105-57). The CCP provides programmatic guidance, in the form of goals, objectives, and strategies, to provide managers with a 15-year vision that contributes to the achievement of refuge purposes and the mission of the Refuge System. The CCP provides a comprehensive look at management of waterfowl, resource values, wetlands loss, and native coastal prairie, and a desire to preserve and protect the natural values for which the Refuge was created. Specific implementation activities will be developed for individual program areas through step-down management plans within approximately 5 years after CCP completion. Some step-down plans may require additional NEPA compliance. Step-down plans anticipated for the Refuge Complex include the following:

- Revised Fire Management Plan
- Habitat Management Plan
- Oil & Gas Management Plan
- Inventory and Monitoring Plan
- Revised Hunt Plan
- Visitor Services Plan
- Integrated Pest Management Plan

The Land Protection Plan delineates a refuge acquisition boundary for the four constituent refuges to help the USFWS better achieve refuge purposes and accomplish mandates provided by law and treaty that are related to the protection of migratory birds and other USFWS Trust resources. Implementation of a boundary expansion proposal is expected to assist the USFWS meet its goals and objectives of the ecosystem plan for the Texas Gulf Coast. Expansion of any of the Refuge Complex's constituent refuge acquisition boundaries would then authorize the USFWS to work with willing sellers using the acquisition standards and parameters defined in USFWS law, policy, and government regulation. Lands acquired by the USFWS would be managed as part of the Refuge System. Although achievement of the refuge purposes is not necessarily dependent upon additional land acquisition, the possible inclusion of other lands within these refuges should assist the USFWS in achieving its larger ecosystem-wide goals and objectives to ensure the long-term sustainability of migratory bird populations.

BRIEF BACKGROUND OF THE TEXAS CHENIER PLAIN REFUGE COMPLEX

The USFWS identified a need to retain and intensively manage a significant block of the coastal marsh for waterfowl habitat in the upper coastal region of Texas. As the coastal region of Texas became settled, marshlands were modified to meet the demand for farmland and later land for industry. Waterfowl suffered loss of nesting, feeding, and resting areas when vast tracts of marshland were drained but thrived on the feed available from the rice fields and cultivated pasture lands which replaced the wetlands. As more industry flourished in the Galveston-Houston-Beaumont metropolitan area, the economic expansion created a demand for more land to accommodate the continued growth. Coastal marshes have been filled to provide sites for factories, refineries, roads, commercial, and residential areas.



Land acquisition to form the Refuge began in 1954. Currently, the Refuge Complex administers a total of 103,668 acres in combined fee title and conservation easements. As additional parcels were added to the National Wildlife Refuge System for the protection of coastal waterfowl habitat through the Migratory Bird Conservation Act, these acquisitions created a closely linked cluster of Refuges along the coast. In the early 1980s, the USFWS decided that this closely-related group of four refuges could be more efficiently administered as one Refuge Complex. Subsequently, the Refuge Complex was named for the geologic/geographic feature called “cheniers” found along this part of the Louisiana and Texas coastline.

The management focus of these refuges is to retain and intensively manage this significant block of the coastal marsh for migrating, wintering and breeding waterfowl, shorebirds and waterbirds, and provide strategic and crucial resting areas for neotropical migratory songbirds migrating across the Gulf of Mexico. The Refuge Complex encompasses a diversity of habitats: aquatic habitats (open water and near-shore Gulf habitats); freshwater to saline marshes; riparian habitats; coastal woodlots; rice fields; native prairies, cheniers, and coastal beach; and dune habitats. These areas host a multitude of plant, invertebrate and vertebrate species including over 300 bird species, 75 species of freshwater fish, and 400 species of salt and brackish water fish and shellfish. Water management, prescribed burning, and controlled grazing have been traditional tools in the management of coastal marshes in these Refuges. Rice farming has been continued on Anahuac NWR to provide valuable foraging habitats for waterfowl. Wildlife recreation including waterfowl hunting, which has been a long tradition of the area, and fishing and bird watching continue to be popular on the Refuge Complex.

Establishment Purposes of the Texas Chenier Plain Refuge Complex

National Wildlife Refuge System lands are acquired and refuges are established under a variety of legislative acts and administrative orders. The USFWS defines the purposes of national wildlife refuges when a refuge is established, based upon the establishing authorities or legislation. The primary authority used in establishing the four Refuges comprising the Texas Chenier Plain Refuge Complex was the Migratory Bird Conservation Act. National wildlife refuges established through this Act were acquired:

“...for use as an inviolate sanctuary, or for any other management purpose for migratory birds.” 16 U.S.C. § 715d (Migratory Bird Conservation Act).

Three other acquisition authorities have been utilized at Anahuac NWR, with the three following additional purposes:

“...the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions...” 16 U.S.C. § 3901 (b), 100 Sta. 3583 (Emergency Wetlands Resources Act);

“...suitable’ for — (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species...” 16 U.S.C. § 460K-1 (Refuge Recreation Act); and,

“... for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon...” 16 U.S.C. § 661-667e (Fish and Wildlife Coordination Act).

The large majority of lands within the Texas Chenier Plain Refuge Complex were acquired with Migratory Bird Conservation Funds; and, in compliance with the statutory restrictions (1958 Amendment to the Duck Stamp Act), approximately 40% of Anahuac, McFaddin, and Texas Point NWRs are open to waterfowl hunting. Priority recreation uses at the Texas Chenier Plain Refuge Complex includes the six wildlife-dependent uses in accordance with the National Wildlife Refuge Administration Act (Administration Act), as amended by the 1997 National Wildlife System Improvement Act: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Compatibility Determinations completed in accordance with the Administration Act for existing and proposed uses on the Texas Chenier Plain Refuge Complex are found in Appendix E.

National Wildlife Refuge System Mission and Goals

The mission of the National Wildlife Refuge System is:

“To administer a national network of lands and waters for the conservation, management and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.” (National Wildlife Refuge System Improvement Act of 1997)

The goals of the National Wildlife Refuge System (Director’s Order No. 132, January 18, 2001) are:

- To fulfill our statutory duty to achieve refuge purpose(s) and further the System mission.
- Conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered.
- Perpetuate migratory bird, inter-jurisdictional fish, and marine mammal populations.
- Conserve a diversity of fish, wildlife, and plants.
- Conserve and restore, where appropriate, representative ecosystems of the United States, including the ecological processes characteristic of those ecosystems
- To foster understanding and instill appreciation of fish, wildlife, and plants, and their conservation, by providing the public with safe, high-quality, and compatible wildlife-dependent public use. Such use includes hunting, fishing, wildlife observation and photography, and environmental education and interpretation.

Texas Chenier Plain Refuge Complex Vision Statement and Goals

Vision Statement

The Texas Chenier Plain Refuge Complex will provide healthy and sustainable habitats for the diverse fish and wildlife resources of this rich coastal ecosystem. The full array of the region’s native habitats - coastal marshes and prairie wetlands, coastal tallgrass prairie, and coastal woodlands - will be represented on the Refuge Complex. Protection, enhancement, and restoration of these habitats will help maintain and restore the ecosystem’s rich biological diversity.

Refuge habitats will be enhanced through management and restoration with an emphasis on benefiting waterfowl and other wetland-dependent migratory birds, declining songbird species, and all other species at risk within the ecosystem. Management activities on the Refuges will also seek to maintain and enhance habitat values for coastal fisheries, which support vital recreational and commercial fishing industries. Sound scientific monitoring and research will support an adaptive approach to management, facilitating continual refinement and improvement of Refuge management practices.

By working with partners both governmental and private, the Refuge Complex will seek to ensure the long-term sustainability of coastal wetlands threatened by erosion, subsidence, rising sea levels, and altered hydrological regimes. Working with the scientific community, the Refuge Complex will actively seek to develop and implement solutions to these complex problems.

The Refuges will provide high quality recreational and educational opportunities for the public. The importance of the Refuge Complex in supporting a rapidly expanding nature tourism industry will be increased. By reaching out to and working within our communities, awareness of the importance of conserving fish, wildlife and habitats will increase and new and innovative opportunities to promote and implement conservation on private lands will emerge. By helping to conserve natural resources, the Refuges will maintain and enhance the quality of life for residents, who have always greatly valued and treasured the region’s rich natural heritage.

Goals

The Texas Gulf Coast Ecosystems goals and objectives were considered in developing the Refuge goals. The goals of the Texas Chenier Plain Refuge Complex are:

- Goal 1 - Conserve, enhance and restore the Texas Chenier Plain region's coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent migratory birds, and habitat for other native fish and wildlife.
- Goal 2 - Conserve, enhance and restore the Texas Chenier Plain region's coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/earctic migratory birds, and habitat for other native wildlife.
- Goal 3 - A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.
- Goal 4 - By working with others locally and on a landscape level, threats to biological integrity, biological diversity and environmental health on the Refuge Complex will be addressed.
- Goal 5 - All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex's role in conserving the region's coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast.

SUMMARY OF SCOPING AND PUBLIC INVOLVEMENT

Major issues related to the proposed actions were actively solicited from the general public, local public officials, local governmental entities, affected landowners, federal and state agencies, private organizations, and the USFWS' interdisciplinary core Planning Team. A "Notice of Intent to Prepare a Comprehensive Conservation Plan and Associated Environmental Impact Statement" was published in the Federal Register on October 21, 1999. The public scoping efforts began with public meetings on January 11-12, 2000; public workshops on November 16 & 18, 2000; a town hall meeting on March 20, 2000; multiple briefings for local government officials and their staffs; and a waterfowl hunters' forum on October 23, 2000. A second set of public scoping meetings were held on June 18 & 20, 2002 to present a conceptual set of the management alternatives and refuge boundary alternatives. A mailing list of over 1,200 persons and organizations is maintained at the Refuge Complex Office and was used to distribute planning newsletters and public meeting announcements. A summary of public involvement efforts is provided in Chapter 1, Part VI of the EIS/CCP/LPP.

MAJOR ISSUES

Four (4) major issues identified during the public and internal scoping process were considered during the development of alternatives and evaluations of environmental impacts.

Issue 1: Expansion of the Refuge Complex (Land Acquisition)

- The USFWS has insufficient resources (people and money) to adequately manage current lands, never mind any additional lands it might acquire. USFWS should spend its money on taking care of what they already own, not spend it on buying more land that they won't be able to adequately manage.
- Private lands would be taken away through condemnation in a big Federal "land grab."
- Federal land acquisition removes lands from the tax rolls and causes a permanent loss of tax base. This results in substantially lower revenues to the counties, school districts, and other taxing entities.
- USFWS should have a large expansion of the Refuge Complex to include all the marshes and adjoining uplands in both Jefferson and Chambers Counties because all of those lands will eventually be lost to development.
- Land acquisition by USFWS would cause large negative economic impacts to agribusiness and the service industry that supports it because ongoing agricultural practices will cease when USFWS acquires land.

- Land acquisition by USFWS would harm the commercial waterfowl guide and outfitter industry because commercial guides/outfitters would lose leases on lands acquired in fee title by the USFWS.
- The commercial alligator ranching industry would be negatively impacted by USFWS land acquisition. Most alligator eggs supporting this industry come from the wild on private lands and most eggs are currently collected in areas identified for refuge expansion. Alligator egg collecting is not allowed on refuge lands.
- Land acquisition by the USFWS would cause negative economic impacts because restrictions imposed on oil and gas development on refuges limits or prevents such development from occurring.
- The USFWS should acquire and protect woodlots as critical resting and foraging habitat for neotropical migratory birds.
- Conservation easements should be considered as a means of protecting wildlife habitat while still retaining lands in private ownership.
- Major drainage/flood control projects being planned for western Jefferson County and eastern Chambers County would be prevented or made more difficult by USFWS land acquisition.
- Waterfowl hunting would decrease on lands acquired by the USFWS because hunting is allowed on only up to 40% of the lands acquired with Migratory Bird Conservation Funds and hunting is allowed only three days a week until noon on the refuges.
- Conservation easements negatively impact waterfowl hunters who have helped fund the acquisition with their duck stamp purchases because typically, the USFWS doesn't purchase hunting rights, and therefore the property is not open for public hunting.
- Conservation of coastal wetlands and associated habitats in the project area through additional land acquisition by the USFWS is needed to ensure healthy populations of waterfowl, shorebirds and other migratory birds.
- Native coastal prairie should be acquired and protected because most of the native tallgrass coastal prairie on the Texas Gulf Coast has already been lost to development and conversion to other land uses. Protection of remaining prairies is critical to protecting the region's biological diversity.
- Many "at risk" fish, wildlife and plant species would benefit from additional habitat protection through USFWS land acquisition in the project area.

Issue 2: Administration of Wildlife-Dependent Recreational Uses

- The areas on the refuges open to waterfowl hunting are inaccessible. Access to the marsh in the areas open to hunting is so difficult that it limits hunting to young, in-shape hunters.
- The USFWS closes the areas on the refuges where the best waterfowl hunting is located.
- All of the refuges should be closed to hunting and maintained as "inviolate sanctuaries".
- The USFWS does not provide adequate facilities for disabled hunters.
- The USFWS should allow hunting of other species including rails, gallinules, mourning doves, and feral hogs.
- Waterfowl hunting opportunities on the refuges are too restricted by only opening the refuges to hunting three days per week until noon.
- The reservation and permit issuance system at McFaddin NWR is not working well and is inherently unfair to parts of the working public. Also, waterfowl hunters accessing McFaddin's Star Lake from adjacent private lands have an unfair advantage over hunter's entering through the main refuge entrance.
- Airboats should or should not be allowed on the refuges.
- The USFWS should improve access for waterfowl hunting by developing more access facilities (roads, boat launches, access ditches, walkways, etc.) and by supporting the reconstruction of State Highway 87.
- An annual Hunting Permit which applies to the entire Refuge Complex should be made available to the public by the USFWS.

- The USFWS should offer more “spaced blind” hunting opportunities on the refuges to decrease the problems caused by hunters setting up too close to each other and interfering with the quality of each other’s hunts.
- The USFWS should improve maintenance of existing facilities (roads, boat ramps, etc.) and develop new facilities (fishing piers, walkways, etc.) to support recreational fishing on the refuges.
- Additional fishing, wildlife observation and photography opportunities should be provided on McFaddin NWR by lengthening the hours the refuge is open on weekdays, opening the refuge on weekends, and allowing these uses in additional areas of the refuge.
- The USFWS should improve maintenance on existing and develop additional facilities for wildlife observation and photography (paths, boardwalks, observation platforms, photography blinds, etc.)
- More interpretive signs and kiosks are needed on the refuges to interpret natural resources and refuge management programs and to provide more information to orient visitors.
- The Refuge Complex needs a new Visitor Center/Administrative Headquarters in Chambers County. This building should include interpretive exhibits and classroom space to support the environmental education and interpretive programs on the refuges.

Issue 3: Habitat Management and Restoration of Refuge Lands

- The USFWS has done a poor job managing for waterfowl because there were more ducks and geese in the marsh before the USFWS took over.
- The USFWS is holding too many ducks and geese in refuge sanctuary areas, where they are unavailable to hunters.
- The Willow Slough Levee and spillway project on the North Unit of McFaddin NWR has impeded drainage in upstream areas and has caused flooding on adjacent private land resulting in the landowners being unable to farm rice.
- Smoke from prescribed burning activities is causing air quality problems in the Beaumont-Port Arthur area. Even when prescribed burns are done on a north wind, smoke which has blown out over the Gulf gets blown back into town when the wind turns around the next day.
- The marshes on McFaddin NWR are drying up. When it was privately-owned, water was managed better and marshes stayed wet for waterfowl and other wildlife.
- Too much water is held on marshes on Anahuac NWR, for too long. This causes problems with the vegetation and also depletes oxygen from the water causing fish kills.
- The USFWS is not adequately maintaining water control structures and other infrastructure, thereby allowing saltwater intrusion which is destroying the marshes.
- Most of the refuges were bought with “Duck Stamp” dollars, generated by hunter’s purchases; therefore, the USFWS should be managing habitat on these refuges primarily for migratory waterfowl.
- The timing of refuge prescribed burns, combined with a better grazing program, should be modified to improve the habitat benefits to waterfowl.
- The USFWS should burn more acreage and more often.
- Prairie habitats should be restored because most native prairie on the Texas Gulf Coast has been lost and this habitat type is critically important for declining populations of grassland songbirds and other rare native plants and animals.
- The USFWS should restore, enhance and protect woodlots because these habitats are critical for nearctic/neotropical migratory birds, especially those making trans-Gulf migrations in the spring.
- Refuges should expand habitat management efforts for shorebirds.
- Annual breeding pair and monthly wintering waterfowl surveys on Texas Coast national wildlife refuges indicate the Mottled Duck populations are declining. Refuge habitat projects are needed to restore/enhance shallow freshwater wetlands and grasslands to provide brood-rearing and nesting habitat for Mottled Ducks.
- Alligator populations on the refuges are too high and may be negatively impacting Mottled Duck production.
- The USFWS needs to expand monitoring and biological research to gain baseline data on all native fish, wildlife and plant species, with rare and declining species being the priority.

- The USFWS should expand existing and develop new partnerships to enhance conservation of natural resources in the project area. This includes working with landowners, volunteers, conservation organizations, industry and other agencies.

Issue 4: Threats to the Ecosystem

- Rising sea levels, land subsidence and reduced sediment supplies have accelerated coastal erosion along the Gulf of Mexico, resulting in significant loss of wetlands and other important coastal habitats on McFaddin and Texas Point NWRs. Shoreline erosion is also a concern along Anahuac NWR's Galveston Bay shoreline.
- Loss of the barrier beaches and dunes on McFaddin NWR has resulted in increased saltwater intrusion in interior marshes, and coastal erosion and wetland loss on McFaddin NWR will greatly accelerate if the already threatened beach ridge is lost completely.
- Saltwater intrusion, erosion of marsh soils, subsidence and rising sea levels are factors contributing to marsh loss (conversion of emergent marsh to open water) in the project area's interior marshes.
- Erosion along the Gulf Intracoastal Waterway is also causing wetland loss and is threatening thousands of acres of fresh and intermediate marshes on McFaddin and Anahuac NWRs with saltwater intrusion and conversion to brackish marsh.
- Land subsidence and eustatic sea level rise pose a significant future threat to the region's coastal wetlands. If marshes cannot accrete vertically (gain elevation through soil building processes) at a rate which keeps up with relative sea level rise (subsidence plus eustatic sea level rise), marshes will be inundated and converted to open water resulting in a major loss of wildlife habitat.
- Loss or restriction of freshwater inflows has contributed, along with saltwater intrusion, to the conversion of historically fresh or intermediate marsh to brackish marsh resulting in a loss of biological diversity.
- Chinese tallow is a highly invasive exotic plant species which rapidly invades upland habitats and shallow wetlands, levees, and fallowed fields in the project area. It quickly forms monotypic closed-canopy stands, out-competes native plants and provides few benefits to native wildlife resulting in a loss of biological diversity.
- Several exotic/invasive aquatic plant species, including water hyacinth and alligatorweed, are also threatening biological diversity and wetland habitat value for migratory waterfowl and other native fish and wildlife species. Giant Salvinia, which is a great threat to freshwater wetlands, has recently been discovered in the project area.
- Deep-rooted sedge, a South American sedge, has recently become established and is invading fallowed rice fields and wet pastures in the project area. Little is currently known about this invasive species, other than it forms dense monotypic stands and out-competes native plants.
- Feral hogs are causing damage to habitats and management infrastructure on the Refuge Complex.
- The USFWS must expand its Integrated Pest Management Program and overall efforts to manage exotic and invasive species.
- Contaminants in the air, water, and soils pose a threat to native fish and wildlife in the region. Petroleum and petrochemical spills from underground pipelines and shipping in the Gulf Intracoastal Waterway and the Gulf of Mexico could have significant negative impacts on habitats, fish and wildlife.

GENERAL DESCRIPTION OF THE ALTERNATIVES AND ASSOCIATED ENVIRONMENTAL CONSEQUENCES

The alternatives must meet the purposes of the Federal proposal, meet the goals of the refuges, and comply with the missions of the Refuge System and the USFWS. NEPA also requires that the alternatives include the alternative of "No Action" and rigorously explore and objectively evaluate a reasonable range of alternatives.

The USFWS is considering two separate, but related federal actions and purposes within this EIS. The first proposes the development of a CCP for each of the Refuges in the Refuge Complex, and the second proposes the expansion of the Refuge boundary for each of the Refuges in the Refuge Complex. To more accurately inform the public and to better facilitate analysis of the impacts, the USFWS has developed two separate sets of alternatives, with each set addressing one of the two Federal actions. There is a set of “Refuge Management Alternatives” addressing the development of a CCP for each Refuge, and there is a set of “Refuge Boundary Expansion Alternatives” addressing the expansion of each Refuge’s boundary. Each set contains the appropriate “No Action” alternative, explores and evaluates a reasonable range of alternatives to the proposed action, and identifies a “Preferred Alternative” to be implemented.

The following criteria will be used in selecting the alternatives for implementation:

- Best meets the Refuge System mission
- Best meets the refuge purposes
- Best meets the USFWS Biological Integrity, Biological Diversity, and Environmental Health Policy

Based on this criteria, 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. A CCP and a Land Protection Plan for the Preferred Alternatives are presented in Appendix D and Appendix H, respectively, which represent the final plan products that would be implemented if these alternatives were selected.

The environmental consequences that could result from the management prescriptions of the five Refuge Management Alternatives (A-E) and four Refuge Boundary Expansion Alternatives (A-D) are described in Chapter 4 and are summarized and compared in tables located at the end of Chapter 4, Parts A and B of the EIS/CCP/LPP. A general summary of those impacts identified are presented in this section below the alternatives descriptions. Combined and cumulative impacts are discussed in detail in Chapter 4, Part C.

Refuge Management Alternatives

The CCP provides a framework for future management of the Moody, Anahuac, McFaddin, and Texas Point NWRs. The CCP is designed to serve as a vision for the Refuge Complex and provide management guidance through maintenance, restoration, and use of Refuge resources during the next 15 years. The environmental analysis of this plan is addressed at the conceptual and programmatic level. While it contains some relative analytical specificity, it is not intended to be a detailed site plan with exact locations for facilities or precise descriptions of programs. Overall, there is a need to make the management of each Refuge consistent with the National Wildlife Refuge System mission, goals, and policies. The five Refuge Management Alternatives (A - E) are listed below with a short summary for each. Each of these five Refuge Management Alternatives is described in much more detail in Chapter 2, Part A of the EIS/CCP/LPP.

Elements Common to All Refuge Management Alternatives

Although the Refuge Management Alternatives all differ in their emphasis and focus, the management programs for each of the Alternatives have a number of elements or features common to all. Following is a description of those elements or features common to all of the Refuge Management Alternatives. More detail is provided in Chapter 2, Part A of the EIS.

- **Complete Land Acquisition within Current Refuge Boundaries.** The remaining lands within the current Refuge boundaries will be acquired when, and if, the owners are willing to sell and funding is available.
- **Wilderness Review.** The USFWS is required to conduct a wilderness review for each Refuge as part of the CCP process, which is contained in Appendix F in the EIS.

- **Protection of Cultural Resources.** The USFWS will ensure the same level of cultural resource protection required by law under each of the Refuge Management Alternatives.
- **Protection for Research Natural Areas (RNAs).** RNAs are areas where natural processes are allowed to predominate without human intervention. There is one RNA within the Texas Chenier Plain Refuge Complex, the 200-acre Lone Tree Bayou Research Natural Area located within the Anahuac NWR.

Alternatives Considered

There were five alternatives considered and analyzed for Refuge Management. In addition to the No Action Alternative (Refuge Management Alternative A) and the Preferred Alternative (Refuge Management Alternative D), three other action alternatives were considered. These alternatives are briefly discussed below.

- **Refuge Management Alternative A (NEPA No Action Alternative): Continuation of Current Management.** Under this Alternative, current management programs on the Refuge Complex would continue unchanged. Management of wetland habitats, coastal marsh, prairie, and woodlands to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory birds would continue at current levels and intensities using existing techniques. Currently, activities include prescribed burning on 12-15,000 acres annually, rotational grazing on approximately 41,000 acres, water level and salinity management (approximately 30,000 acres of semi-impoundments and impoundments on the Refuge Complex), rice farming on 500-700 acres, 500 acres of moist soil units, and mowing and haying on 100 acres. The Refuge Complex biological program involving systematic field surveys to monitor population status and trends of migratory birds including waterfowl, shorebirds and neotropical and neoartic migratory songbirds, alligators, and habitats would continue. Ongoing efforts to address threats to ecosystem health posed by relative sea level rise and hydrological alterations, invasive/exotic species and contaminants would continue. These include coordination with other agencies and conservation organizations on ongoing planning processes and studies aimed at developing solutions to address coastal land loss, continuing to implement small-scale erosion abatement projects along the Gulf of Mexico, Galveston Bay and the Gulf Intracoastal Waterway through interagency partnerships, and maintaining existing shoreline restoration projects. Invasive plant and animal control programs would continue at current levels. The Refuge Complex would continue to provide opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation through the use of existing programs and facilities. Waterfowl hunting opportunities would continue under existing regulations on approximately 37,300 acres of the Refuge Complex.
- **Refuge Management Alternative B: Emphasis on Intensifying Management of Wetland Habitats for Waterfowl, Shorebirds, Wading Birds, and Other Wetland-Dependent Migratory Birds.** Under this Alternative, the Refuge Complex would focus its management efforts on active management of wetland and upland habitats to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory and resident birds. The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses, with an emphasis on providing more public hunting opportunities.
- **Refuge Management Alternative C: Emphasis on Native Habitat Restoration and Addressing Major Threats to the Ecosystem.** Under this Alternative, the Refuge Complex would focus its management efforts on restoring wetlands, native prairie and woodlots, and on reversing trends of loss and degradation of these native habitats by increasing efforts to address coastal erosion, saltwater intrusion, and loss of freshwater and sediment inflows. The Refuge Complex would continue to provide the current level of opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses.
- **Refuge Management Alternative D (Preferred Alternative): Emphasis on an Integrated Management Approach Combining: 1) Expanded Habitat Management and Restoration Programs, 2) New Research and Wildlife Population Monitoring, and 3) Increased Efforts to Address Major Threats to the Ecosystem.** Under this Alternative, the Refuge Complex would

continue and expand current habitat management and native habitat restoration programs, with increased monitoring and research to assess management actions and facilitate an adaptive management approach. Management under this Alternative is explained in more detail on the following pages.

- **Refuge Management Alternative E: Emphasis on a Passive Management Approach.** Under this Alternative, the Refuge Complex would change its management focus from active habitat management and restoration to a more passive management approach, in which plant communities and wildlife populations are influenced primarily by natural events such as lightning-caused fires, herbivory by native wildlife, and tidal or stream flooding. The Refuge Complex would continue to provide opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation, but administrative oversight and management would occur at reduced levels.

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

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

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

The following summary of impacts would be associated with implementation of this alternative. A detailed description of the impacts analysis is provided in Chapter 4, Part A, Section IV.

- **Impacts to Air Quality.** Potential smoke impacts to air quality would continue to occur from USFWS prescribed burns on 12-15,000 acres annually.
- **Impacts to Geology and Soils.** Shoreline protection and marsh restoration help reduce coastal land loss. Water management and prescribed burning may contribute to organic soil formation. A substantial increase in shoreline protection and marsh restoration using dredge material would occur through expanded interagency coordination. Expanded monitoring and research on factors affecting coastal land loss would also occur.
- **Impacts to Hydrology and Water Quality.** Extensive water management would continue to help maintain historic continuum of coastal marsh habitats by reducing saltwater intrusion, managing water levels, and providing freshwater inflows. It would protect nationally-declining wetland types. Expanded interagency coordination would occur on watershed hydrologic

restoration projects, enhancement of water management, and acquisition of additional water rights. Water quality monitoring would also be expanded.

- **Impacts to Vegetation and Habitats.** Structural marsh management would continue to help maintain / restore a historic continuum of coastal marshes and plant and animal communities that are dependent on these habitats. Moist soil units would be expanded and the same levels of cooperative rice farming would occur. Native prairie plant associations would be increased by restoring 2,223 acres to native prairie and 29 acres to woodlands. Refined burning and grazing to increase benefits to migratory birds and other wildlife would occur. The IPM program would be expanded to additional areas. Interagency coordination efforts would be expanded to increase shoreline protection and marsh restoration. Additional monitoring and research to assess threats to habitats would also occur. Visitation would increase and Public Use Programs would result in some impacts to wetland vegetation, primarily from motorized boating (associated with hunting/fishing) and local impacts to habitats in heavily used areas. Regulations would help ensure that impacts are localized and not substantial. Impacts from the biological program, management of oil and gas exploration/development, and community outreach and partnerships would minimize impacts to habitats. Expanded monitoring and research would guide habitat management and restoration and improve exotic and invasive species management. Outreach and partnerships to increase habitat restoration and protection would also be expanded.
- **Impacts to Fish and Wildlife.** Expanded and enhanced habitat management and restoration activities would result in a diverse habitat mosaic which increases benefits to wintering waterfowl, Mottled Ducks, shorebirds, wading birds, and other wetland-dependent migratory birds. Prairie restoration and woodlot protection would benefit many declining landbird species. Overall, this Alternative provides greatest diversity of habitats benefiting several Avian Species of Conservation Concern. Increased beneficial impacts to fisheries would occur by incorporating fish passage into water management protocols. Management aimed at ensuring biological diversity and ecological integrity would benefit Threatened and Endangered species, declining species, and other wildlife species. An increase in all types of visitation associated with public use programs would be expected to result in minimal, localized increases in impacts to migratory birds and other wildlife. No change in impacts to Threatened and Endangered species or fisheries would be anticipated. Expansion of all programs associated with the biological program, management of oil and gas exploration/development, and community outreach and partnerships would enhance benefits to fish and wildlife resources. Additional monitoring and research would focus on priority avian and other wildlife species.
- **Economic Impacts.** A substantial increase in direct contributions from Refuge operations by \$1.0m would occur. Smaller increases in grazing (\$.3m) and recreational visitors (\$.2m) would occur, but rice farming would remain at \$.25m. Corresponding increases in indirect and induced economic impacts would be anticipated with increases in direct impacts.
- **Impacts on Populations, Fiscal Impacts on Local Governments, and Social Impacts.** No environmental justice or population impacts would be anticipated. Payments would continue to local government entities under Refuge Revenue Sharing Act. Social conditions would remain generally unchanged with unresolved issues.
- **Cultural Impacts.** There is a potential for direct and indirect impacts to cultural sites under all of the management alternatives; however, avoidable impacts would not be considered adverse, but rather minor in nature. Unavoidable adverse impacts are anticipated to continue to occur at potentially eligible sites from natural phenomenon. In addition, this alternative may also reduce wave action at the McFaddin Beach site. Because water control and facilities construction and improvements occur more frequently under Refuge Management Alternative D, cultural resources may indirectly benefit.

Summary of Impacts from Other Alternatives Analyzed

The following summary of impacts would be associated with implementation of the four other alternatives analyzed. A detailed description of the impacts analysis is provided in Chapter 4, Part A, Sections I, II, III, and V.

Impacts under Refuge Management Alternatives A, B, and C would be similar to Alternative D; however, different management emphasis under Alternatives A, B, and C would result in focus of management

actions and extent of management. Refuge Management Alternative D represents the medium between Alternatives B and C and changes to issues identified under Alternative A. For example, prescribed burning and associated impacts would increase under Alternative B and decrease under Alternative C, but would not change between Alternatives A and D. Two new marsh semi-impoundments would expand water management under Alternative B, whereas interagency coordination and acquiring water rights would be the focus under Alternative C. Existing water management practices would continue under Alternative A. Existing cooperative rice farming would continue under Alternative A, increase under Alternative B, and be phased out under Alternative C. Native prairie restored and coastal woodlots protected under Alternative A. Prairie restoration would be reduced under Alternative B and would increase under Alternative C. Integrated burning, grazing, and water management would continue under Alternative A. Burning and grazing programs would be expanded under Alternative B and would be reduced under Alternative C. Economic impacts would also vary from Alternative D. Under Alternative A, refuge operations contribute \$2.7 million (m) directly to the local economy; refuge agriculture programs add \$2.1m (grazing) and \$.25m (rice farming); recreational visitors contribute another \$1.1m; and indirect and induced economic impacts from these direct impacts contribute an estimated \$3.3m more to local economies. Under Alternative B, direct contributions from refuge operations would increase by 10%, from grazing by \$0.5m, rice farming by \$0.16m, and recreational visitors by \$0.1m, with corresponding increases in indirect and induced economic impacts from increases in direct impacts. Under Alternative C, direct contributions from refuge operations would increase by 25%, but there would be substantial decreases from grazing by \$1.1m and rice farming by \$0.25m, and a very small increase in direct expenditures by recreational visitors. Corresponding increases or decreases in indirect and induced economic impacts would be dependent on direction of change in direct impacts.

Impacts associated with Refuge Management Alternative E would be markedly different from all other alternatives, as this alternative would remove all active management. Many programs and associated impacts would be discontinued, such as prescribed burning, shoreline protection and restoration, water management, moist soil units, cooperative rice farming, grazing, and the IPM program. Other programs such as surveys and monitoring and outreach and partnerships would be reduced to passive maintenance levels. This type of management in turn would generally result in increased coastal land loss, saltwater intrusion, loss of freshwater, altered hydroperiods, later successional plant communities, and increased populations of exotic / invasive plant and animal species. This in turn would decrease habitat values and use by waterfowl and other migratory birds and wildlife, contrary to the mission and goals of the Refuge Complex. As a result, visitation would decrease as well as direct economic contributions from refuge operations (by more than half by end of planning period) along with complete elimination of revenues from all refuge agricultural programs. A small localized reduction in employment in a rural area could also occur.

Refuge Boundary Expansion Alternatives

The second proposal addressed in this EIS/CCP/LPP is that of expanding the acquisition boundary of the four constituent refuges. The purpose of implementing a refuge boundary expansion proposal is to help the USFWS achieve larger mandates provided by law and treaty that are related to the protection of migratory birds and other Trust resources. Implementation of a boundary expansion proposal is expected to assist the USFWS meet its goals and objectives of the ecosystem plan for the Texas Gulf Coast. Although achievement of the refuge purposes is not necessarily dependent upon additional land acquisition, the possible inclusion of other lands within the refuges would assist the USFWS in more effectively managing existing refuges in this Refuge Complex and achieving its larger ecosystem-wide goals and objectives to ensure the long-term sustainability of migratory bird populations. Expansion of any of the Refuge Complex' constituent refuge acquisition boundaries would thereby authorize the USFWS to work with willing sellers using the acquisition standard and parameters defined in USFWS law, policy, and government regulations. Lands acquired by the USFWS would be managed as part of the National Wildlife Refuge System. The four Refuge Boundary Expansion Alternatives (A-D) are listed below with a short summary for each. Each of these four Refuge Boundary Expansion Alternatives is described in much more detail in Chapter 2, Part B of the EIS/CCP/LPP.

Elements Common to All Refuge Boundary Expansion Alternatives

Although the Refuge Boundary Expansion Alternatives all differ in the areas proposed for acquisition, the land acquisition program for each of the Alternatives has a number of elements or features common to all. The following is a list and description of those elements or features common to all of the Refuge Boundary Expansion Alternatives. More detail is provided in Chapter 2, Part B of the EIS/CCP/LPP.

- **Willing Sellers Only.** Although the USFWS, like all agencies of the United States Government, has condemnation authority, it is USFWS policy to acquire land and interests in land from willing sellers only. No lands have been condemned in the past for any refuge in the Refuge Complex and the USFWS does not propose condemnation of any lands in the future. The USFWS can acquire land or interests in land only within an approved refuge boundary. In fact, the USFWS can't even accept a donation of land outside of an approved refuge boundary. Lands in any of the refuge boundary expansions would be acquired only from willing sellers as funding becomes available. Landowners within an expanded refuge boundary would be completely free to keep their land, to sell their land to whoever they wished, to leave their land to their heirs, or to change uses of their land.
- **Acquisition methods.** For all land and interests in land acquired by the USFWS, title is taken by the United States of America. The USFWS acquires most land in one of two ways: 1) in fee, or 2) conservation easement. Both methods have been used in the past on the refuges in the Refuge Complex (A detailed acquisition history for each of the Refuges is located in the description of Refuge Boundary Expansion Alternative A: No Action in Chapter 2, Part A of the EIS/CCP/LPP). The "fee" means virtually all of the rights and interests in the land, that which would be generally recognized as "ownership of the land". Fee acquisition removes the land from the tax rolls. With conservation easements, the private landowner retains "ownership of the land" and associated tax obligations. Conservation easements can consist of one or more of the two following categories of interests in land: 1) negative covenants, which prevent a specific use (i.e., no development); and 2) possessory interests, which grant a specific use right (i.e., public hunting). Conservation easements are appraised and purchased in the same way as fee acquisitions. In a few instances, the USFWS acquires interests in land by lease, right-of-way easement, or agreement. These are typically either for a shorter period of time or for more limited use purposes compared to fee and conservation easements.
- **Acquisition funding sources.** The USFWS has only two primary land acquisition funding sources: 1) the Migratory Bird Conservation Fund and 2) the Land and Water Conservation Fund (LWCF). With funds acquired through the sale of Federal Duck Stamps, the Migratory Bird Conservation Fund has been the primary source of funding for land acquisition for all of the refuges within the Refuge Complex and it is expected that it will remain the primary source of funding in the future. This discretionary land acquisition funding source is very actively competed for on a national level within the USFWS. Some LWCF money has been appropriated to purchase land at McFaddin NWR, but it has been a minor amount compared to the amount of Migratory Bird Conservation Funds used for land acquisition on the Refuge Complex.
- **Refuge Revenue Sharing.** Lands acquired by the USFWS in fee are removed from the tax rolls, because as an agency of the United States Government, the USFWS, like city, township, county and state governments, is exempt from taxation. Those lands in which the USFWS only acquires a conservation easement remain on the tax rolls and the tax obligation remains with the private landowner. The Refuge Revenue Sharing Act (the Act of June 15, 1935, as amended in 1978 by Public Law 95-469) or (16 U.S.C. 715s) authorizes the USFWS to make payments to the county or other local unit of government to offset the tax losses for lands administered solely or primarily by the USFWS. The net income the USFWS receives from the sale of products or privileges on Refuges (like timber sales, grazing fees, right-of-way permit fees, etc.) is deposited in the National Wildlife Refuge Fund for revenue sharing payments. Table 3-52, representing the ten-year history of Refuge revenue sharing payments for the Refuge Complex, is located in Chapter 3, Affected Environment of the EIS/CCP/LPP. All lands acquired in the future or lands donated in the future to the Refuges would be included in the calculation and payment of Refuge Revenue Sharing payments.

- **Habitat and public use management on newly acquired lands.** Lands which are acquired in the future within the expanded refuge boundaries will be managed under the concepts expressed in the Preferred Refuge Management Alternative (Refuge Management Alternative D).

Alternatives Considered

There were four alternatives considered and analyzed for Refuge Boundary Expansion. In addition to the No Action Alternative (Refuge Boundary Expansion Alternative A) and the Preferred Alternative (Refuge Boundary Expansion Alternative C), two other alternatives were considered. These alternatives are briefly discussed below. A summary of the existing land acquisition status is provided in the table below.

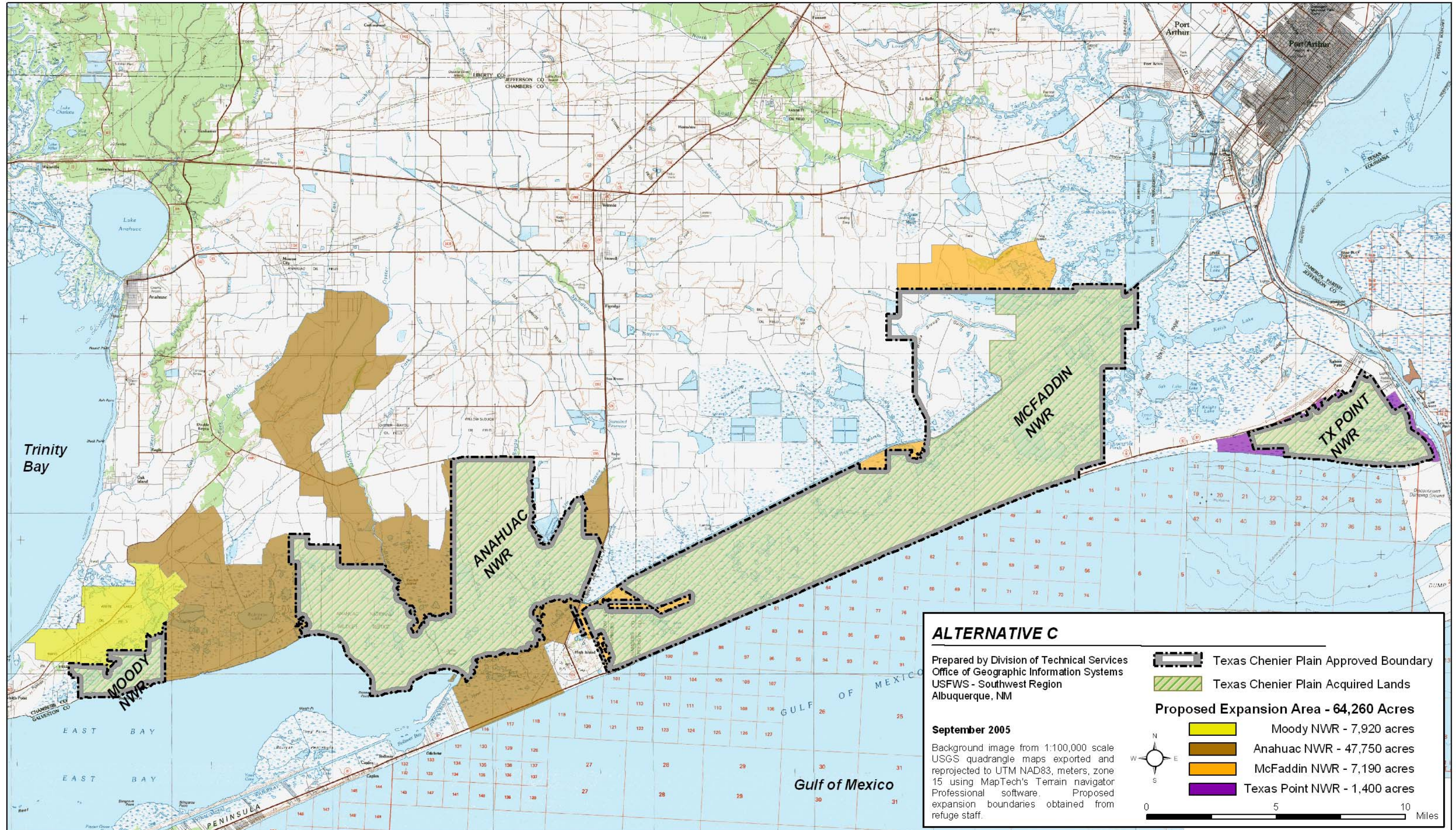
Summary of Current Land Acquisition Status			
<u>Refuge</u>	<u>Approved Boundary</u>	<u>Acquired Lands</u>	<u>Percentage Acquired</u>
Moody NWR	3,516 acres	3,516 acres	100%
Anahuac NWR	34,339 acres	34,339 acres	100%
McFaddin NWR	70,710 acres	58,861 acres	83%
Texas Point NWR	8,952 acres	8,952 acres	100%

- **Refuge Boundary Expansion Alternative A (NEPA No Action Alternative): No Expansion, Current Status.** This Alternative assumes no change from the existing refuge boundaries within the Refuge Complex. This is the “no action” alternative as required under NEPA and is considered the base from which to compare the other expansion alternatives. There would be no expansion of any of the four refuge boundaries within the Refuge Complex.
- **Refuge Boundary Expansion Alternative B: 33,590 Acre Expansion.** This Alternative continues the four refuges’ historic focus on land acquisition primarily in the coastal marsh and the adjacent agricultural uplands that are contiguous to existing refuges.
- **Refuge Boundary Expansion Alternative C (Preferred Alternative): 64,260 Acre Expansion*** ***Please note that this alternative includes all of the lands in the Refuge Boundary Expansion Alternative B.** Similar to Refuge Boundary Expansion Alternative B, this Alternative continues the four refuges’ historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands, and includes two areas of important native coastal prairie. Management under this Alternative is explained in more detail on the following pages.
- **Refuge Boundary Alternative D: 104,120 Acre Expansion*.** *Please note that this alternative includes all of the lands in the Refuge Boundary Expansion Alternative C. Similar to Refuge Boundary Expansion Alternative C, this Alternative continues the four refuges’ historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands that are contiguous to existing refuges. In addition to these primarily wetland areas, this Alternative also includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. This Alternative also includes an important near-coast bottomland hardwood area, which is an acquisition target new to this Refuge Complex.

Refuge Boundary Expansion Alternative C (Preferred Alternative): 64,260 Acre Expansion* ***Please note that this alternative includes all of the lands in the Refuge Boundary Expansion Alternative B.** Similar to Refuge Boundary Expansion Alternative B, this Alternative continues the four refuges’ historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetlands portions of this expansion alternative concentrate on high-value wintering waterfowl habitats near the coast that are contiguous to existing Refuges. In addition to these primarily wetland areas, this Alternative includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. In addition to these two kinds of high biological value habitats, this Alternative also includes areas identified as necessary for refuge management. Expansion is proposed for each of the four refuges in the Refuge Complex (see map on next page).



Texas Chenier Plain Refuge Complex & Proposed Expansion Areas



The following summary of impacts would be associated with implementation of the preferred alternative. A detailed description of the impacts analysis is provided in Chapter 4, Part B, Section I of the EIS/CCP/LPP.

- **Impacts to Air Quality.** Smoke impacts to air quality from USFWS prescribed burning on newly acquired lands would be mitigated by strict adherence to prescription parameters.
- **Impacts to Geology and Soils.** USFWS would expand interagency coordination to address threats from coastal land loss on newly acquired lands, with goal of implementing major structural erosion abatement projects implemented along Gulf, Gulf Intercoastal Waterway, and East Galveston Bay shorelines. USFWS water management and prescribed burning on newly acquired lands may benefit soil formation and vertical accretion in marshes.
- **Impacts to Hydrology and Water Quality.** Wetland management and hydrologic restoration by USFWS on newly acquired lands would help restore historic continuum of fresh, intermediate, brackish, and saline marshes which support a natural diversity of native plant, fish, and animal communities. USFWS would increase efforts to improve water quality.
- **Impacts to Vegetation and Habitats.** USFWS would use habitat management and restoration activities, such as structural water management, on newly acquired lands to control salinities and water levels within marsh habitats to mimic natural marsh hydroperiods and provide more productive habitats for fish and wildlife. Moist soil management would be expanded and cooperative rice farming would be maintained where possible on newly acquired lands to provide freshwater habitat for waterfowl and other migratory birds. Prairie restoration and management on newly acquired lands would increase the abundance of native prairie grasses and forbs, protecting Globally Imperiled plant communities. USFWS would increase protection and enhancement of woodlot habitats. USFWS would use prescribed burning, controlled grazing, and exotic/invasive species control to enhance native habitats on newly acquired lands. Shoreline protection/restoration and marsh restoration on newly acquired lands would positively impact nationally-declining wetland habitats. Motorized boating for fishing and hunting can impact wetland vegetation; impacts from other public uses would be localized and minimal. The biological program would support the adaptive management approach and oil and gas management would reduce impacts to vegetation/habitats. Continuation of outreach and partnership efforts would result in additional habitat restoration and enhancement on the Refuge Complex and private lands throughout the project area.
- **Impacts to Fish and Wildlife.** Marsh habitats on newly acquired lands would be managed to enhance habitat for waterfowl, shorebirds, wading birds and other wetland-dependent migratory birds. Moist soil management would be expanded and cooperative rice farming continued on newly acquired lands providing additional high quality wetland habitat for wintering and resident waterfowl and other migratory birds. USFWS would provide and enhance habitats specifically needed by Mottled Ducks. USFWS would focus management/restoration activities to obtain a mosaic of diverse habitat types benefiting a wide variety of avian species, including several Avian Species of Conservation Concern. Restoration and enhanced management of native prairie habitats would benefit many declining landbird species. Integrated burning, grazing, and invasive species control on newly acquired lands would maintain naturally diverse and productive wetland and upland habitats benefiting avian species, Threatened and Endangered species, and a wide variety of other wildlife species. USFWS management of water control structures on newly acquired lands would benefit fisheries by increasing fish passage. USFWS would open specific areas within newly acquired lands for public wildlife-dependent recreational uses. Waterfowl and dove harvest would not affect overall populations and their long-term viability. Sanctuary areas would be established on newly acquired lands to maintain local waterfowl populations and mitigate hunting pressure. Motorized boating does affect distribution and habitat use of waterfowl and other wildlife species. Impacts from other recreational activities would be localized and minimal as to most species. No impacts to Threatened and Endangered species or long-term viability of fisheries resources would be anticipated. USFWS would implement a variety of new/expanded surveys, monitoring, and research on newly acquired lands to facilitate adaptive management, allowing continual refinement and improvement of management activities. The biological program would focus on priority wildlife species needing conservation action. Net effect of oil and gas management would be reduction of impacts to fish and wildlife resources from

these activities. Expanded outreach/partnership efforts would result in benefits to fish and wildlife resources as important habitats are restored and enhanced on private lands.

- **Economic Impacts.** New land acquisition would result in losses of agricultural support programs for rice farming by \$407,596 in Direct Payments, \$289,319 in Counter-Cyclical Payments, and \$175,710 in Indirect/Induced impacts. This represents maximum possible loss, more likely only a percentage of this would occur because some acreage would be included in coop rice farming and some base acreage would be retained by current landowners as farms are reconfigured. New land acquisition would be not expected to cause significant impacts in cattle grazing industry or commercial hunting operations.
- **Fiscal Impacts on Local Governments.** New land acquisition would result in losses of tax revenues to local governments by \$99,054. This represents maximum possible loss if all lands were acquired within an expansion boundary. Refuge Revenue Sharing payments on newly acquired lands would offset a portion of loss in tax revenues.
- **Impacts on Populations and Social Impacts.** No impacts on population or environmental justice would be anticipated. Social conditions would remain generally the same with some unresolved issues.
- **Cultural Impacts.** Unavoidable adverse impacts from natural phenomenon are anticipated to continue to occur at cultural resource sites under all of the Refuge Boundary Expansion Alternatives. In addition, Federal acquisition would provide additional protections under NHPA and associated regulations not afforded to cultural sites on private lands. Private lands acquired would also be subject to the actions and impacts identified for the preferred management alternative on existing Refuge Complex lands.

Summary of Impacts from Other Alternatives Analyzed

The following summary of impacts would be associated with implementation of the three other alternatives considered. A detailed description of the impacts analysis is provided in Chapter 4, Part B, Sections I and II of the EIS/CCP/LPP.

Although the acquisition area changes under Refuge Boundary Expansion Alternatives B and D, impacts would be the same as Alternative C. However, some loss of development potential in and around Taylors Bayou by new land acquisition would be anticipated under Alternative D. Economic and Fiscal impacts would also slightly change from Alternative C. New land acquisition would result in losses of agricultural support programs for rice farming by \$351,808 under Alternative B and \$1,545,295 under Alternative D in Direct Payments, \$249,720 under Alternative B and \$1,096,880 under Alternative D in Counter-Cyclical Payments, and \$151,661 under Alternative B and \$666,160 under Alternative D in Indirect/Induced impacts. New land acquisition would result in losses of tax revenues to local governments by \$47,258 under Alternative B and \$184,303 under Alternative D.

Under Refuge Boundary Expansion Alternative A, coastal land loss would continue at existing or accelerated rates on private lands. Economic considerations would dictate the type and scope of activities affecting large-scale hydrology on private lands. Less management of marshes would be anticipated resulting from the trend to smaller ownerships. Habitat management and restoration activities such as water management on private lands primarily support agricultural uses, especially livestock grazing. Rice production would continue to decline with former rice fields fallowed or converted to improved pasture. Burning, grazing, water management, and invasive species control on some private lands would continue to enhance wetland habitats for waterfowl and other migratory birds. On private lands, economic considerations dictate land uses and habitat management or restoration practices that result in benefits to fish and wildlife. Agricultural practices would continue to provide substantial benefits to waterfowl, but may reduce wetland habitat available for other wetland-dependent avian species. Direct, indirect, and induced impacts from existing Refuge Complex operations, agriculture, and recreation would be the same as the impacts indicated for Refuge Management Alternative D. Refuge Revenue Sharing payments made to local governments based on already acquired lands would continue.

CONSULTATION AND COORDINATION

USFWS formally and informally coordinated and consulted with the local, State, and Federal governments/agencies as part of this process. This consultation and coordination is summarized below. More detail is provided in Chapter 5 of the EIS/CCP/LPP.

- **Cooperating Agencies.** The USFWS invited two federal agencies to participate as Cooperating Agencies in this planning effort the U.S. Army Corps of Engineers (COE) and the Federal Highway Administration (FHWA). Both agencies formally agreed in response to the invitations to become a part of the process.
- **National Marine Fisheries Service.** Habitats within the Refuge Complex include areas that have been identified by the Gulf of Mexico Fisheries Council (GMFMC) as Essential Fish Habitat (EFH) for juvenile white and brown shrimp and juvenile red drum. Required consultation with National Marine Fisheries Service for impacts to EFH from individual projects/strategies implemented under this EIS/CCP/LPP will be conducted as mandated under the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 104-297).
- **Texas Parks and Wildlife Department.** The USFWS recognizes that both the USFWS and the State fish and wildlife agencies have authorities and responsibilities for management of fish and wildlife on national wildlife refuges, as described in 43 CFR 24. Consistent with the National Wildlife Refuge System Administration Act, as amended by the National Wildlife Refuge System Improvement Act, the Director of the USFWS will interact, coordinate, cooperate and collaborate with the State fish and wildlife agencies in a timely and effective manner on the acquisition and management of national wildlife refuges. Under the Administration Act and 43 CFR 24, the Director as the Secretary's designee will ensure that the National Wildlife Refuge System regulations and management plans are to the extent practicable, consistent with State laws, regulations, and management plans.
- **State Historic Preservation Office (Texas Historical Commission).** The USFWS completed a formal project review under Section 106 of the National Historic Preservation Act from the State Historic Preservation Officer, Texas Historical Commission. A copy of the State Historic Preservation Officer's review document, dated June 8, 2004, is contained in the EIS at Appendix I.
- **County and Local Governments.** The USFWS planning team, in particular the Refuge Complex Project Leader, made extensive efforts to inform and involve the counties and other local governments in the planning process. A number of formal briefings were provided for the Jefferson, Chambers, and Galveston County Judges and various County Commission members. Briefings were also provided for several local Drainage Districts and School Districts. Additionally, many of the County and other local government officials attended and participated in almost all of the public meetings held in their jurisdictions.
- **Elected Representatives.** The USFWS sought to obtain input from elected representatives in the project area by briefing them on the issues developed in the scoping process. The USFWS planning team conducted a number of personal meeting/briefings and telephone briefings during the scoping process.

DISTRIBUTION OF DRAFT EIS/CCP/LPP

The Notice of Availability for the Draft EIS/CCP/LPP was published in the Federal Register on October 17, 2006; with a public comment period closing on January 16, 2007. A copy was posted on the Service's Internet website at: <http://www.fws.gov/southwest/refuges/Plan/completeplans.html>. Digital and/or hard copies were provided to 15 libraries in the project area, two cooperating Federal agencies, Texas Parks and Wildlife Department, Environmental Protection Agency, 38 interested organizations, and a total of 58 other Federal or State agencies, governmental entities and elected representatives. Additionally, notice of availability letters were sent to the 400 landowners within the preferred expansion area, 272 individuals who participated in public meetings or workshops, and 220 members of the refuge "Friends" groups. (These letters also provided the date and time for two public hearings to receive comments)

COMMENTS AND SERVICE'S RESPONSES

A total of 23 comments were received and these are either printed verbatim or summarized in Chapter 6 along with the Service's responses.

Neither of the two cooperating Federal agencies made a comment on the draft document. However, TPWD provided a two page written comment generally supporting both of the preferred alternatives and expressing appreciation for the Complex's active hunting program. The Service thanks TPWD for their cooperation and participation in the development of this document; and, their continuing support. The Service also received a "Lack of Objections" comment from EPA following their review of the draft document. The NOAA's National Marine Fisheries Service commented that the Service will have to consult with NMFS on future structural marsh management projects; and, the Service readily recognizes its consultation obligations. No direct comments were received from local government entities or elected officials except for an action initiated by Chambers County. Chambers County Commissioner's Court has approved a donation of up to 25 acres to the United States for use by the Service as an administrative and visitor center for the Refuge Complex. The Beaumont Enterprise Newspaper issued an editorial supporting the Service's expanded acquisition program and recognizing the need for habitat protection. Additionally, the Service was contacted in writing by two landowners who expressed current interest in selling their land for inclusion in the Refuge Complex.

Five individuals provided comments at the two public hearings held on November 28 & 30, 2006, in Port Arthur and Hankamer, Texas. These comments generally supported the Service's proposals and added comments about the economic benefits of ecotourism, desire for additional hunting opportunities, need for added habitat protection, and the damages from feral hogs. The Service thanks these individuals for their participation and support; and, will continue to try to address their specific concerns.

Four organizations in the local area provided written comments: Golden Triangle Audubon Society (GTAS), Houston Audubon Society (HAS), Gulf Coast Bird Observatory (GCBO), and Houston Regional Group of the Sierra Club (HSC). Five individuals provided comments which were virtually identical to those from HSC; and three other individuals provided their comments. Comments from organizations and individuals generally supported the Service's conservation efforts and largely supported the Service's preferred management and refuge boundary expansion alternatives. However, some did express support for the larger refuge boundary expansion alternative; and, similarly, for Refuge Management Alternative C because of its emphasis on native habitat restoration and addressing threats to the ecosystem. The HSC and five individuals urged the removal of cattle to be replaced by bison and their opposition to the implementation of an entrance fee for Anahuac NWR. Some groups and individuals oppose initiating a dove hunt on Anahuac NWR; and, also, oppose fishing in Shoveler Pond and adjacent areas. There are some who feel that habitat types, in particular woodlots, are being outweighed by the focus on marshes. Also, some feel that a greater emphasis should be given to non-consumptive recreational users vs. the consumptive recreational users.

The Service thanks all of the individuals and groups who provided comments and refers readers to Chapter 6 of the EIS/CCP/LPP for the Service's detailed responses to these comments.

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GLOSSARY OF TERMS

Adaptive Management: A process in which policy decisions are implemented within a framework of scientifically driven experiments to test predictions and assumptions inherent in a management plan. Analysis of results help managers determine whether current management should continue or whether it should be modified to achieve desired results.

Biological Diversity: The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur.

Biological Integrity: The biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.

Cultural Resources: The remains of sites, structures, or objects used by people in the past; including archeological sites, historic sites, historic buildings, historic districts, cultural landscapes, and traditional cultural properties.

Ecosystem: A dynamic and interrelating complex of plant and animal communities and their associated non-living environment.

Environmental Health: Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.

Estuarine: Deep water tidal habitats and adjacent tidal wetlands that are usually partly enclosed by land but have some access to the open ocean and are diluted by freshwater from riverine in-flows.

Exotic and Invasive Species: Any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem; and whose introduction does or is likely to cause environmental or economic harm or harm to human health.

Forb: A broad-leaved, herbaceous flowering plant that is not a grass; for example, an annual sunflower.

GIS: Geographic Information System. A computer based system for the collection, processing, and managing of spatially referenced data. GIS allows for the overlay of many data layers and provides a valuable tool for resource management.

Habitat: Suite of existing environmental conditions required by an organism for survival and reproduction. The place where an organism typically lives.

Invertebrate: Any animal without a spinal column. The group includes 97% of all animal species.

Hydroperiod: Number of days per year that an area of ground is covered with water.

Neotropical Migratory Bird: A bird that breeds in Canada and the United States during summer and spends the winter in Mexico, Central America, South America or the Caribbean islands.

Midden: A slightly elevated mound composed of shell fragments and other debris left as waste by native Indians.

Paleoindian: People who hunted now-extinct animals prior to 6,000 years ago.

Palustrine: Nontidal wetlands dominated by trees, shrubs, or persistent emergents.

Prescribed Burning: Burning conducted under controlled conditions to enhance natural habitats and/or to reduce vegetative fuels to reduce the risk from uncontrolled natural fires.

Relative Sea Level Rise: The combination of global and local rises in sea level. Local rises can occur from the shifting downward of the earth's surface (see subsidence).

RONs: Refuge Operating Needs System. A national database which contains the unfunded operational needs of each refuge.

Scoping Process: An early and open public participation process for determining the scope of issues to be addressed in an Environmental Impact Statement, and for identifying significant issues related to a proposed action.

Smoke Management: Methodologies used to reduce adverse impacts of smoke from wildland fires on people and communities.

Submerged Aquatic Vegetation: Plants which grow beneath and at the water's surface.

Subsidence: The motion of the Earth's surface as it shifts downward relative to a datum such as sea-level.

Succession: The natural replacement of one biotic community by another.

Wetland: Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water; and, which support, under natural conditions, plants and animals that require saturated or seasonally saturated soils.

CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

Introduction

This Environmental Impact Statement/Comprehensive Conservation Plan/Land Protection Plan (EIS/CCP/LPP) for the Texas Chenier Plain National Wildlife Refuge Complex (Refuge Complex) combines three documents required by federal laws and U.S. Fish and Wildlife Service (USFWS) policy: an Environmental Impact Statement required by the National Environmental Policy Act (NEPA) of 1969, a Comprehensive Conservation Plan required by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57) (Refuge System Improvement Act), and a Land Protection Plan required by Service policy. The Texas Chenier Plain Refuge Complex (Refuge Complex) consists of four separate units of the National Wildlife Refuge System administered by the U.S. Fish and Wildlife Service (USFWS) as one Refuge Complex. The four units are: Anahuac National Wildlife Refuge (NWR), McFaddin NWR, Texas Point NWR, and Moody NWR. These refuge units are located along the upper Texas Gulf Coast in Chambers County, Jefferson County, and Galveston County.

The EIS/CCP/LPP accomplishes several functions including the following:

- Identification of the USFWS proposed action and alternatives for management of habitat and wildlife resources on the refuges
- Identification of the USFWS proposed action and alternatives involving expansion of land acquisition boundaries at all four of the refuges in the Refuge Complex. The set of alternatives for land protection/acquisition describe a range of approaches that would meet specific conservation goals and objectives
- Analysis of the effects of the proposals and alternatives on the human environment.

The CCP will be used by the refuge staff and other partners for refuge management and resource conservation, protection and restoration purposes. The CCP will guide management decisions throughout the next fifteen years. The plan serves to identify strategies for achieving Refuge goals and objectives. The LPP will implement a refuge acquisition boundary expansion proposal for Anahuac, Moody, McFaddin and Texas Point NWRs. Although achievement of the refuge purposes is not necessarily dependent upon additional land acquisition, the possible inclusion of other lands within the refuges will greatly benefit management of existing refuge lands and assist the USFWS in achieving its larger ecosystem-wide goals and objectives to ensure the long-term sustainability of migratory bird populations.

The Refuge Complex contributes to the conservation of wildlife and their habitats in the Texas Gulf Coast Ecosystem. The individual refuges in the Refuge Complex encompass a diversity of habitats: aquatic habitats (open water and near-shore Gulf habitats), freshwater to saline marshes, riparian habitats, coastal woodlots, rice fields, native prairies, cheniers and coastal beach and dune habitats. These areas host a multitude of plant, invertebrate and vertebrate species including over 300 bird species, 75 species of freshwater fish, and 400 species of salt and brackish water fish and shellfish. The Refuge Complex protects quality habitats for migrating, wintering and breeding waterfowl, shorebirds and waterbirds, and provides strategic and crucial resting areas for neotropical migratory songbirds migrating across the Gulf of Mexico.

Waterfowl hunting has long been a tradition in the coastal wetlands of Texas. Hunting and fishing date back to the area's earliest occupants, the Karankawa and Atakapa Indians. More recently, wildlife observation, particularly bird watching, has become increasingly popular, as has environmental education. Individuals who have experienced and come to appreciate the wealth of natural resources in the area have become the most vocal supporters of the Refuge Complex' many wildlife resources.

I. STATEMENT OF PROPOSED ACTIONS

This planning document involves two separate, but related Federal actions:

1. First, the document proposes the approval and implementation of a compendium of programmatic refuge management goals, objectives and strategies. The goals and associated objectives and strategies have varying degrees of specificity, and it is clear that additional environmental analysis per NEPA may be necessary prior to implementation of a specific strategy. Nevertheless, these goals, objectives and strategies are proposed because the USFWS has concluded that in comparison to other considered alternatives, those proposed, best achieve the purpose, vision and goals of the Refuge Complex, contribute to the National Wildlife Refuge System mission, are consistent with the principles of sound fish and wildlife management, and address relevant mandates and the major issues identified during scoping.
2. The second proposal is that of expanding the acquisition boundary of the four constituent refuges, increasing the habitat and wildlife resources already managed for wildlife conservation and habitat purposes, especially migratory waterfowl. Expansion of any of the Refuge Complex's constituent refuge acquisition boundaries would then authorize the USFWS to work with willing sellers using the acquisition standards and parameters defined in USFWS law, policy, and government regulation. Lands acquired by the USFWS would be managed as part of the Refuge System.

II. PURPOSES OF PROPOSED ACTIONS

As there are essentially two separate but related Federal Actions in this integrated EIS/CCP/LPP, there are two separate but related purposes for these proposals:

1. **Comprehensive Conservation Plan** - The purpose of proposing the compendium of goals, objectives and strategies as represented in the draft Comprehensive Conservation Plan for the Texas Chenier Plain Refuge Complex is to provide managers with a 15 year vision that contributes to the achievement of Refuge purposes and the mission of the Refuge System.
2. **Land Protection Plan – Refuge Acquisition Boundary Expansion** - The purpose of establishing new approved refuge boundaries for the Moody, Anahuac, McFaddin and Texas Point NWRs by implementing a refuge acquisition boundary expansion proposal is to help the USFWS better achieve Refuge purposes and accomplish mandates provided by law and treaty that are related to the protection of migratory birds and other USFWS Trust resources. Implementation of a boundary expansion proposal is expected to assist the USFWS meet its goals and objectives of the ecosystem plan for the Texas Gulf Coast Ecosystem. Although achievement of the refuge purposes is not necessarily dependent upon additional land acquisition, the possible inclusion of other lands within the refuges will greatly benefit management of existing refuge lands and assist the USFWS in achieving its larger ecosystem-wide goals and objectives to ensure the long-term sustainability of migratory bird populations.

III. NEED FOR PROPOSED ACTIONS

A. Comprehensive Conservation Plan

The Texas Chenier Plain Refuge Complex administers four of the more than 540 refuges in the National Wildlife Refuge System managed by the USFWS. Overall, there is a need to make the management of each refuge consistent with the new National Wildlife Refuge System mission, goals and policies. A Comprehensive Conservation Plan, required by the Refuge System Improvement Act, is needed to

address "...significant problems that may adversely affect the populations and habitats of fish, wildlife and plants and the actions necessary to correct or mitigate such problems."

Specifically, these problems at this Refuge Complex include the need to ensure biological integrity and maintain biological diversity and environmental health by reducing saltwater intrusion and restoring freshwater and sediment inflows to marshes and littoral systems, restoring altered wetland systems, restoring degraded prairie and woodland habitats, protecting unique and rare habitats and fish and wildlife species, controlling exotic and invasive species, reducing threats from contaminants, and considering and addressing the future impacts of relative sea level rise.

With appropriate implementation, the CCP maps out strategies that will:

- Accomplish management goals and objectives
- Describe habitat projects that support goals and objectives
- Initiate step-down management planning
- Outline compatible wildlife-dependent recreational uses

The CCP provides a framework for future refuge management. This CCP is designed to serve as a vision for the Refuge Complex, and provide management guidance through maintenance, restoration and use of Refuge resources during the next 15 years. The environmental analysis of this plan is addressed at the conceptual and programmatic level. While it contains some relative analytical specificity, it is not intended to be a detailed site plan with exact locations for facilities or precise descriptions of programs.

B. Land Protection Plan – Refuge Acquisition Boundary Expansion

In a recent 25 year period, over 100,000 acres of coastal wetlands were lost in the upper Texas Gulf Coast region (Moulton *et al.* 1997). Also, this area contains three (3) nationally recognized scarce and declining wetland types: estuarine intertidal emergent, palustrine emergent and palustrine forested wetlands. Less than one-percent of the historic 9,000,000 acre tallgrass prairie once found along the Louisiana and Texas Gulf coasts remains (Diamond and Smeins 1984, Smeins *et al.* 1991), and the majority of the native coastal prairie in the project area has been lost. Direct loss of native habitat to development and conversion to other land uses within the project area has been extensive. Native prairies have been converted for agricultural uses and residential and industrial development. Development has greatly altered natural hydrological and sediment regimes, resulting in loss or severe restriction of freshwater and sediment inflows and increased saltwater intrusion. These changes continue to impact the project area's native prairie and coastal marshes, resulting in a continuing trend of habitat loss and degradation.

Coastal wetland habitats are being lost directly through erosion along the shorelines of the Gulf of Mexico, bays and lakes, and navigation channels (particularly the Gulf Intracoastal Waterway). Average annual rates of shoreline retreat along the Gulf at Texas Point and McFaddin NWRs are significant, ranging from 9 to over 50 feet per year. Interior marsh loss is occurring due to the combined effects of saltwater intrusion, land subsidence and sea level rise, resulting in the conversion of emergent marsh habitats to open water. Due to channelization and a reduction of freshwater inflows, saltwater now reaches farther inland into historically freshwater marshes, changing the plant and animal communities and reducing the overall biological diversity. Construction of the Gulf Intracoastal Waterway (GIWW) in 1933 divided the once-contiguous marshes in the project area, of the Chenier Plain, severed the natural freshwater inflows of the bayou systems to downstream marshes, and channelized several miles of the natural bayous which drained into the Galveston Bay and Sabine Lake estuaries.

The large scale alterations to the project area and ongoing threats from sea level rise and land subsidence require that the USFWS adopt a proactive approach to ensure the long-term protection of natural resources in the region. USFWS acquisition from willing sellers would provide an opportunity to extend protection, management and restoration to important segments of this marsh and coastal prairie ecosystem. Some of the areas adjoining already acquired refuge lands have important hydrological links

to those refuge lands and increased wildlife habitat benefits would result from single ownership and management. Future development would further reduce an important natural resource area which has already been significantly diminished in size and quality.

IV. ENVIRONMENTAL IMPACT STATEMENT (EIS) PLANNING PROCESS

A. NEPA Planning Process

The overall process used to develop this EIS/CCP/LPP is consistent with the planning requirements specified in the National Environmental Policy Act (NEPA), (42 U.S.C. 4321-4347) and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of NEPA (CEQ) (40 CFR 1500-1508). The five (5) major steps in the NEPA process for developing an EIS were utilized in the preparation of this document and are summarized as follows:

1. Scoping

Following publication of a Notice of Intent to prepare an EIS in the Federal Register, scoping is the early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. The agency shall invite the participation of affected Federal, State, and local agencies, any affected Indian tribe, the affected public, and any other interested persons, including those who might not be in accord with the action on environmental grounds. Major issues identified during the public and internal scoping process will be considered during the development of alternatives and evaluations of environmental impacts.

2. Alternative Development

The purpose of this step is to develop alternative approaches to the major issues. The alternatives must meet the purposes of the Federal proposal, meet the goals of the refuges and comply with the missions of the refuge system and the USFWS. The alternatives shall include the alternative of "No Action" and shall rigorously explore and objectively evaluate a reasonable range of alternatives. This document contains two separate sets of alternatives addressing the two separate but related purposes in this integrated EIS/CCP/LPP.

3. Environmental Impact Analysis

This is the heart of the EIS and presents the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among the options for the decision maker and the public. Impacts mean the same thing as effects. Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.

4. Draft EIS

A Notice of Availability is published in the Federal Register announcing completion and distribution of the Draft EIS. Copies of the draft are made available to the public, and public meetings are held to present/discuss the document and illicit comments. The range of alternatives addressed in the draft will include those to be considered by the ultimate USFWS decision maker and will identify the USFWS' preferred alternative.

5. Final EIS

The final EIS will review and analyze all the comments received on the Draft EIS and modify the draft as needed, including refining the preferred alternative and publishing a Final EIS. Following a 30-day review

period for additional public comment or protest, a Record of Decision is issued that describes the actions that will be implemented. The Record of Decision identifies the rationale the decision maker used to make the decision on the actions to be implemented.

B. Comprehensive Conservation Plan (CCP) and Land Protection Plan (LPP) Planning Processes

The process for the preparation of the CCP is guided by requirements in the Refuge System Improvement Act, the Refuge Planning Chapter of the U.S. Fish and Wildlife Manual (Part 602 FW 2; 1, November 1996), and the evolving policy related to the implementation of the Refuge System Improvement Act.

The Refuge System Improvement Act specifies two areas that are to be addressed in the CCP process: (1) identification and description of problems that may adversely affect populations and habitats of fish, wildlife, and plants within the planning unit, and the actions necessary to correct or mitigate such problems; and (2) identification, description, and facilitation of opportunities for wildlife-dependent recreation and a determination that these recreational uses (specific activities, levels of use and distribution) will be compatible with refuge purposes. The major issues, identified during scoping, relative to these two areas provide the primary guidance in developing objectives and strategies within the CCP to achieve refuge goals and purposes. While the life-span of the CCP is fifteen (15) years, periodically the USFWS will review the plan. The plan may be amended, as necessary, at any time under an adaptive management strategy.

As to the development of the CCP and the management strategies, this EIS is a comprehensive or “**programmatic**” EIS addressing a broad agency program which is the development of a formal plan for the management of the Complex. This differs from the more typical project-specific EIS which addresses a new construction project, substantial modification of a facility, or some similar type of project. This “programmatic” EIS does not attempt to provide NEPA compliance for site-specific projects which may be undertaken in the future to implement the plan strategies. If these projects are proposed in the future, then the Service will provide whatever compliance is required for the project. This compliance may be accomplished within a step-down plan or on a project-by-project basis.

The CCP provides programmatic guidance, in the form of goals, objectives, and strategies, for several refuge program areas. Specific implementation will be developed for individual program areas through step-down management plans within approximately 5 years after CCP completion. Some step-down plans may require additional NEPA compliance. Step-down plans for the Texas Chenier Plain Refuge Complex include the following:

<u>Step-Down Management Plans</u>	<u>Status</u>
Revised Fire Management Plan	Future planning
Habitat Management Plan	In progress
Oil & Gas Management Plan	Future planning
Inventory and Monitoring Plan	Future planning
Revised Hunt Plan	Future planning
Visitor Services Plan	Future planning
Integrated Pest Management Plan	Future planning

The process for the preparation of the LPP is guided by the Land Acquisition Planning Chapter of the U.S. Fish and Wildlife Manual (Part 341 FW 2; 12, April 1996), and the evolving policy related to the Land Acquisition Planning Procedures. This includes the Director’s memo of Aug. 11, 2000, requiring Director’s approval of all documents proposing the significant expansion of an existing unit of the National Wildlife Refuge System.

C. Decisions to be Made and Criteria for Decision Making

1. Land Protection/Acquisition

The Director of the U.S. Fish and Wildlife Service will decide which of the refuge boundary expansion alternatives best meet the criteria described below. This decision will be made in full recognition of the environmental effects of each alternative. The decision will be designated in a Record of Decision (ROD) document no sooner than 30 days after the final EIS is filed with the Environmental Protection Agency (EPA) and distributed to the public.

2. Comprehensive Conservation Plan

The USFWS Southwest Regional Director will select an alternative to implement as the Texas Chenier Plain Refuge Complex Comprehensive Conservation Plan. This decision will be made with an understanding of the environmental consequences of all alternatives considered. The decision will be documented in a ROD no sooner than 30 days after the final EIS is filed with the EPA and distributed to the public. Implementation of the plan will begin immediately upon publishing a summary of the ROD in the Federal Register.

The following criteria will be used in selecting the alternatives for implementation:

- Best meets the Refuge System mission
- Best meets the refuge purposes
- Best meets the USFWS Biological Integrity, Diversity, and Environmental Health Policy

The National Wildlife Refuge System Improvement Act of 1997 (Refuge Improvement Act) established that the fundamental mission of the Refuge System is “to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitat within the United States for the benefit of present and future generations of Americans.” The primary refuge purpose for refuges within the Texas Chenier Plain Refuge Complex is: “...for use as an inviolate sanctuary, or for any other management purpose for migratory birds.” 16 U.S.C. § 715d (Migratory Bird Conservation Act). Therefore of primary consideration will be the alternative that best facilitates this mission and this refuge purpose.

The Biological Integrity, Diversity, and Environmental Health Policy is an additional directive for refuge managers to follow while achieving refuge purpose(s) and System mission. It provides for the consideration and protection of the broad spectrum of fish, wildlife and habitat resources found on refuges and associated ecosystems. Further, it provides refuge managers with an evaluation process to analyze their refuge and recommend the best management direction to prevent further degradation of environmental conditions; and where appropriate and in concert with refuge purposes and System mission, restore lost or severely degraded components.

Further the Refuge Improvement Act recognizes wildlife-dependent recreational uses involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation as the priority public uses of the Refuge System. These uses are legitimate and appropriate public uses where compatible with the Refuge System mission and the individual refuge purposes. When a proposed wildlife-dependent recreational use is a compatible use within a refuge, that activity should be facilitated, subject to such restrictions or regulations as may be necessary, reasonable, and appropriate. The legislation also states that these priority public uses receive enhanced consideration over other uses in planning and management. Consideration of alternatives will include evaluating how opportunities for compatible wildlife-dependent recreation are best facilitated and/or enhanced.

In summary, the selection of an alternative for implementation on refuge lands within the Texas Chenier Plain Refuge Complex will be based primarily on the extent to which it would meet the following criteria, listed in priority order, as compared to the other alternatives:

1. Conservation of native fish, wildlife, plants, and their habitats with an emphasis on migratory birds consistent with refuge purposes.
2. Provide balanced opportunities for wildlife -dependent recreational uses that are compatible with Refuge purposes.

D. Legal Mandates and Policy Guidance

Refuges are guided by the mission and goals of the National Wildlife Refuge System (NWRS), the designated purpose of the Refuge unit as described in establishing legislation or executive orders, USFWS laws and policy, and international treaties. Key concepts and guidance of the System are covered in the NWR Administration Act of 1966, the Refuge Recreation Act of 1962, Title 50 of the Codes of Federal Regulations, the U.S. Fish and Wildlife Service Manual, and, most recently, through the National Wildlife Refuge System Improvement Act of 1997.

The Refuge Improvement Act amends the Refuge Administration Act of 1966 by including a unifying mission for the Refuge System, a new process for determining compatible uses on refuges, and a requirement that each refuge will be managed under a Comprehensive Conservation Plan. The Refuge Improvement Act states that wildlife conservation is the priority of NWRS lands and that the Secretary of the Interior shall "...ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans...." Each refuge must be managed to fulfill the Refuge System mission and the specific purposes for which it was established. Additionally, this Act identifies the six wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation) that are to be priority public uses of the Refuge System. These uses will receive enhanced consideration over other uses in planning and management.

Lands within the National Wildlife Refuge System are different from other, multiple use public lands in that they are closed to all public uses unless specifically and legally opened. No use may be allowed on a refuge unless it is determined to be compatible with the purposes of which each refuge was established. A compatible use is a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. Sound professional judgment is further defined as a decision that is consistent with principles of fish and wildlife management and administration, available science and resources and adherence with law.

The Refuge Improvement Act requires that a Comprehensive Conservation Plan (CCP) be in place for each refuge by the year 2012 and that the public have an opportunity for active involvement in plan development and revision. It is USFWS policy that CCPs are developed in an open public process and the USFWS is committed to securing public input throughout the process.

V. BACKGROUND

A. Brief History of the Texas Chenier Plain Refuge Complex

As the coastal region of Texas became settled, the early economy of the area was based on raising cattle and growing rice. A demand for farmland and later land for industry developed. Marshlands were drained or altered to make rice fields and to provide sites for industrial installations. Waterfowl suffered loss of nesting, feeding, and resting areas when vast tracts of marshland were drained but thrived on the feed available from the rice fields and cultivated pasture lands which replaced the wetlands. The metropolitan area, centered around Houston, with its major seaport and growing complex of industrial, petrochemical, scientific research, and transportation installations, has been the major influence on the land use of a large segment of southeast Texas. As more industry flourished in the Galveston-Houston- Beaumont metropolitan area, the economic expansion created a demand for more land to accommodate the

continued growth. Coastal marshes have been filled to provide sites for factories, refineries, roads, commercial, and residential areas. The USFWS identified a need to retain and intensively manage a significant block of the coastal marsh for waterfowl habitat in the upper coastal region of Texas.

Through his will in 1954, W. L. Moody, Jr. conveyed as a gift to the USFWS an undivided ½ fee interest in 714 acre Lake Surprise, which became Moody NWR on November 9, 1961. In 1982, the USFWS exchanged the fee interest in Lake Surprise with the Moody Foundation for a non-development conservation easement on a little over 3500 acres of wetland habitat around Lake Surprise which comprises the current Moody NWR. Anahuac NWR was established on February 27, 1963 through donation and fee-title acquisition under authority of the Migratory Bird Conservation Act of 1929 (MBCA). Since then, the boundary was expanded in 1979, 1982, 1989, 1991, 1993, and 2005 under authority of the MBCA, Emergency Wetlands Resources Act, Refuge Recreation Act and Fish and Wildlife Coordination Act. Total acreage in fee title ownership is currently 34,339 acres. McFaddin NWR was established on May 1, 1980, under authority of the MBCA. Its boundary was expanded in 1995, 1996, and 2005, also under authority of the MBCA. Currently, the Refuge administers a total of 58,861 acres in combined fee title and conservation easements. Texas Point National Wildlife Refuge was established in 1979, under authority of the MBCA. It is comprised of 8,952 acres in fee title ownership.

Summary of Current Land Acquisition Status

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

As additional parcels were added to the National Wildlife Refuge System for the protection of coastal waterfowl habitat through the Migratory Bird Conservation Act, these acquisitions created a closely linked cluster of refuges along the coast. In the early 1980’s, the USFWS decided that this closely-related group of four refuges could be more efficiently administered as one Refuge Complex. Subsequently, the Refuge Complex was named for the geologic/geographic feature called “cheniers” important along this part of the Louisiana and Texas coastline. “Cheniers” are described in more detail in Chapter Three, Affected Environment.

The initial management focus of these refuges was to retain and intensively manage this significant block of the coastal marsh for waterfowl habitat. Water management, prescribed burning, and controlled grazing have been traditional tools in the management of coastal marshes on these refuges. Rice farming has been continued on Anahuac NWR to provide valuable foraging habitats for waterfowl.

B. Refuge Purposes and the Migratory Bird Conservation Act

National Wildlife Refuge System lands are acquired and refuges are established under a variety of legislative acts and administrative orders. The USFWS defines the purposes of national wildlife refuges when a refuge is established, based upon the establishing authorities or legislation. The primary authority used in establishing the four refuges comprising the Texas Chenier Plain Refuge Complex was the Migratory Bird Conservation Act. National wildlife refuges established through this act were acquired:

“...for use as an inviolate sanctuary, or for any other management purpose for migratory birds.” 16 U.S.C. § 715d (Migratory Bird Conservation Act).

Three other acquisition authorities have been utilized at Anahuac NWR, with the three following additional purposes:

“...the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions...” 16 U.S.C. § 3901 (b), 100 Sta. 3583 (Emergency Wetlands Resources Act);

“...suitable for — (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species...” 16 U.S.C. § 460K-1 (Refuge Recreation Act); and,

“... for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon...” 16 U.S.C. § 661-667e (Fish and Wildlife Coordination Act).

The Migratory Bird Conservation Act, passed in 1929, authorized the acquisition and management of refuges as “inviolate sanctuaries” for migratory birds. This Act originally required that all refuges be inviolate sanctuaries and deemed that refuges primary purposes were as breeding ground and habitat for migratory birds. Further, the Migratory Bird Hunting and Conservation Stamp Act of 1934 (Duck Stamp Act) required that lands purchased with revenues from this Act are to be managed as “inviolate migratory bird sanctuaries” and prohibited migratory bird hunting. The 1949 Amendment to the Duck Stamp Act modified the “inviolate sanctuary” requirement and allowed public waterfowl hunting on up to 25% of the lands acquired with Migratory Bird Conservation Funds in a refuge. The portion of refuge lands acquired with Migratory Bird Conservation Funds which could be opened to hunting was increased to 40% by the 1958 Amendment to the Duck Stamp Act. The large majority of lands within the Texas Chenier Plain Refuge Complex were acquired with Migratory Bird Conservation Funds and in compliance with the statutory restrictions; approximately 40% of Anahuac, McFaddin, and Texas Point NWRs are open to waterfowl hunting.

The Refuge Recreation Act of 1962 further defined how recreational uses on refuges would be evaluated and firmly established the concept of compatibility. The 1966 Refuge System Administration Act permitted “the use of any area within the system for any purposes, including but not limited to hunting, fishing, public recreation and accommodations, as long as such uses are compatible with the major purposes for which such areas were established. “ Typically, a refuge is closed to a particular use until it is opened administratively through the Federal Register. Refuge managers must determine compatibility of all public, economic, and military uses proposed or occurring on a refuge. The 1997 National Wildlife Refuge System Improvement Act amended the Refuge System Administration Act and further defined priority uses to be the following six wildlife-dependent uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Existing compatibility policy is described in the Refuge Manual (5 RM 20). Compatibility Determinations for existing and proposed uses on the Texas Chenier Plain Refuge Complex are in Appendix E.

C. National Wildlife Refuge System Mission and Goals

The mission of the National Wildlife Refuge System is:

“To administer a national network of lands and waters for the conservation, management and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.” (National Wildlife Refuge System Improvement Act of 1997)

Starting with the first refuge, Florida’s Pelican Island, established in 1903 by President Theodore Roosevelt, the National Wildlife Refuge System has grown to more than 96 million acres in size. It includes more than 540 refuges, at least one in every state, and over 3,000 Waterfowl Production Areas. The needs of wildlife and their habitats come first on refuges, in contrast to other public lands managed for multiple uses.

The goals of the National Wildlife Refuge System (Director’s Order No. 132, January 18, 2001) are:

- To fulfill our statutory duty to achieve refuge purpose(s) and further the System mission.

- Conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered.
- Perpetuate migratory bird, inter-jurisdictional fish, and marine mammal populations.
- Conserve a diversity of fish, wildlife, and plants.
- Conserve and restore, where appropriate, representative ecosystems of the United States, including the ecological processes characteristic of those ecosystems.
- To foster understanding and instill appreciation of fish, wildlife, and plants, and their conservation, by providing the public with safe, high-quality, and compatible wildlife-dependent public use. Such use includes hunting, fishing, wildlife observation and photography, and environmental education and interpretation.

D. The Texas Gulf Coast Ecosystem Goals

The Texas Chenier Plain Refuge Complex, comprised of Moody NWR, Anahuac NWR, McFaddin NWR, and Texas Point NWR, is located within the USFWS administrative boundary of the Texas Gulf Coast Ecosystem and is expected to fulfill the ecosystem goals and objectives outlined below:

Goal - To help restore, maintain and enhance the level of natural species diversity (floral and faunal communities) indigenous to the Texas Gulf Coast ecosystem, in close cooperation with resource management agencies, other government and non-government entities, industries, private landowners and other citizenry.

Objective 1 - Maintain, restore, and create wetlands in order to achieve a net gain in wetland quality, quantity (based on National Wetlands Inventory data), and natural productivity.

Objective 2 - Restore, conserve, enhance, and maintain approximately 25% of the historic Gulf coastal prairies in Texas, Louisiana, and Mexico to ensure the continued existence of native flora and fauna.

Objective 3 - Protect, restore, and enhance the biological integrity of the near coastal forest systems to maintain viable communities of natural flora and fauna.

Objective 4 - Maintain and where possible, enhance the biological productivity of existing high quality habitat and restore the biological productivity of degraded estuarine habitat.

Objective 5 - Develop and provide environmental education, outreach programs, and outdoor wildlife activities (consumptive and non-consumptive) involving at least 2 million public contacts annually to foster a broad conservation ethic.

E. Refuge Vision Statement

The Texas Chenier Plain Refuge Complex, comprised of Moody NWR, Anahuac NWR, McFaddin NWR, and Texas Point NWRs and located on the Upper Texas Gulf Coast in Chambers, Jefferson, and Galveston counties, will provide healthy and sustainable habitats for the diverse fish and wildlife resources of this rich coastal ecosystem. The full array of the region's native habitats - coastal marshes and prairie wetlands, coastal tallgrass prairie, and coastal woodlands - will be represented on the Refuge Complex. Protection, enhancement and restoration of these habitats will help maintain and restore the ecosystem's rich biological diversity.

Refuge habitats will be enhanced through management and restoration with an emphasis on benefiting waterfowl and other wetland-dependent migratory birds, declining songbird species, and all other species

at risk within the ecosystem. Management activities on the refuges will also seek to maintain and enhance habitat values for coastal fisheries, which support vital recreational and commercial fishing industries. Sound scientific monitoring and research will support an adaptive approach to management, facilitating continual refinement and improvement of refuge management practices.

By working with partners both governmental and private, the Refuge Complex will seek to ensure the long-term sustainability of coastal wetlands threatened by erosion, subsidence, rising sea levels and altered hydrological regimes. Working with the scientific community, the Refuge Complex will actively seek to develop and implement solutions to these complex problems.

The refuges will provide high quality recreational and educational opportunities for the public. The importance of the Refuge Complex in supporting a rapidly expanding nature tourism industry will be increased. By reaching out to and working within our communities, awareness of the importance of conserving fish, wildlife and habitats will increase and new and innovative opportunities to promote and implement conservation on private lands will emerge. By helping to conserve natural resources, the refuges will maintain and enhance the quality of life for residents, who have always greatly valued and treasured the region's rich natural heritage.

F. Refuge Goals

Goal 1 - Conserve, enhance and restore the Texas Chenier Plain region's coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent migratory birds, and habitat for other native fish and wildlife.

Goal 2 - Conserve, enhance and restore the Texas Chenier Plain region's coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/neartic migratory birds, and habitat for other native wildlife.

Goal 3 - A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.

Goal 4 - By working with others locally and on a landscape level, threats to biological integrity, biological diversity and environmental health on the Refuge Complex will be addressed.

Goals 5 - All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex's role in conserving the region's coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast.

VI. SCOPING AND SUMMARY OF PUBLIC INVOLVEMENT

A. Summary of Public Involvement

Major issues related to the proposed actions were actively solicited from the general public, local public officials, local governmental entities, affected landowners, federal and state agencies, private organizations, and the USFWS' interdisciplinary core Planning Team. A "Notice of Intent to Prepare a Comprehensive Conservation Plan and Associated Environmental Impact Statement" was published in the Federal Register on October 21, 1999. Public scoping efforts included two series of public scoping meetings, public workshops, a town hall meeting, multiple briefings for local government officials and their staffs, and a waterfowl hunters' forum. A mailing list of over 1200 persons and organizations is maintained at the Refuge Complex Office and was used to distribute planning newsletters and public meeting announcements. The following is a summary of public involvement efforts.

B. Interdisciplinary Core Planning Team

The USFWS chartered a core planning team consisting of refuge managers, wildlife biologists, reentry specialists, migratory bird specialists, geographic information specialists, NEPA specialists, and natural resource planners. At the request of the USFWS, an employee of the Texas Parks and Wildlife Department was named to represent the state fish and wildlife agency and actively participated on the core planning team. This team met regularly, providing important input in the scoping process and the issues development. The team also provided invaluable advice and comment during the development of the alternatives and other sections of the document.

C. Initial Public Scoping Meetings: January 11 & 12, 2000

Notices of the meetings were mailed to a list of over 1200 affected individuals, agencies, and organizations. Additionally, meeting notices were published in the local newspapers during the week prior to the meetings. Personal invitations were sent to the local Congressman, County Judges, and other public officials. "Fact Sheets", summarizing the proposals to be presented, were prepared to be handed out to all attendees at the meetings. Each meeting included an open public forum and breakout sessions to allow the concerned public to present their views and concerns in either a general or a smaller group setting to accommodate individual comfort levels. Light refreshments were provided for the public at each meeting.

The January 11th meeting was held from 4:00 p.m. to 7:00 p.m. at the Ramada Inn at 3801 Highway 73 in Port Arthur, Jefferson County, Texas. The meeting was attended by well over 150 people. Congressman Nick Lampson and Jefferson County Judge Carl Griffith personally made statements to begin the meeting. USFWS personnel/contractors gave a presentation explaining the EIS planning process and describing the two related purposes to be addressed in this document. There was a lively exchange with a number of verbal comments and questions coming from the audience during different parts of the presentation. Responding to the USFWS' invitation, some 30 individuals came forward and made verbal statements on the public address system. The USFWS recorded these statements as part of the public input to be used in identifying issues to be addressed in this EIS. Afterwards, the public was invited to talk individually with the dozen or so USFWS personnel stationed around the room. Comment sheets were provided for the public and a large number of people filled-in and left comment sheets. Announcements were made during this meeting and the subsequent meeting in Hankamer that everyone could mail or e-mail comments to the USFWS during the next few months, and cumulatively, the USFWS received nearly 100 additional comments by mail/e-mail.

The January 12th meeting was held from 4:00 p.m. to 7:00 p.m. at White's Park off of Interstate 10 near Hankamer, Chambers County, Texas. The meeting was attended by approximately 80 people. To begin the meeting, USFWS personnel/contractors gave a presentation explaining the EIS planning process and describing the two related purposes to be addressed in this document. Responding to the USFWS' invitation, some 19 individuals came forward and made verbal statements on the public address system, including Congressman Lampson's staff person, reading a prepared statement from the Congressman. The USFWS recorded these statements as part of the public input to be used in identifying issues to be addressed in this EIS. Afterwards, the public was invited to talk individually with the dozen or so USFWS personnel available in the building. Comment sheets were provided for the public and a large number of people filled-in and left comment sheets. As mentioned above, announcements were made that people could mail or e-mail comments to the USFWS during the next few months.

D. Town Hall Meeting: March 20, 2000

U.S. Congressman Nick Lampson hosted a U.S. Fish and Wildlife Service Town Hall Meeting in the Port Arthur Civic Center from 3:00 – 6:00 p.m. on March 20, 2000. The purpose of the meeting was to explore the USFWS' plan that will guide the management of the Texas Chenier Plain Refuge Complex and also address the agency's role in the State Highway 87 rebuilding project. Congressman Lampson, Nancy Kaufman, USFWS Regional Director from Albuquerque, NM, and Jefferson County Judge Carl Griffith

made presentations to begin the meeting. Afterwards, the public was invited to give statements. The public testimony was followed by a question/answer session with a panel of USFWS representatives. The meeting was attended by just over 100 people and about two dozen people voiced their opinions on USFWS activities and State Highway 87 in public statements.

E. Waterfowl Hunt Program Forum: October 23, 2000

An annual meeting on public waterfowl hunts for the McFaddin, Texas Point, and Anahuac National Wildlife Refuges was held on Monday, October 23rd, beginning at 6:00 p.m. at the Port Arthur Public Library in Port Arthur, Jefferson County, Texas. The meeting was jointly hosted by the USFWS and Texas Parks and Wildlife Department. Notices for the meeting were included in local newspapers and the meeting was attended by 24 interested hunters. The meeting provided hunters with information on current hunt programs and invited their input on possible changes/improvements for future hunts. Then, the hunters were given worksheets listing five hunt program issues identified in earlier scoping efforts and were broken into workgroups of 6-8 individuals for discussion. They were asked to provide input on these issues and any other items/issues they wished to comment on for the EIS/CCP/LPP. Most of the worksheets and comments were collected at the end of the meeting, but several were received by mail in the weeks following.

F. Workshops: November 16 & 18, 2000

Two workshops were held to provide an exchange of information and opinions between interested members of the public and the USFWS planning team. The affected public was invited to participate in the workshops through a very large (1200+) mail-out of Planning Newsletter 2. Prior to the workshops, each pre-registered participant was sent a package of preliminary draft management scenarios drawn from issues identified in the earlier scoping meetings. After a general presentation on the Refuge Complex, planning process, alternative management scenarios, and land acquisition options, the attendees were divided into small (5-6 persons) workgroups for discussions. The USFWS provided professional facilitators to direct the workshops and interact with the workgroups. The facilitators captured the opinions and comments of the individual members of the workgroups in notes and on flipcharts. The opinions and comments from the participants in the workshops were consolidated and documented in a Workshop Summary prepared by the facilitators/contractors.

The November 16, 2000, workshop was held on a Thursday from 6:00 p.m. to 9:00 p.m. at White's Park off of Interstate 10 near Hankamer, Chambers County, Texas. Twenty-two (22) people from the affected public participated with the USFWS planning team in this workshop.

The November 18, 2000 workshop was held on a Saturday from 1:00 p.m. to 4:00 p.m. at the Ramada Inn in Port Arthur, Jefferson County, Texas. Twenty-five (25) people from the affected public participated with the USFWS planning team in this workshop.

G. Final Public Scoping Meetings: June 18 & 20, 2002

The USFWS conducted a final series of scoping meetings, one in the afternoon and one in the evening at each of two different locations, to present to the public preliminary drafts of conceptual alternative outlines for both the refuge management and refuge boundary expansion portions of the EIS/CCP/LPP. These preliminary alternative outlines were drawn from the scoping efforts up to this point and strived to present a reasonable range of alternatives to accomplish project purposes. Maps based on aerial photography detailing four refuge expansion alternatives (including the "No Action" alternative) were hung from the walls at each meeting site. Also, large poster boards outlining key elements for each of five refuge management alternatives (including the "No Action" alternative) were displayed at each meeting site. The meeting rooms were open for at least an hour before each presentation to provide an opportunity for the public to look at the maps and poster boards. The public was invited to attend these meetings by numerous notices in the local newspapers, press releases, extensive press coverage in local newspaper articles, and a very large (2100+) mail-out of a special Planning Update which included outlines of the

management and expansion alternatives. Additionally, personal invitations had been extended to each public official during the briefings presented by the Refuge Complex Project Leader in May and June.

Each session included a joint presentation by the Refuge Complex Project Leader and the Lead Planner. Each presentation consisted of a short explanation of the planning process, a statement of the current status of work on this project, and a conceptual description of each of the refuge management and refuge boundary expansion alternatives being considered. After the presentation, the meetings were opened to the public for a question/answer or comment session. The two presenters remained in front of the audience and answered the questions or listened to the comments. USFWS personnel captured the gist of the questions and comments on laptop computers for consideration in finalizing the alternatives. Additionally, the public was offered comment sheets to fill-out and return, and were given the option of dictating their comments to USFWS personnel who recorded them using laptop computers.

The June 18, 2002, meetings were held on a Tuesday at White's Park off of Interstate 10 near Hankamer, Chambers County, Texas. The afternoon presentation started at 2:00 p.m. and the evening presentation started at 7:00 p.m. Total attendance at these meetings was approximately 30 people. There were good question and answer sessions with a number of questions coming mainly from land owners in the Anahuac NWR area and people interested in the refuge hunt program.

The June 20, 2002, meetings were held on a Thursday in the John Gray Center at Lamar University, Beaumont, Jefferson County, Texas. The afternoon presentation started at 2:00 p.m. and the evening presentation started at 7:00 p.m. About 60 people attended these sessions. The question and answer portion of the evening session was particularly lively with many questions or comments from the public primarily focused on land acquisition, including some from Jefferson County Judge Carl Griffith.

In addition to these scoping efforts focused on the public, the USFWS tried to actively engage county and other local governments in the scoping process. Similarly, the USFWS sought to obtain input from elected representatives in the project area by briefing them on the issues developed in the scoping process. The USFWS planning team conducted a number of personal meeting/briefings and telephone briefings during the scoping process. Documentation and description of the many briefings given to County officials, other local government officials, and elected representatives are contained in Chapter 5: Coordination and Consultation.

VII. DESCRIPTION OF MAJOR ISSUES

Under the National Environmental Policy Act (NEPA), federal agencies must identify the issues associated with the proposed action(s). The following four (4) major issues identified during the public and internal scoping process were considered during the development of alternatives and evaluations of environmental impacts. The Summary of Concerns and Recommendations listed under each major issue consolidates the input provided by the public and the core planning team during the scoping process.

A. Expansion of the Refuge Complex (Land Acquisition)

One of the ways the United States protects wildlife habitat is through acquisition of land for management in the National Wildlife Refuge System. Should the USFWS expand the refuge boundaries of the Texas Chenier Plain Refuge Complex refuges and acquire additional lands in the project area to benefit wildlife and to protect and restore native habitats?

The USFWS is only authorized to acquire land within the approved boundary of a National Wildlife Refuge. To acquire additional lands, the USFWS must first expand existing refuge boundaries to include those lands with high habitat values which the USFWS would be interested in acquiring. This expanded boundary then constitutes the approved refuge boundary. Subsequently, if a landowner within the approved refuge boundary wants to sell to the USFWS, the USFWS can seek funding and acquire that person's property. Although the United States government has the authority to condemn land (called the power of eminent domain), it is the policy of the USFWS to acquire land only from willing sellers. The

only time the USFWS uses condemnation is the rare situation when a willing seller has such a serious title problem that it can only be cured by judicial action.

The USFWS can acquire land, or interests in land, within an approved refuge boundary in two basic ways: 1) acquisition of fee title, or 2) acquisition of a conservation easement. Both methods have been used in acquiring lands for the refuges in the past and both would be used, as appropriate, in the future. The habitat management needs of a particular property determine which acquisition strategy the USFWS should use.

Most of the previous boundary expansions on the Refuge Complex were driven by an opportunity to purchase a single ownership. When a landowner in close proximity to the existing refuge was interested in selling to the USFWS, the NEPA compliance document addressed the expansion of the refuge boundary for only that ownership. Even though much habitat has been acquired and conserved in the past with this somewhat piece-meal planning approach, the USFWS feels that it is necessary to take a long-term, ecosystem-wide planning approach to preserve the important, remaining coastal marsh and prairie habitats in the project area.

Summary of Concerns and Recommendations

- The USFWS has insufficient resources (people and money) to adequately manage current lands, never mind any additional lands it might acquire. USFWS should spend its money on taking care of what they already own, not spend it on buying more land that they won't be able to adequately manage.
- Private lands would be taken away through condemnation in a big Federal "land grab."
- Federal land acquisition removes lands from the tax rolls and causes a permanent loss of tax base. This results in substantially lower revenues to the counties, school districts, and other taxing entities.
- USFWS should have a large expansion of the Refuge Complex to include all the marshes and adjoining uplands in both Jefferson and Chambers Counties because all of those lands will eventually be lost to development.
- Land acquisition by USFWS would cause large negative economic impacts to agribusiness and the service industry that supports it because ongoing agricultural practices will cease when USFWS acquires land.
- Land acquisition by USFWS would harm the commercial waterfowl guide and outfitter industry because commercial guides/outfitters would lose leases on lands acquired in fee title by the USFWS.
- The commercial alligator ranching industry would be negatively impacted by USFWS land acquisition. Most alligator eggs supporting this industry come from the wild on private lands and most eggs are currently collected in areas identified for refuge expansion. Alligator egg collecting is not allowed on refuge lands.
- Land acquisition by the USFWS would cause negative economic impacts because restrictions imposed on oil and gas development on refuges limits or prevents such development from occurring.
- The USFWS should acquire and protect woodlots as critical resting and foraging habitat for neotropical migratory birds.
- Conservation easements should be considered as a means of protecting wildlife habitat while still retaining lands in private ownership.
- Major drainage/flood control projects being planned for western Jefferson County and eastern Chambers County would be prevented or made more difficult by USFWS land acquisition.
- Waterfowl hunting would decrease on lands acquired by the USFWS because hunting is allowed on only up to 40% of the lands acquired with Migratory Bird Conservation Funds and hunting is allowed only three days a week until noon on the refuges.
- Conservation easements negatively impact waterfowl hunters who have helped fund the acquisition with their duck stamp purchases because typically, the USFWS doesn't purchase hunting rights, and therefore the property is not open for public hunting.
- Conservation of coastal wetlands and associated habitats in the project area through additional land acquisition by the USFWS is needed to ensure healthy populations of waterfowl, shorebirds and other migratory birds.

- Native coastal prairie should be acquired and protected because most of the native tallgrass coastal prairie on the Texas Gulf Coast has already been lost to development and conversion to other land uses. Protection of remaining prairies is critical to protecting the region’s biological diversity.
- Many “at risk” fish, wildlife and plant species would benefit from additional habitat protection through USFWS land acquisition in the project area.

B. Administration of Wildlife-Dependent Recreational Uses

The Refuge Improvement Act declared that compatible wildlife-dependent recreational uses are legitimate and appropriate priority uses of the Refuge System. These six priority uses (hunting, fishing, wildlife observation, photography, environmental education, and interpretation) are to receive enhanced consideration in planning and management over all other general public uses; and, when compatible, are to be strongly encouraged on the refuges. A compatibility determination is required for a wildlife-dependent recreational use or any other public use of a Refuge. A compatible use is one which, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from fulfillment of the Refuge System Mission or Refuge purposes.

All six of the priority wildlife-dependent public uses are now ongoing on the Refuge Complex. Waterfowl hunting and recreational fishing are popular uses on McFaddin, Texas Point and Anahuac NWRs. Opportunities for wildlife observation, particularly on Anahuac NWR, annually attract birders and other nature enthusiasts from throughout the U.S. and many foreign countries. Facilities including observation platforms, boardwalks, signs and brochures have been developed to provide wildlife observation and photography opportunities and to interpret the refuges’ ecological values. Anahuac NWR now serves as an outdoor classroom for many area students participating in an environmental education program.

Challenges confronting the USFWS include providing quality recreational opportunities for the public while ensuring that public uses remain compatible with the refuges established purposes and mission of the NWRs, preventing conflicts between public uses, maintaining the quality of the visitor experiences, providing universally-accessible public use programs, providing information to the public through expanded outreach, and protecting public safety.

Summary of Concerns and Recommendations

- The areas on the refuges open to waterfowl hunting are inaccessible. Access to the marsh in the areas open to hunting is so difficult that it limits hunting to young, in-shape hunters.
- The USFWS closes the areas on the refuges where the best waterfowl hunting is located.
- All of the refuges should be closed to hunting and maintained as “inviolate sanctuaries.”
- The USFWS does not provide adequate facilities for disabled hunters.
- The USFWS should allow hunting of other species including rails, gallinules, mourning doves, and feral hogs.
- Waterfowl hunting opportunities on the refuges are too restricted by only opening the refuges to hunting three days per week until noon.
- The reservation and permit issuance system at McFaddin NWR is not working well and is inherently unfair to parts of the working public. Also, waterfowl hunters accessing McFaddin’s Star Lake from adjacent private lands have an unfair advantage over hunter’s entering through the main refuge entrance.

- Airboats should or should not be allowed on the refuges.
- The USFWS should improve access for waterfowl hunting by developing more access facilities (roads, boat launches, access ditches, walkways, etc.) and by supporting the reconstruction of State Highway 87.
- An annual Hunting Permit which applies to the entire Refuge Complex should be made available to the public by the USFWS.
- The USFWS should offer more “spaced blind” hunting opportunities on the refuges to decrease the problems caused by hunters setting up too close to each other and interfering with the quality of each other’s hunts.
- The USFWS should improve maintenance of existing facilities (roads, boat ramps, etc.) and develop new facilities (fishing piers, walkways, etc.) to support recreational fishing on the refuges.
- Additional fishing, wildlife observation and photography opportunities should be provided on McFaddin NWR by lengthening the hours the refuge is open on weekdays, opening the refuge on weekends, and allowing these uses in additional areas of the refuge.
- The USFWS should improve maintenance on existing and develop additional facilities for wildlife observation and photography (paths, boardwalks, observation platforms, photography blinds, etc.)
- More interpretive signs and kiosks are needed on the refuges to interpret natural resources and refuge management programs and to provide more information to orient visitors.
- The Refuge Complex needs a new Visitor Center/Administrative Headquarters in Chambers County. This building should include interpretive exhibits and classroom space to support the environmental education and interpretive programs on the refuges.

C. Habitat Management and Restoration of Refuge Lands

Consistent with the establishment purpose of its refuges, the primary objective of habitat management on the Refuge Complex is to enhance and restore habitat for wintering, migrating, and nesting waterfowl and other migratory bird species. Management practices for waterfowl, shorebirds and other wetland - dependent wildlife on the Refuge Complex include structural management for manipulating water levels and salinity within managed wetlands, prescribed burning, controlled livestock grazing, moist soil management, and rice farming. Prescribed burning, controlled grazing, mowing and haying are tools utilized to manage upland habitats including remnant stands of native prairie and newly-restored native prairie sites. Often, a combination of management activities is applied as appropriate to the various habitats on the Refuge Complex. Almost all acres receive some treatment annually.

Restoration of native habitats is another aspect of habitat management on the Refuge Complex. Wetland restoration activities include reestablishing shallow freshwater wetlands and initiating moist soil management practices in fallowed croplands, and restoring salt marsh along the Galveston Bay shoreline and the Gulf Intracoastal Waterway. Restoration of native prairie is ongoing in formerly farmed uplands, and additional woodlot habitats have been established.

The declining number of wetland acres within the project area accelerates the loss of wintering and migration habitat for waterfowl, shorebirds, wading birds and other wetland-dependent wildlife; and, highlights the need to continue intensive management for these species on the Refuge Complex. Recent declines have been greatest for freshwater wetlands including cultivated rice acreage and natural palustrine emergent wetlands. General declines in many grassland bird populations highlight the

importance of maintaining, enhancing, and restoring upland prairie habitats. Chenier and riparian woodlands within the project area are extremely important habitats for many neotropical/nearctic migratory birds making trans-Gulf migrations. The USFWS has adopted a landscape-level ecosystem approach to natural resource conservation. This broader approach challenges the Refuge Complex to ensure that habitat management practices to benefit waterfowl and other migratory birds remain consistent with maintaining the natural biological diversity of this rich coastal ecosystem. This approach also requires the USFWS to increase collaboration, coordination and partnerships with local communities, landowners, local and state governments and agencies, other federal agencies, industry, conservation organizations and other stakeholders.

Summary of Concerns and Recommendations

- The USFWS has done a poor job managing for waterfowl because there were more ducks and geese in the marsh before the USFWS took over.
- The USFWS is holding too many ducks and geese in refuge sanctuary areas, where they are unavailable to hunters.
- The Willow Slough Levee and spillway project on the North Unit of McFaddin NWR has impeded drainage in upstream areas and has caused flooding on adjacent private land resulting in the landowners being unable to farm rice.
- Smoke from prescribed burning activities is causing air quality problems in the Beaumont-Port Arthur area. Even when prescribed burns are done on a north wind, smoke which has blown out over the Gulf gets blown back into town when the wind turns around the next day.
- The marshes on McFaddin NWR are drying up. When it was privately-owned, water was managed better and marshes stayed wet for waterfowl and other wildlife.
- Too much water is held on marshes on Anahuac NWR, for too long. This causes problems with the vegetation and also depletes oxygen from the water causing fish kills.
- The USFWS is not adequately maintaining water control structures and other infrastructure, thereby allowing saltwater intrusion which is destroying the marshes.
- Most of the refuges were bought with "Duck Stamp" dollars, generated by hunter's purchases; therefore, the USFWS should be managing habitat on these refuges primarily for migratory waterfowl.
- The timing of refuge prescribed burns, combined with a better grazing program, should be modified to improve the habitat benefits to waterfowl.
- The USFWS should burn more acreage and more often.
- Prairie habitats should be restored because most native prairie on the Texas Gulf Coast has been lost and this habitat type is critically important for declining populations of grassland songbirds and other rare native plants and animals.
- The USFWS should restore, enhance and protect woodlots because these habitats are critical for nearctic/neotropical migratory birds, especially those making trans-Gulf migrations in the spring.
- Refuges should expand habitat management efforts for shorebirds.
- Annual breeding pair and monthly wintering waterfowl surveys on Texas Coast national wildlife refuges indicate the Mottled Duck populations are declining. Refuge habitat projects are needed

to restore/enhance shallow freshwater wetlands and grasslands to provide brood-rearing and nesting habitat for Mottled Ducks.

- Alligator populations on the refuges are too high and may be negatively impacting Mottled Duck production.
- The USFWS needs to expand monitoring and biological research to gain baseline data on all native fish, wildlife and plant species, with rare and declining species being the priority.
- The USFWS should expand existing and develop new partnerships to enhance conservation of natural resources in the project area. This includes working with landowners, volunteers, conservation organizations, industry and other agencies.

D. Threats to the Ecosystem

Two factors, acting in combination with the loss of native habitat through development and conversion to other land uses, constitute the greatest threats to this area's ecosystem. They are:

- Loss of coastal and inland wetlands through land subsidence, sea level rise, loss of freshwater and sediment inflows and saltwater intrusion, manifested as shoreline erosion and retreat along the Gulf of Mexico and bay systems and conversion of inland vegetated marshes to open water.
- Occurrence and expansion of invasive plant and animal species in wetlands, uplands, and coastal woodlands.

These two region-wide factors contribute to the loss of native habitats and the destruction of biological integrity within the entire ecosystem, including the four refuges within the Refuge Complex.

The combination of rising sea levels, land subsidence, loss of freshwater and sediment inflows and saltwater intrusion has resulted in loss of coastal habitats as shorelines erode and retreat and vegetated marshes convert to open water. Development activities in the ecosystem have significantly altered hydrological and sedimentation regimes. A significant percentage of the project area's historical freshwater marshes have been converted to less diverse brackish marsh types.

As rice agriculture declines in the area, fallowed rice fields are rapidly overwhelmed by invading Chinese tallow which easily out-competes native vegetation. Chinese tallow also readily establishes itself on pasture, ditch banks, levees and any other land which no longer has native cover. Also, invasive aquatic plants like water hyacinth and Giant Salvinia are establishing themselves in the area's freshwater marshes.

Summary of Concerns and Recommendations

- Rising sea levels, land subsidence and reduced sediment supplies have accelerated coastal erosion along the Gulf of Mexico, resulting in significant loss of wetlands and other important coastal habitats on McFaddin and Texas Point NWRs. Shoreline erosion is also a concern along Anahuac NWR's Galveston Bay shoreline.
- Loss of the barrier beaches and dunes on McFaddin NWR has resulted in increased saltwater intrusion in interior marshes, and coastal erosion and wetland loss on McFaddin NWR will greatly accelerate if the already threatened beach ridge is lost completely.
- Saltwater intrusion, erosion of marsh soils, subsidence and rising sea levels are factors contributing to marsh loss (conversion of emergent marsh to open water) in the project area's interior marshes.

- Erosion along the Gulf Intracoastal Waterway is also causing wetland loss and is threatening thousands of acres of fresh and intermediate marshes on McFaddin and Anahuac NWRs with saltwater intrusion and conversion to brackish marsh.
- Land subsidence and eustatic sea level rise pose a significant future threat to the region's coastal wetlands. If marshes cannot accrete vertically (gain elevation through soil building processes) at a rate which keeps up with relative sea level rise (subsidence plus eustatic sea level rise), marshes will be inundated and converted to open water resulting in a major loss of wildlife habitat.
- Loss or restriction of freshwater inflows has contributed, along with saltwater intrusion, to the conversion of historically fresh or intermediate marsh to brackish marsh resulting in a loss of biological diversity.
- Chinese tallow is a highly invasive exotic plant species which rapidly invades upland habitats and shallow wetlands, levees, and fallowed fields in the project area. It quickly forms monotypic closed-canopy stands, out-competes native plants and provides few benefits to native wildlife resulting in a loss of biological diversity.
- Several invasive aquatic plant species, including water hyacinth and alligatorweed, are also threatening biological diversity and wetland habitat value for migratory waterfowl and other native fish and wildlife species. Giant Salvinia, which is a great threat to freshwater wetlands, has recently been discovered in the project area.
- Deep-rooted sedge, a South American sedge, has recently become established and is invading fallowed rice fields and wet pastures in the project area. Little is currently known about this invasive species, other than it forms dense monotypic stands and out-competes native plants.
- Feral hogs are causing damage to habitats and management infrastructure on the Refuge Complex.
- The USFWS must expand its Integrated Pest Management Program and overall efforts to manage exotic and invasive species.
- Contaminants in the air, water, and soils pose a threat to native fish and wildlife in the region. Petroleum and petrochemical spills from underground pipelines and shipping in the Gulf Intracoastal Waterway and the Gulf of Mexico could have significant negative impacts on habitats, fish and wildlife.

VIII. ISSUE OUTSIDE THE SCOPE OF THE EIS – STATE HIGHWAY 87

At the scoping meetings held in Jefferson County, the public raised the issue of relocating and reconstructing the closed portion of State Highway 87 along the Gulf shoreline and within the McFaddin NWR. Jefferson County elected officials also raised this issue during briefings provided them by the USFWS. The State Highway 87 project is a proposal of Jefferson County, the Texas Department of Transportation, and the Federal Highway Administration. The State Highway 87 project is currently being addressed in its own Environmental Impact Statement, with the Federal Highway Administration as the lead federal agency. The USFWS is participating as Cooperating Agency in the development of the State Highway 87 EIS because the proposed relocated highway lies within the McFaddin NWR.

The State Highway 87 project is not within the scope of this EIS because it is not a USFWS proposal and as such is not a part of either the Refuge Management Alternatives or the Refuge Boundary Expansion Alternatives. However, the project is addressed in the Cumulative Impacts section of Chapter 4 of this EIS, along with other proposed federal, state, and local government and private projects in the study area.

CHAPTER 2: ALTERNATIVES

Introduction

The National Environmental Policy Act of 1969 (NEPA) prescribes that federal managers make their decisions with regard to major federal actions in a logical and informed manner. Managers should consider a reasonable range of alternatives, and managers should reflect upon the consequences of each alternative, including the one proposed for implementation, as well as the alternative of taking no action. NEPA and USFWS policy require the development of alternatives taking into account the issues and concerns of stakeholders, interest groups, and the public in general. In an effort to acquire public input, the USFWS has engaged in workshops and public meetings to allow for the maximum personal access to the process by the public during the scoping process. Alternatives are derived only after there has been careful consideration of public and stakeholder comments obtained in the scoping process. The alternatives must meet the purposes of the Federal proposal, meet the goals of the refuges, and comply with the missions of the Refuge System and the USFWS. NEPA also requires that the alternatives include the alternative of “No Action” and rigorously explore and objectively evaluate a reasonable range of alternatives.

The USFWS is considering two separate, but related federal actions and purposes within this EIS. The first proposes the development of a Comprehensive Conservation Plan (CCP) for each of the refuges in the Refuge Complex, and the second proposes the expansion of the refuge boundary for each of the refuges in the Refuge Complex. The proposed refuge boundary expansions are described and detailed in a Land Protection Plan (LPP). To more accurately inform the public and to better facilitate analysis of the impacts, the USFWS has developed two separate sets of alternatives, with each set addressing one of the two Federal actions. There is a set of “Refuge Management Alternatives” addressing the development of a CCP for each refuge, and there is a set of “Refuge Boundary Expansion Alternatives” addressing the expansion of each refuge’s boundary. Each set contains the appropriate “No Action” alternative, explores and evaluates a reasonable range of alternatives to the proposed action, and identifies a “Preferred Alternative” to be implemented.

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

In 2005, the USFWS published a national list of “Avian Species of Conservation Concern (USFWS 2005). Thirty-seven of the 48 Avian Species of Conservation Concern listed by the USFWS for the Gulf Coastal Prairie Bird Conservation Region (BCR) occur on the Refuge Complex and within wetland, prairie, and woodland habitats in areas identified in the Refuge Boundary Expansion Alternatives.

Wetland-dependent Avian Species of Conservation Concern occurring on the Refuge Complex and areas identified in the Refuge Boundary Expansion Alternatives include Yellow and Black rails, American Bittern, White Ibis, Hudsonian Godwit, Long-billed Curlew, Short-billed Dowitcher, Least Tern, Seaside

Sparrow, and Sprague's Pipit. Avian Species of Conservation Concern utilizing prairie grassland habitats on the Refuge Complex and areas identified in the Refuge Boundary Expansion Alternatives include LeConte's Sparrow, Nelson's Sharp-tailed Sparrow, Henslow's Sparrow, Buff-breasted Sandpiper, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk. Neo-tropical migrant landbirds listed as Species of Conservation Concern which utilize woodland habitats on the Refuge Complex and areas identified in the Refuge Boundary Expansion Alternatives include Swainson's Warbler, Prothonotary Warbler, Kentucky Warbler and Swallow-tailed Kite.

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

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

The North American Waterbird Conservation Plan (Kushlan *et al.* 2002) classified colonial and semi-colonial breeding water bird species into one of several "at risk" categories, including "not currently at risk", "low", "moderate", "high", "highly imperiled", and identified those species for which there is

“insufficient information available to assess risk”. Wetland habitats within the project area on the Refuge Complex provide important wintering, migrational and/or nesting habitat for 14 colonial and semi-colonial water bird species deemed at moderate risk, and 6 species deemed at high risk. High risk species include Tri-colored Heron, Little Blue Heron, Snowy Egret, Least Tern (all four nest on the Refuge Complex), Wood Stork, and Gull-billed Tern. The population status of solitary breeding marsh birds will be assessed in the second version of the NAWCP. The lands within the Refuge Complex are extremely important for many of these species, including several already identified by the USFWS as Species of Conservation Concern. These include Yellow Rail, Black Rail, and American Bittern. For the Southeast U.S. Region, the NAWCP identifies major concerns or threats to waterbirds to be fisheries “by-catch”, loss and deterioration of habitat, disturbance of nesting areas (particularly to beach-nesting terns and skimmers), and effects from contaminants. Standardization and coordination of systematic population monitoring of priority water bird species is also recommended.

The Partners in Flight (PIF) Conservation Program is an international, multi-agency and multi-organization conservation initiative for North American landbirds and waterbirds. PIF recently completed an assessment of the status and conservation needs of all North American land and waterbirds. This assessment included consideration of population trends, habitat trends, and threats on breeding and wintering grounds. National, regional, and more local conservation priorities were determined. These species represent conservation priorities for the USFWS and other PIF partners including state wildlife agencies, the U.S. Forest Service, and other governmental and private partners. Multi-agency PIF conservation strategies for Texas are currently under development, and these strategies will guide management activities at the local and regional scale. In Texas, the PIF partners have identified priority species for conservation, monitoring and management in relation to specific habitat types and seasons within the Texas Coastal Prairies region (Texas Parks and Wildlife Department 2000), which includes the Refuge Complex. Habitats on the Refuge Complex provide wintering, migrational and/or nesting habitat for 16 species of wetland-associated birds, 10 species of grassland birds, and 13 species utilizing woodland habitats which are listed as Rare and Declining within the Texas Coastal Prairies Region. Currently, the Gulf Coast Bird Observatory in Lake Jackson, Texas, in partnership with the Gulf Coast Joint Venture, is preparing the PIF Landbird Conservation Plan for the Gulf Coastal Prairies (Bird Conservation Region 37) which includes project area and Refuge Complex.

PART A: REFUGE MANAGEMENT ALTERNATIVES

The first of the two separate, but related, proposals addressed in this EIS is the development of a Comprehensive Conservation Plan (CCP) for the Refuge Complex. The Comprehensive Conservation Plan provides a framework for future management of the Moody, Anahuac, McFaddin and Texas Point NWRs. The CCP is designed to serve as a vision for the Refuge Complex and provide management guidance through maintenance, restoration, and use of Refuge resources during the next 15 years. The environmental analysis of this plan is addressed at the conceptual and programmatic level. While it contains some relative analytical specificity, it is not intended to be a detailed site plan with exact locations for facilities or precise descriptions of programs. Overall, there is a need to make the management of each refuge consistent with the National Wildlife Refuge System mission, goals, and policies. The USFWS' CCP policy encourages managers and planners to develop alternatives in order to arrive at the best decision possible on behalf of the American public as well as the overall mission of the Refuge System. All of the alternatives will accomplish, in different ways and with different perspectives, the Refuge Goals that define the responsibilities of the refuge staff as they relate to achievement of the purposes for which the refuge was established and the overall mission of the Refuge System. Also, some Refuge Goals relate to the USFWS' responsibilities toward compliance with a number of federal statutes such as the Endangered Species Act, the National Historic Preservation Act, the Antiquities Act, and the Clean Water Act, among others.

Since the USFWS is conducting an ongoing action and is considering developing new management plans, the "No Action" alternative is the continuance of current management activities and programs on the Refuge Complex under existing management plans. Four additional refuge management alternatives were developed, considering refuge establishment purposes for the conservation and management of migratory birds, the mission of the Refuge System, and the major issues developed during public and internal scoping.

The Refuge System Improvement Act states that a CCP for each refuge is needed to address "...significant problems that may adversely affect the populations and habitats of fish, wildlife and plants and the actions necessary to correct or mitigate such problems." Specifically, these problems at this Refuge Complex include the need to ensure biological integrity and maintain biological diversity and environmental health by reducing saltwater intrusion and restoring freshwater and sediment inflows to marshes and littoral systems, restoring altered wetland systems, restoring degraded prairie and woodland habitats, protecting unique and rare habitats and fish and wildlife species, controlling exotic and invasive species, reducing threats from contaminants and considering and addressing the future impacts of relative sea level rise. Development of the refuge management alternatives considered addressing these problems and issues.

The Refuge System Improvement Act also directs the USFWS to facilitate compatible wildlife-dependent recreational uses on national wildlife refuges. Through the refuge management alternatives, the six priority wildlife-dependent uses occurring on Refuge Complex are evaluated (hunting, fishing, wildlife observation and photography, and environmental education and interpretation), as are strategies to better manage them and/or provide additional opportunities for these uses to occur.

The Refuge System Improvement Act also directed that the Secretary of the Interior in administering the Refuge System will, in preparing each Comprehensive Conservation Plan, consult with adjoining Federal, State, local, and private landowners and affected State conservation agencies. Consistent with the Refuge System Improvement Act, the USFWS expressed in Director's Order No. 148 recognition that the various State game and fish organizations have a unique role in the planning and decision making process for CCPs; and, provided for State fish and wildlife agency representation on the CCP planning teams. Representatives of Texas Parks and Wildlife Department (TPWD) have been involved from the very start of the planning process for this EIS. A designated TPWD representative has participated as a member of the Core Planning Team in the scoping and alternative development stages of this EIS. Preliminary drafts of both sets of alternatives were presented for discussion and comment at the TPWD offices in Austin, Texas.

Summary of Refuge Management Alternatives

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

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

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

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

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

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

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

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

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

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

Refuge Management Alternative E: Emphasis on a Passive Management Approach

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

Elements Common to All Refuge Management Alternatives

Although the Refuge Management Alternatives all differ in their emphasis and focus, the management programs for each of the Alternatives have a number of elements or features common to all. Following is a description of those elements or features common to all of the Refuge Management Alternatives:

Complete Land Acquisition within Current Refuge Boundaries

The remaining lands within the current refuge boundaries will be acquired when, and if, the owners are willing to sell and funding is available. This is relevant only at McFaddin NWR because all the lands within the current refuge boundaries have already been acquired at the other refuges within the Refuge Complex. Acquisition of the remaining lands would not alter the emphasis or implementation within each of the different Refuge Management Alternatives.

Wilderness Review

The USFWS is required to conduct a wilderness review for each refuge as part of the CCP process. A wilderness review is the process used by the USFWS to determine whether or not to recommend lands or waters in the National Wildlife Refuge System to Congress for designation as a wilderness. A detailed Wilderness Review for each of the refuges within the Refuge Complex is contained in Appendix F in this document. The Wilderness Review and the recommendation to not include any of the Refuge Complex' lands or waters in the Wilderness System is valid for all of the Refuge Management Alternatives.

Protection of Cultural Resources

Cultural resources are those physical remains, objects, historic records, and traditional life ways that connect us to our nation's past. They include archaeological resources, historic properties, buildings/structures, Indian sacred sites, museum collections, objects of antiquity, and similar cultural properties. As a Federal agency, the USFWS is responsible for carrying out an array of laws and regulations concerning cultural resources. Some of the more important Federal cultural resources protection statutes are: the Antiquities Act, the Historic Sites Act, the National Historic Preservation Act, and the Archaeological Resources Protection Act. The purpose of the Federal historic preservation program is to ensure that cultural resources are duly considered as Federal agencies carry out their missions. The USFWS will ensure the same level of cultural resource protection required by law under each of the Refuge Management Alternatives.

Protection for Research Natural Areas (RNAs)

Research Natural Areas (RNAs) on national wildlife refuges are part of a national network of designated lands permanently reserved for research and educational purposes. They are intended to represent the full array of North American ecosystems, biological communities, habitats, and phenomena; and geological and hydrological formation and conditions, all intended for research purposes. RNAs are areas where natural processes are allowed to predominate without human intervention. Under certain circumstances, however, deliberate manipulation is used to maintain unique features that the RNA was established to protect (Refuge Manual, 8 RM 10). RNA's were originally intended to be treated as a kind of "wilderness" concept without the strict constraints placed on officially designated wilderness areas. They are intended to promote the naturalness of the area and encourage universities and other conservation groups to conduct research of these areas.

There is one RNA within the Texas Chenier Plain Refuge Complex. The Lone Tree Bayou Research Natural Area was designated on February 3, 1967 and is located within the Anahuac NWR. This RNA consists of approximately 200 acres of A7 Tidal Salt Marsh located along Lone Tree Bayou, a tributary of Oyster Bayou. It is managed for native plant associations and provides important habitat for a variety of native fauna including waterfowl, wading birds, alligators, and several marine fish and shellfish species. The Lone Tree Bayou Research Natural Area will be afforded the same level of protection under all of the Refuge Management Alternatives.

Detailed Description of Refuge Management Alternatives

The following sections contain a detailed narrative description of each Refuge Management Alternative along with the array of goals, objectives and strategies. While the goals do not vary between Alternatives, the objectives and strategies vary to differentiate the specific approaches to managing resources.

Each of the Refuge Management Alternatives contains a particular management emphasis or combination of emphases that distinguishes that alternative from the others. These emphases directly or indirectly influence the composition of the compendium of objectives and strategies derived from a particular alternative. Each alternative carries with it a particular philosophy or perspective that translates into a set of objectives and strategies that drive the achievement of the refuge goals and thus, become

the heart of the CCP. It is through this process that the USFWS eventually chooses its management direction leading to the fulfillment of the refuge purposes and the realization of its overall vision.

I. REFUGE MANAGEMENT ALTERNATIVE A (NEPA NO ACTION ALTERNATIVE) - CONTINUATION OF CURRENT MANAGEMENT

Alternative A Concept

Management Focus

Under this Alternative, current management programs on the Refuge Complex would continue unchanged. Management of wetland habitats including coastal marsh and freshwater wetlands to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory birds would continue at current levels and intensities using water level and salinity management, prescribed burning, grazing, cooperative rice farming, moist soil management, and mowing and haying. Restoration and protection of native habitats including wetlands, prairie and woodlands would proceed at current annual acreage rates and using existing techniques. Refuge staff would continue to provide technical assistance to private landowners wishing to enhance wetland and upland habitats for waterfowl and other wildlife on private lands.

The Refuge Complex biological program involving systematic field surveys to monitor population status and trends of migratory birds including waterfowl, shorebirds and neotropical and nearctic migratory songbirds, alligators, and habitats would continue. Periodic research would be conducted through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Ongoing efforts to address threats to ecosystem health posed by relative sea level rise and hydrological alterations, invasive/exotic species and contaminants would continue. These include coordination with other agencies and conservation organizations on ongoing planning processes and studies aimed at developing solutions to address coastal land loss, continuing to implement small-scale erosion abatement projects along the Gulf of Mexico, Galveston Bay and the Gulf Intracoastal Waterway through interagency partnerships, and maintaining existing shoreline restoration projects. Exotic plant and animal control programs would continue at current levels. Periodic monitoring of contaminant levels in air, soil and water and fish and wildlife resources would be conducted through the USFWS' Environmental Contaminants program.

The Refuge Complex would continue to provide opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation through the use of existing programs and facilities.



Administration of refuge management programs would continue using existing staffing levels, facilities and equipment.

Rationale for this Management Focus

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total Flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as Avian Species of Conservation Concern. Coastal prairie and coastal woodlots support over 150 migratory and resident landbird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 avian species designated by the USFWS as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005).

The high degree of alteration in this ecosystem has resulted in loss and degradation of native habitats, loss of biological diversity, and decreased habitat quality for migratory birds and other native wildlife. Alterations of historic hydrology including loss of freshwater inflows and increased saltwater intrusion in combination with sea level rise, land subsidence and interruption of mineral sediment supply are contributing to ongoing coastal land loss and marsh degradation. Almost all of the region's historic native tallgrass coastal prairie and its associated prairie wetlands have disappeared, and remaining coastal woodlots are imminently threatened by development and other land use changes. Several highly invasive exotic plant species are replacing native habitats and impacting natural biological diversity. Air and water quality issues in the region pose a potential contaminant threat to habitats and fish and wildlife, as do accidental spills and discharges from the major petrochemical shipping, storage, and processing facilities located in close proximity to sensitive habitats. Habitat losses to date and ongoing ecosystem threats are such that intensive management of remaining habitats, in combination with habitat restoration where feasible, are required to conserve fish and wildlife resources.

The Refuge Complex provides over 170,000 annual visitors opportunities to waterfowl hunt, fish for fresh and saltwater species, observe and photograph wildlife, and learn about this coastal ecosystem through interpretive and environmental education programs. Southeast Texas has a long and rich tradition of outdoor recreation. Demand for these recreational opportunities on public lands and waters is increasing. The human population in the 8-county area surrounding Houston now exceeds 6 million people, and the Texas Gulf Coast has become a popular nature tourism destination nationally and internationally.

A. USFWS Habitat Management and Restoration

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

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

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

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

These habitat management and restoration activities focus on achieving the following two Refuge goals:

- GOAL 1. Conserve, enhance and restore the Texas Chenier Plain region's coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent birds, and habitat for other native fish and wildlife.
- GOAL 2. Conserve, enhance and restore the Texas Chenier Plain region's coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/nearctic migratory birds, and habitat for other native wildlife species.

1. Wetland Specific Management and Restoration

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

The typical water management regime for managed marshes on the Refuge Complex involves maintaining salinities within the range of the particular marsh type being targeted. Salinity inputs may be increased to higher than target levels if required to control aquatic invasive species. The general water level management regime across most of the Refuge Complex involves maintaining pre-determined water levels which provide favorable conditions for dabbling ducks and geese during fall and winter. Following the wintering migratory bird season, marsh units are allowed to draw down gradually to create soil conditions favorable for the germination of a variety of seed producing annual plants in emergent marshes and water levels conducive to the germination and establishment of submerged and floating aquatic plants in open water habitats. Summer water levels are maintained to promote the growth of these species.

a. Emergent Wetlands

The objective for Emergent Wetlands (Estuarine and Palustrine) is to maintain the historic continuum of fresh, intermediate, brackish and saline coastal marshes on the Refuge Complex, and to maintain a diversity of marsh plant communities both in species composition and vegetational structure (stem densities and height). Habitat values for waterfowl, shorebirds and many wading bird species are greatly enhanced in slightly brackish to fresh marshes containing several perennial and annual plant species (primarily grasses and sedges) which provide important food resources, and where disturbance reduces the height and/or density of vegetation. Perennial emergent plants important to wintering waterfowl include seashore paspalum (*Paspalum vaginatum*) and Olney bulrush (*Scirpus olneyi*). Early successional emergent plant species important as waterfowl food producers also include annual grasses such as millet (*Echinochloa* spp.) and sprangle-top (*Leptichloa fascicularis*) and forbs such as water hyssop (*Bacopa monnieri*) and purple ammania (*Ammania coccinea*). Coastal marshes have evolved with a disturbance regime which includes fire, herbivory by native wildlife and more recently livestock, and infusion of saline waters during tidal surges associated with tropical storms and hurricanes. Water level and salinity management, prescribed burning, and controlled grazing are available tools for influencing plant communities (species composition and structure) in marsh habitats.

Current USFWS management activities in emergent wetlands:

- Actively manage water levels and salinities in managed marsh units (approximately 30,000 acres of semi-impoundments and impoundments on the Refuge Complex) utilizing water control structures, levees and water delivery and drainage infrastructure to maintain a continuum of brackish to fresh conditions and desirable marsh hydroperiods (wetting and drying cycles).
- On Texas Point NWR, utilize passive water management with rock weirs to reduce saltwater intrusion and restore hydrology.
- On Moody NWR, monitor non-development conservation easement.

- Conduct a rotational prescribed burning program in emergent marsh habitats on the Refuge Complex, with an annual burning objective of 12,000-15,000 acres. Prescribed burns are conducted primarily in fall and early winter (late September to early December). Conduct wildland fire suppression activities with full consideration of natural resource objectives.
- Conduct a rotational grazing program on approximately 41,000 acres of marsh and upland habitats on the Refuge Complex.
- Manage muskrat and nutria populations on the Refuge Complex utilizing trapping under Special Use Permit for nuisance animal control when necessary to prevent damage to emergent marsh habitats.

b. Open Water Wetlands (Estuarine and Palustrine)

The objective for Open Water Wetlands (Estuarine and Palustrine) is to produce a diverse and healthy annual crop of submerged and floating aquatic vegetation in ponds and other open water habitats, and to maintain a desirable interspersed of open water and emergent marsh habitats on the Refuge Complex. The diversity and productivity of aquatic plant communities are also dependent upon maintenance of the historic continuum of fresh to saline marsh types. The submerged aquatic plant community serves as a direct source of important waterfowl foods (e.g., seeds and tubers), and indirectly, as a rich environment for aquatic macroinvertebrates, which are heavily utilized by waterfowl and many other wetland birds (Baldassarre and Bolen 1994). These habitats are extremely important for brood-rearing and molting Mottled Ducks (Stutzenbaker 1988), and these habitats are important to fishery resources providing vital nursery habitat for many species of marine fish and shellfish (Stutzenbaker and Weller 1989). Water level and salinity management within marsh semi-impoundments are important tools for restoring and maintaining submerged aquatic vegetation production and species diversity. Common reed (*Phragmites communis*), cattail (*Typha* spp.) and California bulrush (*Scirpus californicus*) are aggressive plant invaders which can form dense homogeneous stands in open water habitats in brackish to fresh marshes. In fresh marsh environments, establishment and expansion of maiden cane (*Panicum hemitomen*) and giant cutgrass (*Zizaniopsis miliacea*) can also result in loss of open water habitats. Submerged aquatic vegetation production is substantially reduced due to shading and loss of substrate when extensive encroachment by these species occurs.

Current USFWS management activities in open water wetland habitats:

- Manage water levels and salinities in managed marsh units (semi-impoundments and impoundments) to maximize the annual production of desirable submerged and floating aquatic plants.
- Utilize an integrated management approach involving salinity and water level management, prescribed burning, controlled grazing, herbicide application and mechanical manipulation to control invasive emergent plant encroachment into open water habitats.

c. Freshwater Prairie Wetlands (Palustrine)

The objective in Freshwater Prairie Wetlands (Palustrine) is to maintain approximately 1,000 -1,200 acres of managed and natural shallow freshwater wetlands on the Refuge Complex. The loss of native prairie habitats and their associated shallow prairie wetlands have been substantial along the Texas Coast (Moulton *et al.* 1997). A large portion of the upper Texas Coast prairie habitats have been cultivated for rice production, which provides valuable habitat for waterfowl, shorebirds, and many other migratory birds (Hobaugh *et al.* 1989, Wilson 2001). However, rice production has declined significantly during the last decade in counties surrounding the Refuge Complex, reducing available prairie wetland habitat for waterfowl, shorebirds and other wetland-dependent species. Mottled Ducks heavily utilize prairie habitats adjacent to freshwater wetlands for nesting (Stutzenbaker 1988).

Current USFWS management activities in freshwater “prairie” wetlands:

- Farm 500-700 acres of rice annually through a cooperative farming program on Anahuac NWR.
- Manage approximately 500 acres of moist soil units annually on Anahuac NWR. Of these, 150 acres are managed to provide freshwater habitat during spring and summer for brood-rearing

Mottled Ducks, and 100 acres are managed to provide migrational habitat for shorebirds during spring and fall.

- Mow (and/or hay) 100 acres of transitional wet prairie annually on Anahuac NWR to enhance migrational and wintering habitat for waterfowl and shorebirds.

2. Upland Specific Management and Restoration

a. Native Prairie and other Grasslands

The objective for native prairie and other grasslands is to protect and manage 5,744 acres on non-saline grasslands on the Refuge Complex, including “prairie remnants”, permanently fallowed former croplands which are naturally revegetating, and sites previously restored using intensive restoration techniques. An additional 245 acres of fallowed croplands would be restored on Anahuac NWR under this Alternative. It is now estimated that 99.8% and 99.6 % of little bluestem and eastern gamma grass/switch grass prairies, respectfully, have been lost in Texas (McFarland 1995). Nine of the 13 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in grasslands on the Refuge Complex. In 2005, the USFWS listed 7 avian species occurring in prairie habitats on the Refuge Complex as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region. Intensive restoration of native prairie and enhancement of existing grassland habitats through an integrated management approach utilizing prescribed fire, exotic plant control, controlled grazing and mowing (and/or haying) is needed on the Refuge Complex to provide high quality nesting and wintering habitat for prairie-dependent avian species and other wildlife.

Current USFWS management activities in native prairie and other grassland habitats:

- Conduct spring prescribed burning, rotational controlled grazing, mowing (and haying) and invasive plant control to maintain and enhance existing 5,744 acres of grassland habitats on the Refuge Complex. Conduct wildland fire suppression activities with full consideration of natural resource objectives.
- Increase native prairie plant diversity by planting and sprigging native grasses and forbs within existing grassland habitats on Anahuac NWR.
- Through partnerships with conservation organizations and volunteers, conduct native prairie restoration using intensive restoration techniques on an additional 245 acres on Anahuac NWR in the following management units: Curlew Prairie, Field 51, VIS Prairie Demonstration, Onion Bayou Prairie and Saltcedars. Intensive restoration techniques include exotic plant control/removal, restoring natural contours and hydrology by removing cropland levees and other infrastructure, and seeding with native prairie seed mixtures.

b. Coastal Woodlands

The objective for Coastal Woodlands is to protect and enhance the existing 127 acres of woodland habitats on the Refuge Complex. Coastal woodlots in the Chenier Plain region are extremely important to migrating songbirds, providing essential feeding and resting areas for numerous neotropical migratory birds crossing the Gulf of Mexico (Rappole 1974, Sprunt 1975, Mueller 1981). Although comprising less than 1% of Refuge Complex acreage, woodland habitats are extremely important to overall avian diversity, including several sensitive species. Six of the 7 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in Refuge Complex woodlands. In 2005, the USFWS listed 4 species that occur in Refuge Complex woodlands as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region.

The amount of native coastal woodlot habitat in the Chenier Plain region has been reduced mainly through development, conversion to pasture and logging of bottomland hardwoods (Mueller 1981). Although woody habitat has significantly increased in the region with the rapid expansion of exotic Chinese tallow trees, these new tallow woodlands provide poor habitat for migrant songbirds (Barrow and Renne 2001).

Current USFWS management activities in coastal woodlands:

- Protect and enhance existing 127 acres of woodlands on the Refuge Complex using fencing, invasive plant control, and native tree and shrub plantings to diversify woodlots and create additional understory.

B. USFWS Biological Program – Surveys, Monitoring, and Research

USFWS habitat management and restoration activities benefit many species of native fish, wildlife and plants on the Refuge Complex. The USFWS biological program on the Refuge Complex includes monitoring, field surveys and research studies of fish and wildlife population status, population trends and habitat utilization. The information obtained allows the USFWS to adapt management efforts on the Refuge Complex as needed to achieve Refuge purposes and to maintain and restore natural biological diversity and biological integrity.

These fish and wildlife conservation efforts focus on achieving the following Refuge goal:

- GOAL 3. A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.

1. Waterfowl, Shorebirds, and other Wetland-Dependent Migratory Birds

The biological program's objective for waterfowl, shorebirds and other wetland-dependent migratory birds is to help maintain healthy populations of species utilizing the Refuge Complex, and to document population status and trends and habitat utilization of priority species. Coastal habitats of the Texas Chenier Plain region provide important wintering and migration habitat for waterfowl of the Central Flyway, and for millions of shorebirds, wading birds, colonial nesting waterbirds, and other wetland-dependent migratory birds. Monitoring and studies of population trends and habitat utilization provide information to assess management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

Current USFWS biological program and management activities supporting conservation of waterfowl, shorebirds and other wetland-dependent migratory birds:

- Conduct monthly aerial surveys of wintering and migrating waterfowl (September through March) of the four refuges on the Refuge Complex.
- Conduct periodic spring and fall shorebird surveys in various representative wetland habitats on Anahuac NWR.
- On Anahuac NWR, manage 100 acres of moist soil units annually to provide freshwater wetland and mudflat habitat for shorebirds during spring and fall migrations.
- Conduct annual nesting survey for colonial nesting waterbirds on Gulf shoreline of Texas Point NWR.
- Participate in national, regional and local banding studies of migratory waterfowl and other migratory birds, including ongoing banding studies of Mottled Ducks and Snow Geese.
- Facilitate and support occasional research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.
- Collect data from harvested waterfowl at check stations on Anahuac and McFaddin NWR including body condition indices and lead shot ingestion rates.
- Participate in the annual Audubon Society Christmas Bird Count.
- Maintain existing nesting habitat site for Least Terns on McFaddin NWR.
- Coordinate with the U.S. Army Corps of Engineers to evaluate and develop opportunities for creating colonial water bird habitat through the beneficial use of dredge material.

The objective for Mottled Ducks, an important resident waterfowl species, is to increase breeding populations to long-term average levels by maintaining favorable habitat conditions including nesting, brood-rearing, molting and wintering habitats. Both spring breeding pair and September aerial surveys conducted by the USFWS indicate a steady decline in Mottled Duck populations on coastal national wildlife refuges in Texas over the last 16 years. While drought conditions along much of the Texas Coast

during late 1990's undoubtedly contributed to this decline, other potential causative factors include loss of freshwater wetlands and upland nesting habitat due to land use changes, loss of pair bond, brood rearing and molting habitats due to invasive plant encroachment in open water habitats, brush encroachment in nesting habitats, increased predation by alligators, mammalian predators and fire ants, and lead shot ingestion rates that have remained high in some areas.

Current USFWS biological program and management activities supporting conservation of Mottled Ducks include:

- Conduct annual Mottled Duck breeding pair survey on Texas coastal refuges (including Anahuac NWR) in March.
- Conduct banding program on the Refuge Complex and adjacent private lands in cooperation with Texas and Louisiana state wildlife agencies.
- Coordinate with USFWS Division of Migratory Birds on specific research needs and support research activities.
- On Anahuac NWR, manage 150 acres of moist soil units annually specifically to provide brood rearing habitat for Mottled Ducks during summer.
- Utilize water level and salinity management, prescribed burning, and rotational grazing in managed marsh units (semi-impoundments and impoundments) to provide quality Mottled Duck brood-rearing, molting, and wintering habitat.
- Maintain quality nesting habitat utilizing an integrated brush control program which include, prescribed burning, controlled grazing, herbicide application, and mowing to reduce brush encroachment in salty prairie habitats, on levees and along fence lines.

2. Migratory and Resident Landbirds

The biological program's objective for migratory and resident landbirds is to help maintain healthy populations of species utilizing the Refuge Complex, and to document population status and trends and habitat utilization of priority species. Coastal habitats of the Texas Chenier Plain region provide important wintering, migrating and nesting habitat for migratory and resident landbirds. Monitoring and study of population trends and habitat utilization provides information to assess management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

Current USFWS biological program activities supporting conservation of migratory and resident landbirds:

- Conduct periodic surveys of migratory and resident landbirds on the Refuge Complex, including neotropical and nearctic migrants, in marsh, prairie and woodland habitats.
- Facilitate and support occasional research studies on priority species on the Refuge Complex through partnerships with universities and the U.S. Geological Survey Biological Resources Division.
- Participate in the annual Audubon Society Christmas Bird Count. Two area counts include the Anahuac and McFaddin/Texas Point NWRs.

3. Fish and other Aquatic Species

The biological program's objective for fish and other aquatic species is to ensure healthy populations and document population trends, status and habitat utilization of priority species on the Refuge Complex. Estuarine marsh habitats support over 95% of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. The continuum of fresh to saline aquatic environments on the Refuge Complex support highly diverse aquatic vertebrate and invertebrate communities.

A second objective for fish and other aquatic species is to incorporate fisheries and aquatic resource management into the management of all estuarine marshes on the Refuge Complex.

Current USFWS biological program and management activities supporting conservation of fish and other aquatic species:

- Working with the USFWS' Division of Fisheries, continue to support and facilitate periodic monitoring of fishery resources.
- Retrofit existing water control structures and incorporate design features in any new structures to facilitate ingress and egress of living marine organisms in estuarine marshes.
- Enhance marine organism access to and from managed marshes by managing water control structures to facilitate passage during key movement periods.

4. Threatened and Endangered Species, Species of Conservation Concern

The biological program's objective for Threatened and Endangered species, Species of Conservation Concern, and other "watch species" is to support recovery efforts and to obtain information on population trends, status and habitat utilization of sensitive and/or declining species utilizing the Refuge Complex. Eight federally-listed Threatened and Endangered species occur on or adjacent to the Refuge Complex: Bald Eagle, Piping Plover, Brown Pelican, Loggerhead sea turtle, Kemp's Ridley sea turtle, Green sea turtle, Hawksbill sea turtle, and Leatherback sea turtle. The sea turtles are found offshore in the Gulf and in Galveston Bay, but no nesting on beaches has been documented on the Refuge Complex. The Refuge Complex also provides important habitat for 33 avian species identified by the USFWS as Avian Species of Conservation Concern within the Gulf Prairies Bird Conservation Region. Nine out of the 13 avian species listed by the Texas Parks and Wildlife Department as rare and declining species in coastal prairies and marshes in Texas are found on the Refuge Complex. The Texas Parks and Wildlife Department lists three species of reptiles which occur or potentially occur on the Refuge Complex as threatened: the 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 Nature Conservancy's Texas Conservation Data Center.

Current USFWS biological program activities supporting conservation of Threatened and Endangered species and other species of conservation concern:

- Participate in the annual coast-wide wintering Piping Plover survey.
- Report all incidences of stranded sea turtles to National Marine Fisheries Service.
- Document the occurrence of Threatened and Endangered species and species of conservation concern on the Refuge Complex during field surveys.
- Facilitate and support occasional research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

5. Mammals

The biological program objective for mammals on the Refuge Complex is to help maintain healthy populations and natural diversity and to document population status and trends and habitat utilization of priority species. Coastal habitats of the Texas Chenier Plain region support a diverse mammalian community.

Current USFWS biological program activities supporting conservation of mammals:

- Document the occurrence of mammals on the Refuge Complex during field surveys for other species.
- Facilitate and support occasional research studies on mammals through partnerships with universities and the U.S. Geological Survey Biological Resources Division.
- Control muskrat populations as needed to prevent damage to emergent marsh habitats through issuance of Special Use Permit for trapping and removal.

6. Reptiles and Amphibians

The biological program objective for reptiles and amphibians is to maintain healthy populations and natural diversity, and to document population status and trends. The objective for alligators is to maintain

alligator populations at self-sustaining levels, but at densities consistent with migratory bird management objectives. The American alligator was first afforded protection under the Endangered Species Act in the late 1960's. Since then, populations have increased dramatically throughout its range. Nest counts conducted by the Texas Parks and Wildlife Department indicate a substantial increase in alligator numbers throughout its range in Texas (TPWD, Annual Alligator Reports). Survey information on McFaddin NWR indicates a greater than 200% increase in the refuge alligator population during the past decade; a similar increase has been noted on Anahuac NWR.

Current USFWS biological program activities supporting conservation of reptiles and amphibians:

- Administer an adult alligator harvest program as a compatible refuge economic use on the Anahuac and McFaddin NWRs under the Texas Parks and Wildlife Department's alligator management program.
- Conduct annual basking and nighttime spotlight surveys on Anahuac and McFaddin NWRs to monitor alligator population trends.
- Monitor recoveries of marked alligators on McFaddin NWR to enhance population trend monitoring.
- Continue coordination and information sharing with the Texas Parks and Wildlife Department on alligator harvest management, population monitoring, and research.
- Facilitate and support occasional research studies on sensitive and/or declining species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

7. Invertebrates

The biological program objective for invertebrates is to maintain healthy populations and natural diversity, and to document species occurrence on the Refuge Complex.

Current USFWS biological program activities supporting conservation of invertebrates include:

- Work with partners to conduct baseline inventories of species occurrence and relative abundance. Cooperate with established inventory programs such as "Bio-Blitz" and annual North American Butterfly Association count.

8. Plant Resources

The biological program objective for plant resources is to maintain native plant species diversity and to document native species composition and plant community changes over time on the Refuge Complex. Natural disturbances such as drought and floods, fire and herbivory by wildlife, and management activities such as grazing, prescribed burning, water level and salinity management all impact plant communities on the Refuge Complex. Sea level rise, subsidence and invasive plant and animal species are now also impacting native plant communities. Understanding how these events, processes and management activities affect plant community dynamics is essential to ensure long-term conservation of plant resources.

Current USFWS biological program activities supporting conservation of plant resources:

- Assess habitat response to management activities including prescribed burning and grazing and natural perturbations such as fire and hurricanes through systematic field vegetation surveys and monitoring.
- Facilitate and support periodic research and monitoring of plant resources and factors such as sea level rise, subsidence and exotic species which are impacting plant resources through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

C. Addressing Threats to the Ecosystem

The USFWS has ongoing efforts on the Refuge Complex to address threats to ecosystem health posed by relative sea level rise, hydrological alterations, exotic species, and contaminants. These include coordination with other agencies and conservation organizations on ongoing planning processes and

studies aimed at developing solutions to address coastal land loss due to erosion along the Gulf of Mexico, and to implement erosion abatement projects along the Gulf of Mexico, Galveston Bay and the Gulf Intra-coastal Waterway.

These efforts addressing threats to ecosystem health focus on achieving the following Refuge goal: GOAL 4. By working with others locally and on a landscape level, threats to biological integrity, biological diversity, and environmental health on the Texas Chenier Plain Refuge Complex will be addressed.

1. Coastal Land Loss

The objective for the threat from relative sea level rise and reduced sediment supply is to decrease rates of coastal land loss due to shoreline erosion along the Gulf of Mexico, East Galveston Bay, and the GIWW. Along the Texas Coast, wetland losses between the mid-1950's and mid-1990's were most substantial for estuarine emergent marshes (Moulton *et al.* 1997). Relative sea level rise and reduced coarse sediment supply to Gulf and bay nearshore littoral systems are resulting in significant loss of coastal habitats. Average rates of shoreline retreat along the Gulf adjacent to the refuges are as high as 50 feet per year on Texas Point NWR, and 10-15 feet per year along most of McFaddin NWR (Bureau of Economic Geology unpublished data, Morton 1998). Over 800 acres of dunes and emergent marsh has been lost due to Gulf shoreline erosion on these refuges during the last 25 years, and remaining inland marshes are increasingly threatened by more frequent inundation during high tidal events. Although less severe, erosion along the East Galveston Bay shoreline is also causing wetland loss on Anahuac NWR, and also threatens remaining marshes with saltwater intrusion. Erosion along the GIWW is causing direct loss of wetlands and poses a significant threat to marshes from saltwater intrusion on both McFaddin and Anahuac NWRs. Levees created when the GIWW was constructed have almost entirely eroded away along significant portions of its length within these refuges.

Current USFWS efforts addressing shoreline erosion and resulting land loss:

- Working with the Texas General Land Office and other partners, maintain existing dune restoration project and explore opportunities for additional dune restoration along the Gulf of Mexico on McFaddin NWR.
- Working with the Texas General Land Office and other partners, maintain existing shoreline protection and seek opportunities for additional protection along the GIWW shoreline on McFaddin NWR. Rock breakwaters, shoreline armoring, and emergent marsh plantings are methodologies currently in use.
- Coordinate with the U.S. Army Corps of Engineers and other partners to implement additional projects to beneficially use dredge materials from the Sabine-Neches Ship Channel to reduce land loss by restoring sediment supply to the Gulf shoreline and marshes on and adjacent to Texas Point NWR, and from the GIWW to restore sediment supply to marshes on McFaddin and Anahuac NWRs.
- Coordinate with the U.S. Army Corps of Engineers on their ongoing Section 227 National Shoreline Erosion Demonstration Project in Jefferson County, Sabine Pass to San Luis Pass Shoreline Erosion Feasibility Study for Galveston and Jefferson counties.
- Working with the Galveston Bay Foundation, Galveston Bay Estuary Program, and other conservation partners, maintain existing offshore rock wave breaks and restore emergent marsh by planting smooth cordgrass along the East Galveston Bay shoreline on Anahuac NWR.
- Coordinate with USFWS Partners for Fish and Wildlife and Coastal programs to implement shoreline protection projects on Moody NWR.

2. Altered Hydrologic Processes

The objective for the threat from altered hydrologic processes and resulting interior marsh loss is to protect existing and restore emergent coastal marsh habitat on the Refuge Complex by reducing saltwater intrusion, increasing freshwater and inflows and mineral sediment supply to marshes, and maintaining natural marsh hydroperiods. Land subsidence and sea level rise, channel construction, and channelization of natural waterways has had significant hydrologic impacts including saltwater intrusion, increased tidal energies causing erosion of organic marsh substrates, loss of freshwater inflows and

reduced mineral sediment supply to marshes, and excessive flooding or drainage/drying of marshes. Over the last century, these factors have gradually converted extensive areas of fresh and intermediate marshes to a more brackish regime thereby decreasing natural biological diversity, and in some areas have resulted in conversion of vegetated emergent marshes to open water (marsh loss). Relative sea level rise threatens further loss of vegetated marsh due to submergence and increased saltwater intrusion. To survive, remaining marshes must accrete or gain elevation at a rate that keeps up with relative sea level rise. Maintaining plant productivity and preventing loss of organic marsh soils by restricting saltwater intrusion and tidal energies, increasing freshwater inflows, and beneficially using dredge materials to increase mineral sediment supply appear to offer the most realistic options for reversing current trends of interior marsh loss in the Chenier Plain region.

Current USFWS efforts addressing altered hydrologic processes and marsh loss:

- Actively manage water levels and salinities in managed marsh units on Anahuac and McFaddin NWRs (semi-impoundments and impoundments) utilizing water control structures, levees and water delivery and drainage infrastructure to maintain a continuum of brackish to fresh conditions and desirable marsh hydroperiods (wetting and drying cycles). Utilize passive rock weirs to restore hydrology and decrease saltwater intrusion on Texas Point NWR.
- Coordinate with state and federal agencies and others to implement a hydrological restoration project aimed at stopping emergent marsh loss (conversion of emergent marsh to open water) on J.D. Murphree WMA, Sea Rim State Park and private lands in the eastern portion of the Salt Bayou watershed affected by the Keith Lake Fish Pass in Jefferson County.
- Coordinate with the U.S. Army Corps of Engineers, Texas General Land Office, Texas Parks and Wildlife Department, Texas Department of Transportation and others to develop strategies to restore and enhance wetlands throughout the Refuge Complex through the beneficial use of dredged material.

3. Invasive Species

The objective for the threat from invasive species is to utilize an integrated pest management (IPM) program to control invasive species (exotic and native species) on the Refuge Complex, emphasizing reduction and control of Chinese tallow. Monocultures of invasive plants reduce natural biological diversity, increase erosion, alter nutrient cycling and displace macro- and micro-fauna that depend on native plants for habitat and food (Sheley and Petroff 1999). Refuge habitats are currently significantly impacted by exotic plants and animals including: Chinese tallow (*Sapium sebiferum*), deep-rooted sedge (*Cyperus entrerianus*), water hyacinth (*Eichhornia crassipes*), alligator weed (*Alternanthera ohilcoeroides*), water lettuce (*Pistia stratiotes*), McCartney rose (*Rosa bracteata*), vasey grass (*Paspalum urvillei*), Johnson grass (*Sorghum halepense*), deep-rooted sedge (*Cyperus entrerianus*), Eurasian water milfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), common Salvinia (*Salvinia minima*) Japanese honeysuckle (*Lonicera japonica*) red imported fire ants, nutria, and feral hogs. Giant salvinia (*S. molesta*), to date documented on the Refuge Complex only once and in small amounts near a refuge boat ramp, has been found nearby and poses a significant threat to freshwater wetlands. Invasive native plant species include eastern baccharis (*Baccharis halimifolia*), big-leaf sumpweed (*Iva frutescens*), rattlebox (*Sesbania drummondii*), common reed (*Phragmites communis*) and cattail (*Typha* spp.).

Current USFWS efforts addressing invasive species:

- On the Refuge Complex, annually treat 25% of all Chinese tallow trees seven feet tall or 4" in diameter using basal bark herbicide applications, and utilize mowing, fire and spot herbicide applications on smaller plants.
- Utilize salinity management, mechanical removal and spot herbicide treatments to control water hyacinth near water control structures and in water delivery systems on the Refuge Complex.
- Utilize salinity management, fire, mowing and spot herbicide treatment to control invasive aquatic plants such as cattail and common rush on the Refuge Complex.
- Utilize fire and mowing to control brush encroachment by Eastern baccharis in Refuge Complex grassland habitats.
- Continue feral hog population control efforts on McFaddin and Anahuac NWRs.

- Coordinate with the Trinity Bay Conservation District and the Chambers-Liberty Counties Navigation District on control of aquatic and terrestrial invasive plants on waterways, canals and ditches and on banks and levees within drainage and irrigation easements through the Anahuac NWR.

4. Contaminants

The objective for addressing the threat from contaminants is to identify and assess contaminant threats to fish and wildlife resources on the Refuge Complex. Contaminant issues affecting the Refuge Complex include potential petroleum and petrochemical spills from: 1) on-Refuge oilfield operations; 2) shipping on the GIWW; and 3) offshore production in the Gulf and Galveston Bay. The potential for petrochemical and petroleum spills affecting the Refuge Complex is high. Several active oil and gas wells are currently producing on the Refuge Complex. Significant drilling and production activity occurs in Gulf waters offshore of McFaddin and Texas Point NWRs. The GIWW between Houston and Lake Charles, Louisiana is one of the busiest reaches of this waterway for shipping petrochemical and petroleum products. The GIWW parallels much of McFaddin and Anahuac NWRs, and the Sabine-Neches Ship Channel parallels Texas Point NWR. Former and current oil and gas production areas on the Refuge Complex contain extensive infrastructure which is no longer in use, including flow lines, pipelines, oil pits, well pads, and brine disposal areas. Many of these lines, pits and pads may contain contaminants including heavy metals, normal occurring radio-active material, brine, and petroleum products. In addition, Refuge Complex marshes comprise the downstream end of at least 10 waterways. Factories, refineries, solid waste disposal sites, oil field sludge disposal areas, feedlot operations, agricultural operations and housing developments are potential pollution sources in upstream reaches of these watersheds. Finally, high levels of lead shotgun pellets likely occur over much of the Refuge Complex. Incidence of lead shot in Mottled Duck gizzards remains relatively high to the present in birds harvested on the Anahuac and McFaddin NWRs, even after over 15 years of implementation of non-toxic ammunition regulations.

Current USFWS efforts addressing contaminants:

- Working with the USFWS Division of Ecological Services, conduct periodic monitoring and studies of contaminant levels and impacts to fish and wildlife resources on the Refuge Complex.
- Facilitate and support research and monitoring on contaminants and contaminant impacts to fish and wildlife resources on the Refuge Complex through partnerships with universities and the U.S. Geological Service Biological Resources Division.
- Coordinate with federal, state and local agencies on oil spill response planning, preparedness and implementation.
- Continue monitoring of lead shot ingestion rates in Mottled Ducks harvested on Anahuac and McFaddin NWRs.

5. New Oil and Gas Exploration and Development

Minerals underlying the refuges are privately held and the USFWS must allow reasonable use of the surface of refuges to explore for and develop oil and gas reserves. The objective for management of New Oil and Gas Exploration and Development is to ensure that new oil and gas exploration and development on the Refuge Complex is conducted in the most environmentally-sensitive manner possible by defining a process which facilitates close coordination with industry and timely processing of requests to conduct activities, and which mandates the use of scientifically-accepted "best management practices" for these activities in sensitive coastal environments.

Current USFWS efforts addressing new oil and gas development:

- Coordinate with oil and gas interests on all exploration and development activities on the Refuge Complex, and administer these activities under existing USFWS policy and regulations through issuance of Special Use Permits.

D. USFWS Public Use Program

The Texas Chenier Plain Refuge Complex offers a wide variety of recreational and environmental educational opportunities and received over 172,000 visitors during fiscal year 2002. Guidance for authorizing public uses on National Wildlife Refuges is provided in the National Wildlife Refuge System Improvement Act (the Act) of 1997 (P.L. 105-57). The Act states, "Compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System . . . through which the American public can develop an appreciation for fish and wildlife." Through the use of existing programs and facilities, the Refuge Complex provides opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, which are:

- Hunting
- Fishing
- Wildlife observation and photography
- Environmental education and interpretation

These visitor and recreational opportunities focus on achieving the following refuge goal:

- GOAL 5. All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex' role in conserving the region's coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast.

1. Hunting

The objective for hunting is to provide safe and high quality waterfowl hunting opportunities on the Refuge Complex. Waterfowl hunting is a traditional and still very popular outdoor recreational pursuit in the region. Refuges and other public lands along the Gulf Coast play a key role in providing hunting opportunity to the public.

Current USFWS public use program activities supporting hunting:

- Provide waterfowl hunting opportunities on approximately 37,300 acres of the Refuge Complex. Opportunities include assigned area by reservation or drawing hunts, controlled entry hunts which limit overall numbers of hunters in a particular hunt unit, and unrestricted entry hunts. Reservation, drawing, and controlled entry hunts require a fee permit, while unrestricted hunts do not. All refuge hunters must possess a general refuge hunting permit.
- Administer the waterfowl hunt program under current regulations. Hunting on all hunt units is allowed 3 days per week until noon (except the Pace Tract on Anahuac NWR which is open seven days per week until noon).
- Maintain existing access facilities which support the hunting program including hunter check stations, roads, boat ramps, boat rollers, parking areas, foot bridges and waterways.
- Conduct routine law enforcement activities to protect public safety and natural resources.

2. Fishing

The objective for fishing is to provide safe and high quality fishing opportunities on the Refuge Complex. The Refuge Complex offers exceptional recreational fishing and crabbing opportunities in both saltwater and freshwater environments. Catfish, bass and brim in freshwater environments and speckled trout, flounder and red drum in saltwater environments are among the popular game fish species on the refuges. Crabbing for blue crabs is also a popular recreational pursuit along refuge waterway and lake shorelines.

Current USFWS public use program activities supporting fishing:

- Maintain existing access facilities which support the fishing program including roads, boat ramps, parking areas, fishing piers and trails.
- Host annual National Fishing and Boating Week event on Anahuac NWR.
- Conduct routine law enforcement activities to protect public safety and natural resources.

3. Wildlife Observation and Photography

The objective for wildlife observation and photography is to provide safe and high quality opportunities for wildlife observation and photography on the Refuge Complex. The Refuge Complex provides local, regional, national and international visitors with a wide range of wildlife observation and photography opportunities, supporting a rapidly growing nature tourism industry in Texas. Migratory bird and alligator viewing are the main attractions. The refuges are highlighted Upper Texas Gulf Coast sites on the Great Texas Birding Trail. Anahuac NWR is an internationally known birding destination, receiving visitors each year from all 50 states and over 20 countries.

Current USFWS public use program activities supporting wildlife observation and photography:

- Maintain existing facilities which support wildlife observation and photography including the Anahuac NWR Visitor Information Station, and roads, parking areas, trails, observation platforms, boardwalks, and photography blinds.
- Conduct routine law enforcement activities to protect public safety and natural resources.

4. Environmental Education and Interpretation

The objective for environmental education and interpretation is to provide safe and high quality opportunities for environmental education and interpretation on the Refuge Complex. The implementation of environmental education and interpretive programs for students and visitors on the Refuge Complex is important to increase the quality of the visitor experience and to further public awareness of the benefits, issues and challenges associated with natural resource conservation in this productive and diverse coastal ecosystem.

Current USFWS public use program activities supporting environmental education and interpretation include:

- Through a partnership with the Friends of Anahuac Refuge, refuge volunteers and local school districts, provide an environmental education program on Anahuac NWR for kindergarten through fifth grade students. Specific curricula have been developed for each grade. Over 1,000 students annually are taught during field trips to the refuge, and through an in-school reading program.
- Provide guided tours and interpreted nature walks for visitors on Anahuac NWR in partnership with the Friends of Anahuac Refuge and volunteers.
- Maintain existing facilities which support environmental education and interpretation including the Anahuac NWR Visitor Information Station, roads, parking areas, trails, interpretive signs, observation platforms, and boardwalks.
- Host annual educational special events including the Youth Waterfowl Expo and National Fishing Week celebration on Anahuac NWR and Marsh Madness on McFaddin NWR and participate in educational activities at local and regional festivals including the Texas GatorFest and the Texas Rice Festival.
- Conduct routine law enforcement activities to protect public safety and natural resources.

5. Beach Uses on McFaddin NWR

The objective for beach uses on McFaddin NWR is to protect public safety and natural resources along the Gulf of Mexico shoreline within the refuge. The beaches along the Gulf of Mexico on and adjacent to the McFaddin NWR support recreational uses including surf fishing, swimming, sunbathing, wildlife observation, and camping. The beaches on McFaddin NWR are considered an area of joint Federal and State of Texas jurisdiction. The beach inland of the Mean High water line lies within the Refuge. Motorized vehicular traffic occurs on the beach from the vegetation line seaward to mean low tide line, on the public beach easement established under the State of Texas "Open Beaches Act" (*Texas Natural Resources Code, Chapter 61: Use and Maintenance of Public Beaches*).

Current USFWS public use program activities related to beach use on McFaddin NWR include:

- Conduct routine law enforcement activities to protect public safety and natural resources.

E. Community Outreach and Partnerships

The objective for community outreach and partnerships is to promote conservation of natural resources by working effectively with partners in support of USFWS management programs on the Refuge Complex including habitat management and restoration, fish and wildlife population management, and providing public recreational and educational opportunities. Partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, two citizen support groups, with state agencies such as the Texas Parks and Wildlife Department, the Texas General Land Office and the Galveston Bay Estuary Program, and with conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters have been highly successful. Volunteers on the Refuge Complex currently provide over 10,000 hours of service annually. In addition, the USFWS is working with private landowners to enhance or restore coastal marsh and prairie wetlands habitat on private lands, by providing technical assistance and helping to coordinate use of several private lands programs (such as the USFWS Partners for Fish and Wildlife Program and the multi-partner Texas Prairie Wetland Project). Many private lands in the region are skillfully managed to provide habitat for wintering waterfowl and other migratory birds.

Current USFWS community outreach and partnership activities:

- Maintain existing partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance and conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters.
- Participate in partnership efforts with local and county governments, and state and federal agencies including the Texas Parks and Wildlife Department, Texas General Land Office, Galveston Bay Estuary Program, National Marine Fisheries Service and the U.S. Army Corps of Engineers to protect and enhance coastal natural resources.
- Maintain active refuge volunteer program on the Refuge Complex.
- Provide technical assistance to private landowners in Chambers, Jefferson and Galveston counties wishing to enhance wetland habitats for waterfowl and other wetland-dependent migratory birds through active management and restoration.
- Coordinate with private landowners in Chambers, Jefferson and Galveston counties to develop habitat enhancement and restoration projects through the USFWS Partners for Fish and Wildlife Program, and through other private lands programs such as the Texas Prairie Wetlands Project (a partnership program sponsored by Ducks Unlimited, Texas Parks and Wildlife Department, the Natural Resource Conservation Service, and the USFWS).

F. Administration and Staffing

Current staffing on the Refuge Complex includes 30 full-time positions and 2 seasonal positions. Staffing is complimented by programs such as the Student Career Enhancement Program, the Youth Conservation Corps program, and student interns during the summer field season. Current staffing levels are as follows:

Texas Chenier Plain Refuge Complex

Refuge Manager – Refuge Complex Project Leader

Refuge Complex Administrative Officer

Refuge Complex Law Enforcement Officer

Fire Management Officer

Assistant Fire Management Officer

Prescribed Fire Specialist

Range Technician – Fire Monitor

Range Technician – Fire Crew (5)

Anahuac NWR

Refuge Manager

Refuge Administrative Technician

Refuge Operations Specialist
Wildlife Biologist
Outdoor Recreation Planner
Outdoor Recreation Planner – Volunteer Coordinator
Maintenance Mechanic
Heavy Equipment Operator (2)
Maintenance Worker
Biological Technician – Seasonal

McFaddin NWR
Refuge Manager
Administrative Assistant
Wildlife Biologist
Biological Technician
Heavy Equipment Operator
Maintenance Worker
Biological Technician – Seasonal

Texas Point NWR
Refuge Manager

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

Alternative B Concept

Management Focus

Under this Alternative, the Refuge Complex would focus its management efforts on active management of wetland and upland habitats to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory and resident birds. In marsh habitats, grazing intensity, annual prescribed burn acreage and the frequency of burning would be increased to substantially increase the amount of marsh habitat in early successional plant communities. Two new marsh semi-impoundments totaling 7,500 acres would be constructed and water management capabilities enhanced in existing impoundments through installation of new water control structures and levees. The cooperative rice farming program, moist soil management, mowing (and haying) programs on Anahuac NWR would be expanded to enhance shallow freshwater wetland habitats and adjacent upland prairies for resident Mottled Ducks, and for wintering and migrating waterfowl, shorebirds and wading birds. Management of native prairie and coastal woodlot habitats would focus on protecting existing prairie units and woodlots. Efforts to provide technical and financial assistance to private landowners through implementation of private lands initiatives to enhance waterfowl habitat on private lands would be expanded.

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. Changes to the public waterfowl hunt program would include providing additional opportunity for waterfowl hunting and new hunting opportunities for additional species, more "assigned area" (spaced blind) hunting opportunities, and allowing commercially guided hunting on designated portions of the Refuge Complex. New wildlife observation and photography facilities would be developed to provide for additional opportunities to view wetland-dependent birds. Interpretive and environmental education programs and facility development would focus on habitat management activities in wetlands, and on conservation of waterfowl and other wetland-dependent migratory birds.

Three essential staffing positions would be added and filled to implement Refuge Management Alternative B, and would include a wildlife biologist, law enforcement officer, and heavy equipment operator.

Rationale for this Management Focus

The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total Flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America. The Refuge Complex's coastal marshes host hundreds of thousands of wintering and migrating Central Flyway waterfowl, shorebirds, wading birds and other wetland dependent birds. Intensive management of Refuge Complex habitats is needed to help counter habitat changes over much of the region which have negatively impacted the quantity and quality of habitat for waterfowl and other migratory birds.

Alterations of historic hydrology including loss of freshwater inflows and increased saltwater intrusion, coastal erosion, land subsidence and sea level rise are contributing to ongoing coastal marsh loss and degradation, and these changes are negatively impacting habitat quality for many waterfowl species (Chabreck 1982, Stutzenbaker and Weller 1989). Recent trends in local agriculture have also decreased

the quantity and quality of available habitat for migrating and wintering waterfowl and other migratory birds. Acreage in rice production, which provides valuable freshwater wetland habitat for waterfowl, shorebirds and other migratory birds and freshwater inflows to estuaries, has declined significantly over the last decade in Jefferson and Chambers counties.

Under specific resources in the description of this Alternative and the following Alternatives, some USFWS management activities are described as being “*No Change from Refuge Management Alternative A*”. This means the USFWS would continue the management activities affecting that particular resource as already described in Refuge Management Alternative A, “Continuation of Current Management”. In other places, the USFWS management activities are described as “...would continue with additions and/or modifications” which means the management activities affecting that particular resource as already described in Refuge Management Alternative A would continue with the stated additions and/or modifications.

A. USFWS Habitat Management and Restoration

The primary focus of USFWS land management activities on the Refuge Complex is to fulfill the establishment purpose(s) for the Refuges, i.e., for the conservation and management of migratory birds and their habitats. Habitat management and restoration activities under Refuge Management Alternative B would emphasize enhancing wetland habitats to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory and resident birds. These activities would include water management, prescribed burning, controlled grazing, and mowing (and haying).

These habitat management activities focus on achieving the following two Refuge goals:

- GOAL 1. Conserve, enhance and restore the Texas Chenier Plain region’s coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent birds, and habitat for other native fish and wildlife.
- GOAL 2. Conserve, enhance and restore the Texas Chenier Plain region’s coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/heartic migratory birds, and habitat for other native wildlife species.

1. Wetland Specific Management and Restoration

Water management activities (e.g. structural management of water levels and salinities and freshwater inflows) impact the Refuge Complex’s hydrologic regime and strongly influence wetland plant communities. Managed marsh units within the Refuge Complex are under varying degrees of structural control, and may be best described as marsh semi-impoundments. Some units are entirely or almost entirely behind man-made levees and water control structures, and are intensively managed through manipulation of the water control structures. Most are managed less intensively, relying to some degree on natural topography and drainage to control hydrologic regimes. Structural water management allows maintenance of the historic continuum of fresh, intermediate, brackish and saline marshes on the Refuge Complex.

a. Emergent Wetlands

The objective for Emergent Wetlands (Estuarine and Palustrine) under Refuge Management Alternative B is to establish, manage and maintain 60 to 70% of fresh and intermediate emergent coastal marshes on the Refuge Complex in target plant communities which contain several early successional plant species. Habitat values for waterfowl, shorebirds and many wading bird species are greatly enhanced in fresh and intermediate marshes with early successional plant communities containing several perennial and annual plant species (primarily grasses and sedges) which provide important food resources, and where disturbance reduces the height and/or density of vegetation. [See I.A.1.a. *Emergent Wetlands* for a description of successional emergent plant species]. In addition to water level and salinity management, prescribed burning and controlled grazing are available tools for influencing plant communities (species

composition and physical structure) in marsh habitats. The use of these management tools would be expanded and/or intensified under this Alternative to increase the number of acres of emergent marsh habitats with target plant communities.

USFWS management activities for emergent wetlands in Refuge Management Alternative A would continue, with the following modifications and additional activities:

- Construct a 1,500-acre marsh semi-impoundment with levees and water control structures on the Deep Marsh Unit of Anahuac NWR
- Construct a 5,000-acre marsh semi-impoundment with levees and water control structures in the Dipping Vats Management Unit of McFaddin NWR.
- Conduct a rotational prescribed burning program in emergent marsh habitats on the Refuge Complex, with an annual burning objective of 35,000 acres.
- Conduct annual prescribed burning in selected fresh and intermediate marsh units which are key waterfowl habitats.
- Increase current grazing intensity (stocking rates and duration) in all grazing units containing fresh and intermediate marshes on the Refuge Complex.
- Increase herbivory by native wildlife by developing new grit sites and maintaining sanctuary areas for geese through the special white goose conservation season (in effect since 1999) which follows the regular waterfowl season.

b. Open Water Wetlands (Estuarine and Palustrine)

The objective for Open Water Wetlands (Estuarine and Palustrine) is to increase species diversity and production of submerged aquatic vegetation in marsh habitats and increase open water habitat by 10% in fresh and intermediate marshes on the Refuge Complex. The submerged aquatic plant community serves as a direct source of important waterfowl foods (e.g., seeds and tubers), and indirectly, as a rich environment for aquatic macroinvertebrates, which are heavily utilized by waterfowl and many other wetland birds (Baldassarre and Bolen 1994). [See I.A.1.b. *Open Water Wetlands (Estuarine and Palustrine)* for further explanation of submerged aquatic vegetation and competing vegetation]. Water level and salinity management within marsh semi-impoundments are important tools for restoring and maintaining submerged aquatic vegetation production and species diversity. Construction of marsh terraces in larger open water wetlands to reduce wave fetch and turbidity can promote the establishment and growth of submerged aquatic vegetation.

USFWS management activities for open water wetlands in Refuge Management Alternative A would continue, with the following modifications and additional activities:

- On Anahuac NWR, improve water level management capabilities in Shoveler Pond, Rail Reservoir, Moccasin Pond, Otter Pond, and East Unit South Reservoir of Anahuac NWR by modifying existing and installing new water control structures.
- On McFaddin NWR, enhance water level and salinity management in Wild Cow Bayou Management Unit by installing additional water control structures along the GIWW and rehabilitating levees (LeBlanc's Reservoir, Pond 11, Pond 13), and modifying the existing western levee system to prevent saltwater intrusion.
- On McFaddin NWR, enhance water management in Willow and Barnett Lake units of McFaddin NWR through design and construction of new water control structures along the GIWW.
- On McFaddin NWR, enhance water management in Willow Slough (North Unit of McFaddin NWR) through design and construction of new water control structures/spillways and associated management infrastructure.
- On McFaddin NWR, construct marsh terraces to reduce fetch and turbidity and increase production of submerged aquatic vegetation in Willow/Barnett Lake area and Ponds 28 and 29 on McFaddin NWR, and as needed in open water areas on Texas Point NWR and Anahuac NWR.
- Throughout the Refuge Complex, implement an integrated control program for common reed, cattail and other emergent plants resulting in loss of open water habitats using herbicide application, mechanical removal, salinity control, prescribed burning and controlled grazing on selected units including the Deep Marsh, East Unit and Middleton Tract units of Anahuac NWR,

and the White's Fee, Wild Cow Bayou, White's Pasture and North Unit of McFaddin NWR. Expand control efforts over the life of the CCP using the most effective strategies.

- Develop enhanced Geographic Information System capabilities to monitor status and trends of wetlands on all four refuges in the Refuge Complex. Use GIS technology, remote sensing, LIDAR surveys and other tools to map micro-topography and define watersheds, quantify water usage, and detect trends in open water to emergent marsh ratios and large-scale vegetative changes.
- Facilitate and support a research study to identify causative factors of the "black water phenomenon" which negatively impacts submerged aquatic vegetation production in marsh habitats, and to guide development of adaptive management strategies to prevent or minimize these impacts.

c. Freshwater Prairie Wetlands (Palustrine)

The objective for Freshwater Prairie Wetlands (Palustrine Emergent) is to maintain 2,400 to 2,800 acres of managed and natural shallow freshwater wetlands on the Refuge Complex, and to actively manage adjacent prairie habitats to improve nesting habitat for Mottled Ducks and other ground nesting migratory birds. A large portion of the upper Texas Coast prairie habitats have been cultivated for rice production, which provides valuable habitat for waterfowl, shorebirds, and many other migratory birds (Hobaugh *et al.* 1989, Wilson 2001). However, rice production has declined significantly during the last decade in counties surrounding the Refuge Complex, reducing available prairie wetland habitat for waterfowl, shorebirds and other wetland-dependent species. Mottled Ducks heavily utilize prairie habitats adjacent to freshwater wetlands for nesting (Stutzenbaker 1988).

USFWS management activities proposed to achieve this objective for freshwater prairie wetlands:

- Increase rice acreage in Anahuac NWR cooperative farming program to 800 to 1,200 acres per year (an increase of 300-500 acres over current levels).
- Increase moist soil management on the Refuge Complex by 1,100 acres annually, to a total of 1,600 acres. Develop an additional 900 acres (to a total of 1,400 acres) of moist soil units on the Anahuac NWR (400 acres on the Old Anahuac Unit, 400 acres on the East Unit, and 100 acres on the Middleton Tract Unit), and develop 200 acres of moist soil units on McFaddin NWR.
- Provide migrational habitat for shorebirds annually during spring and fall on 300 acres of moist soil units on Anahuac NWR.
- Mow and/or hay 400 acres of transitional wet prairie annually on Anahuac NWR to enhance migrational and wintering habitat for waterfowl and shorebirds.
- Create shallow freshwater wetland habitat in selected dredge disposal sites along the GIWW on McFaddin NWR by installing levees and water control structures during the next maintenance dredging cycle. This will involve a cooperative project with the U.S. Army Corps of Engineers.

2. Upland Specific Management and Restoration

a. Native Prairie and other Grasslands

The objective for native prairie and other grasslands is to protect and manage the 5,744 acres of non-saline grasslands on the Refuge Complex, including "prairie remnants", permanently fallowed former croplands which are naturally revegetating, and sites previously restored to native prairie using intensive restoration techniques. Prescribed burning, controlled grazing, mowing (and haying) and invasive plant control would be the primary management tools employed.

No Change from Refuge Management Alternative A, except that no additional native coastal prairie will be restored on Anahuac NWR using intensive restoration techniques.

b. Coastal Woodlands

The objective for Coastal Woodlands is to protect and enhance the existing 127 acres of woodland habitats on the Refuge Complex.

No Change from Refuge Management Alternative A.

B. USFWS Biological Program – Surveys, Monitoring, and Research

The USFWS habitat management and restoration activities benefit many species of native fish, wildlife and plants on the Refuge Complex. The USFWS biological program on the Refuge Complex includes monitoring, field surveys and research studies of fish and wildlife population status, population trends and habitat utilization. The information obtained allows the USFWS to adapt management efforts on the Refuge Complex as needed to achieve Refuge purposes and to maintain and restore biological integrity and biological diversity. Data are also used in support of international, national and regional conservation initiatives.

These wildlife conservation efforts focus on achieving the following Refuge goal:

- GOAL 3. A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.

1. Waterfowl, Shorebirds, and other Wetland-Dependent Migratory Birds

The biological program objective for waterfowl, shorebirds and other wetland-dependent migratory birds is to help maintain healthy populations of species utilizing the Refuge Complex, and to document population status and trends and habitat utilization of priority species. Coastal habitats of the Texas Chenier Plain region provide important wintering and migrating habitat for waterfowl of the Central Flyway, and for millions of shorebirds, wading birds, colonial nesting waterbirds, and other wetland-dependent migratory birds. Monitoring and studies of population trends and habitat utilization provide information to assess management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

No change from biological program activities in Refuge Management Alternative A. USFWS biological program activities supporting conservation of waterfowl, shorebirds, and other wetland-dependent migratory birds in Refuge Management Alternative A would continue.

The objective for Mottled ducks, an important resident waterfowl species, is to increase breeding pair densities in suitable habitats on the Refuge Complex to at least 11 breeding pairs per square mile (the 15-year average for the period 1988-2002); and, to gather additional information on the factors impacting Mottled Duck populations through applied research and monitoring. Both spring breeding pair and September aerial surveys conducted by the USFWS indicate a steady decline in Mottled Duck populations on coastal national wildlife refuges in Texas over the last 16 years. While drought conditions along much of the Texas Coast during late 1990's undoubtedly contributed to this decline, other potential causative factors include loss of freshwater wetlands and upland nesting habitat due to land use changes, loss of pair bond, brood rearing and molting habitats due to invasive plant encroachment in open water habitats, brush encroachment in nesting habitats, increased predation by alligators, mammalian predators and fire ants, and lead shot ingestion rates that have remained high in some areas.

USFWS biological program and management activities for Mottled Ducks described in Refuge Management Alternative A would continue. Proposed additional USFWS biological program and management activities supporting conservation of Mottled Ducks include:

- Expand and refine annual Mottled Duck breeding pair index survey on the Refuge Complex to include an assessment of Mottled Duck use by habitat type (fresh, intermediate, and brackish marshes).

- Facilitate and support new research including studies to: 1) evaluate Mottled Duck nesting success and brood survival and identify factors affecting these vital rates; 2) determine habitat utilization and preferences during nesting, brood rearing, and molting periods; and 3) evaluate effects of predation by alligators, mammalian predators and fire ants on Mottled Duck survival. This would include removing alligators and mammalian predators from key Mottled Duck brood-rearing habitats, and assessing impacts on nest success and duckling survival.
- Manage 400 acres of moist soil units annually on Anahuac NWR specifically to provide brood-rearing habitat for Mottled Ducks during summer.
- Enhance management capabilities for Mottled Ducks on 300 acres of freshwater impoundments within the Wild Cow Bayou Management Unit on McFaddin NWR by rehabilitating existing levees and installing new water control structures. Intensively manage approximately 400 hundred acres of marsh habitat located adjacent to freshwater impoundments as optimum brood-rearing habitat.
- Develop and maintain at least two grit sites for Mottled Ducks within the Wild Cow Bayou Management Unit of McFaddin NWR.
- Restore pair pond and brood rearing habitats in key management units on the Refuge Complex (those currently supporting breeding Mottled Ducks) by restoring open water habitats lost to invasive plant encroachment, using an integrated approach (an intensified program involving prescribed burning, controlled grazing, water level and salinity management, mechanical removal, and spot herbicide treatments).
- Provide additional open, shallow freshwater habitat in and adjacent to key management units (those currently supporting breeding Mottled Ducks).
- Maintain optimal nesting cover in salty prairie habitats by applying prescribed fire and grazing at designated frequencies and intensities, based on ongoing site-specific assessments. Manage fire occurrence in salty prairie and other optimum nesting cover using mowed green fire breaks and other innovative techniques.

2. Migratory and Resident Landbirds

The biological program objective for migratory and resident landbirds is to help maintain healthy populations of species utilizing the Refuge Complex, and to document population trends, status and habitat utilization of priority species. Monitoring and study of population trends and habitat utilization provides information used to assess and improve management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

No Change from biological program activities in Refuge Management Alternative A.

3. Fish and other Aquatic Species

The biological program objective for fish and other aquatic species is to ensure healthy populations and document population trends, status and habitat utilization of priority species on the Refuge Complex. A second objective is to incorporate fisheries and aquatic resource management into the management of all estuarine marshes on the Refuge Complex.

No Change from biological program activities in Refuge Management Alternative A.

4. Threatened and Endangered Species, Species of Conservation Concern

The biological program objective for Threatened and Endangered species, Species of Conservation Concern, and other “watch species” is to support recovery efforts and to obtain information on population trends, status and habitat utilization of sensitive and/or declining species utilizing the Refuge Complex. Eight federally-listed Threatened and Endangered species occur on or adjacent to the Refuge Complex: Bald Eagle, Piping Plover, Brown Pelican, Loggerhead sea turtle, Kemp’s Ridley sea turtle, Green sea turtle, Hawksbill sea turtle, and Leatherback sea turtle.

No Change from biological program activities in Refuge Management Alternative A.

5. Mammals

The biological program objective for mammals is to maintain healthy populations and to document population trends, status and habitat utilization of priority species on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

6. Reptiles and Amphibians

The biological program objective for reptiles and amphibians is to maintain healthy populations and natural diversity, and to document population status and trends. The objective for Alligators is to maintain alligator populations at self-sustaining levels, but at densities consistent with migratory bird management objectives.

No change from biological program activities in Refuge Management Alternative A.

7. Invertebrates

The biological program objective for invertebrates is to maintain healthy populations and natural diversity, and document species occurrence on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

8. Plant Resources

The biological program objective for plant resources is to maintain native plant species diversity and to document native species composition and plant community changes over time on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

C. Addressing Threats to the Ecosystem

The USFWS has ongoing efforts on the Refuge Complex to address threats to ecosystem health posed by relative sea level rise, hydrological alternations, exotic species, and contaminants. These include coordination with other agencies and conservation organizations on ongoing planning processes and studies aimed at developing solutions to address coastal land loss along the Gulf of Mexico, and to implement small-scale erosion abatement projects along the Gulf, Galveston Bay, and the Gulf Intracoastal Waterway.

These efforts addressing threats to ecosystem health focus on achieving the following Refuge goal:

- GOAL 4. By working with others locally and on a landscape level, threats to natural biological diversity, ecological integrity, and environmental health on the Texas Chenier Plain Refuge Complex will be addressed.

For addressing threats posed by Relative Sea Level Rise and Reduced Sediment Supply, Altered Hydrologic Processes, Invasive Species, Contaminants, and for managing New Oil and Gas Development, there would be no change from USFWS activities in Refuge Management Alternative A.

D. USFWS Public Use Program

The Texas Chenier Plain Refuge Complex offers a wide variety of recreational opportunities and received over 172,000 visitors during Fiscal Year 2002. Through the use of existing programs and facilities, the Refuge Complex provides opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, which are:

- Hunting

- Fishing
- Wildlife Observation and Photography
- Environmental Education and Interpretation

These visitor and recreational opportunities focus on achieving the following Refuge goal:

- GOAL 5. All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex' role in conserving the region's coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast.

1. Hunting

The objective for hunting is that, within 15 years, 90% of all hunting visits on the Refuge Complex will qualify as high-quality hunting experiences, as determined by surveys of hunters conducted at the waterfowl check stations. Under this Alternative, intensified management of wetland habitats for waterfowl will increase wintering waterfowl populations on the Refuge Complex. Additional hunting opportunities for waterfowl and other game species could be provided. Crowding in the more accessible or "best" hunting spots is a major factor impacting hunt quality on the Refuge Complex. Converting the most accessible hunt units from an unrestricted entry to an "Assigned Area" program would help alleviate the crowding problem.

Current USFWS public use program activities in support of hunting in Refuge Management Alternative A would continue, with the following changes:

- On Anahuac NWR, modify the East Unit hunt program to an "Assigned Area" program for the entire unit, and establish a new Assigned Area program on the Middleton Tract hunt unit.
- Open the Anahuac NWR East Unit to hunting during the September teal season.
- On McFaddin NWR, establish new "Assigned Area" programs on the Star Lake, 5-mile Cut, and Clam Lake hunt areas.
- Open a designated portion of McFaddin NWR to seven-day per week waterfowl hunting.
- Open the Refuge Complex to snipe, rail, and gallinule hunting.
- Establish a guided hunt program (concession with commercial outfitter) on the designated portions of the Anahuac and McFaddin NWRs.
- Open Anahuac NWR for dove hunting in designated area(s) in cooperation with the Texas Parks and Wildlife Department.

2. Fishing

The objective for fishing is that, within 15 years, 90% of all fishing visits on the Refuge Complex will qualify as high-quality fishing experiences, as determined by angler comments documented during routine visitor contacts.

Current USFWS public use program activities in support of fishing in Refuge Management Alternative A would continue, with the following changes:

- Extend the open hours on McFaddin NWR (designated areas accessible from Clam Lake Road) to one hour before sunrise to one hour after sunset on weekdays, and open this portion of the Refuge on weekends.

3. Wildlife Observation and Photography

The objective for wildlife observation and photography is that, within 15 years, several new facilities will be developed to increase opportunities to view and photograph waterfowl, shorebirds and other wetland-dependent migratory birds in managed wetland habitats. Because overall management of the Refuge Complex under this Alternative will emphasize wetland habitat management, new wildlife viewing and photography opportunities should be developed in managed habitats such as marsh semi-impoundments, rice fields and moist soil units for waterfowl, shorebirds and other wetland-dependent migratory birds.

Current USFWS public use program activities in support of wildlife observation and photography in Refuge Management Alternative A would continue, with the development of the following additional facilities:

- Construct a new observation platform overlooking the Anahuac NWR Oyster Bayou Moist Soil units.
- Construct a tree-canopy height observation platform on the Anahuac NWR East Bay Bayou Trail, overlooking the rice and moist soil units.
- Develop a levee trail, boardwalk for wildlife observation and photography blind near the Refuge Headquarters on McFaddin NWR.
- Develop a connecting trail, boardwalk and observation platform on Texas Point NWR.

4. Environmental Education and Interpretation

The objective for environmental education and interpretation is that, within 15 years, 90% of visitors will feel that they have increased their knowledge of wetland management programs and wetland-dependent migratory birds found on the Refuge Complex. Because overall management of the Refuge Complex under this Alternative will emphasize intensified management of wetland habitats, educational and interpretive programs and materials would focus on managed habitats, management techniques, and wetland-dependent fish and wildlife resources.

Current USFWS public use program activities in support of environmental education and interpretation in Refuge Management Alternative A would continue, with the development of the following additional facilities and programs:

- On Anahuac NWR, develop interpretive exhibits on wetland and upland habitat management practices including prescribed burning, controlled grazing, water management and exotic species control and strategically place throughout the Refuge.
- Develop interpretive exhibits on waterfowl for the Anahuac NWR East Unit Hunter Check Station.
- Develop a Refuge Complex brochure on the role of fire management in enhancing marsh and upland habitats for waterfowl.
- Develop interpretive signs for the Anahuac NWR Oyster Bayou Moist Soil Unit overlooks.
- On Anahuac NWR, conduct weekly winter interpretive walks, focusing on wintering waterfowl and the habitats they utilize.
- Develop a Refuge Complex mobile interpretive display focusing on intensive management techniques used to support waterfowl, shorebirds, and other wetland-dependent migratory birds.
- Develop interpretive exhibits on wetland and upland habitat management practices including prescribed burning, controlled grazing, water management and exotic species control and strategically place throughout the Refuge Complex.
- Develop interpretive exhibit on waterfowl for the McFaddin NWR check station.
- Conduct monthly fall and winter waterfowl identification programs, utilizing new observation platforms on McFaddin and Texas Point NWRs.
- Produce a slide show emphasizing the importance of each Refuge in conserving coastal natural resources, emphasizing waterfowl, shorebirds and wetland-dependent migratory birds and their habitats.
- Develop videos describing wetland habitat management programs and how they enhance habitat for wetland-dependent migratory birds.
- Revise each general brochure and website to emphasize each Refuge's role in managing for waterfowl, shorebirds, and other wetland-dependent species.

5. Beach Uses on McFaddin NWR

The objective for beach uses on McFaddin NWR is to protect public safety and natural resources along the Gulf of Mexico shoreline within the refuge.

No change from USFWS law enforcement activities to protect public safety and natural resources on McFaddin NWR in Refuge Management Alternative A.

E. Community Outreach and Partnerships

The objective for community outreach and partnerships is to promote conservation of natural resources by working effectively with partners in support of USFWS management programs on the Refuge Complex including habitat management and restoration, fish and wildlife population management, and providing public recreational and educational opportunities. Partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, two citizen support groups, with state agencies such as the Texas Parks and Wildlife Department, the Texas General Land Office and the Galveston Bay Estuary Program, and with conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters have been particularly effective. Volunteers on the Refuge Complex provide over 10,000 hours of service annually. In addition the USFWS is working with private landowners to enhance or restore coastal marsh and prairie wetlands habitat on private lands, by providing technical assistance and helping to coordinate use of several private lands programs (such as the USFWS Partners for Fish and Wildlife Program and the multi-partner Texas Prairie Wetland Project). Many private lands in the region are skillfully managed to provide habitat for wintering waterfowl and other migratory birds. The objective for Private Lands Partnerships is that, within 15 years, 1,500 acres of coastal marsh and prairie wetlands habitat on private lands in the Texas Chenier Plain region will be enhanced or restored through coordination with interested private landowners and the use of USFWS private lands programs. Many private lands in the region are skillfully managed to provide habitat for wintering waterfowl and other migratory birds. A variety of private lands programs are available to private landowners, and there is widespread interest in managing for waterfowl.

Current USFWS community outreach and partnership activities in Refuge Management Alternative A would continue, with the following efforts to expand partnerships with private landowners to enhance wetland habitats:

- Hold three on-refuge workshops for private landowners and other agency personnel to demonstrate marsh management and restoration, moist soil management, and other wetland management techniques, and to highlight available USFWS private lands programs and grant opportunities.
- Increase coordination with private landowners in Chambers, Jefferson and Galveston counties to develop habitat enhancement and restoration projects through the USFWS Partners for Fish and Wildlife Program, and through other private lands programs such as the Texas Prairie Wetlands Project (a partnership program sponsored by Ducks Unlimited, Texas Parks and Wildlife Department, the Natural Resource Conservation Service, and the USFWS).

F. Administration and Staffing

In addition to the existing Refuge Complex staff positions under Refuge Management Alternative A, three essential staffing positions would be filled to implement Refuge Management Alternative B:

- Wildlife biologist
- Law enforcement officer
- Heavy equipment operator

III. REFUGE MANAGEMENT ALTERNATIVE C – EMPHASIS ON NATIVE HABITAT RESTORATION AND ADDRESSING MAJOR THREATS TO THE ECOSYSTEM

Alternative C Concept

Management Focus

Under this Alternative, the Refuge Complex would focus its management efforts on restoring wetlands, native prairie and woodlots, and on reversing trends of loss and degradation of these native habitats by increasing efforts to address coastal erosion, saltwater intrusion, and loss of freshwater and sediment inflows. Restoration of native prairie and prairie wetlands would occur on all suitable upland sites. Areas currently or formerly in rice cultivation on Anahuac NWR would be restored to native prairie and shallow depressional prairie wetlands. Controlled grazing and prescribed burning programs would be substantially modified. Controlled cattle grazing in marsh units would occur at reduced intensity, and be timed to follow prescribed burns or wildland fires. The frequency of prescribed burning would decrease in marsh habitats, and the primary timing of prescribed burning activities would shift from fall and winter to spring and summer to mimic the historic fire regime. Controlled grazing and prescribed burning in upland prairie habitats would include more short duration, high intensity grazing episodes and increased spring and summer burning.

A portion of the historic fresh and intermediate component of the Refuge Complex's coastal marshes would be restored and ongoing interior marsh loss addressed by working with agencies and other stakeholders on major hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion across watersheds, and through refuge-specific projects.

Following completion of watershed hydrologic restoration projects, intensive water level and salinity management in selected marsh semi-impoundments through active manipulation of water control structures would be replaced by more passive hydrological management using rock weirs. Efforts to address coastal wetland loss resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW would be intensified by increasing coordination among agencies and other stakeholders to develop and implement major projects aimed at stabilizing shorelines, and by implementing smaller scale projects on the Refuge Complex. Restoring sediment supply to the Gulf's near shore littoral zone, restoration of the Gulf beach/dune complex and under shore marshes on Galveston Bay, and stabilizing the banks of the GIWW would be the focus of USFWS efforts. Control and monitoring programs for invasive species would be intensified, and additional efforts to monitor and reduce impacts of contaminants implemented.

The Refuge Complex would continue to provide the current level of opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. No changes in administration of the public waterfowl hunt program would be implemented. New wildlife observation and photography facilities would be developed for viewing wildlife in restored habitats. Interpretive and environmental education programs and facility development would focus on interpreting native habitats and native biological diversity, threats to ecosystem integrity, and habitat restoration techniques and projects.

Rationale for this Management Focus

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Refuge Complex' coastal marshes host hundreds of thousands of wintering and migrating Central Flyway waterfowl, shorebirds, wading birds and other wetland-dependent migratory birds. Coastal prairie and coastal woodlots on the Refuge Complex support over 150 migratory and resident land bird species, including 9 species of

grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region.

The high degree of alteration in this ecosystem has resulted in loss and degradation of native habitats and loss of biological diversity. Alterations of historic hydrology including loss of freshwater inflows and increased saltwater intrusion, coastal erosion, land subsidence and sea level rise are contributing to ongoing coastal marsh loss and degradation. Almost all of the region's historic native tallgrass coastal prairie and its associated prairie wetlands have disappeared, and remaining coastal woodlots are imminently threatened by development and other land use changes. Several highly invasive exotic plant species are replacing native habitats and severely impacting native biological diversity. Air and water quality issues in the region pose a potential contaminant threat to fish and wildlife, as do accidental spills and discharges from the major petrochemical shipping, storage and processing facilities located in close proximity to sensitive wetland habitats on the Refuge Complex.

A. USFWS Habitat Management and Restoration

The primary focus of USFWS land management activities on the Refuge Complex is to fulfill the establishment purpose(s) for the Refuges, i.e., for the conservation and management of migratory birds and their habitats. Under Refuge Management Alternative C, the USFWS would emphasize restoration of wetlands, native prairie and woodlots, and reversing trends of loss and degradation of these native habitats by increasing efforts to address the effects of relative sea level rise and reduced sediment supply, altered hydrologic processes, exotic and invasive species and environmental contaminants.

Habitat management and restoration activities would focus on achieving the following two refuge goals:

- GOAL 1. Conserve, enhance and restore the Texas Chenier Plain region's coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent birds, and habitat for other native fish and wildlife.
- GOAL 2. Conserve, enhance and restore the Texas Chenier Plain region's coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/nearctic migratory birds, and habitat for other native wildlife species.

1. Wetland Specific Management and Restoration

Water management activities (e.g. structural management of water levels and salinities and freshwater inflows) impact the Refuge Complex's hydrologic regime and strongly influence wetland plant communities. Managed marsh units within the Refuge Complex are under varying degrees of structural control, and may be best described as marsh semi-impoundments. Some units are entirely or almost entirely behind man-made levees and water control structures, and are intensively managed through manipulation of the water control structures. Most are managed less intensively, relying to some degree on natural topography and drainage to control hydrologic regimes. Structural water management allows maintenance of the historic continuum of fresh, intermediate, brackish and saline marshes on the Refuge Complex.

a. Emergent Wetlands and Open Water Wetlands (Estuarine and Palustrine)

The objective for emergent and open water wetlands (Estuarine and Palustrine) under this Alternative is to maintain a mosaic of plant communities and successional stage marsh habitats primarily through natural disturbance events such as wildfire and herbivory by native wildlife. The USFWS would work with partner agencies to restore hydrology on a watershed scale, allowing scaling back some water management infrastructure to more passive infrastructure like rock weirs. Prescribed burning and grazing will be applied when needed to mimic the historic disturbance frequency and extent. Meeting the habitat needs of the region's diverse group of wetland-dependent avian species requires maintaining a diversity

of plant communities within marshes. Historically, disturbance events such as wildfire and herbivory by native wildlife (bison in particular) helped maintain this diversity. Although the historic fire frequency for the Chenier Plain marshes is unknown, we are assuming that these habitats historically burned at least every 2-4 years based on the region's high frequency of lightning strikes and long growing seasons which produce fuels capable of carrying fire in a single year. Allowing natural wildfire starts to burn (where practical) followed by controlled cattle grazing most closely replicates the historic disturbance regime; however, prescribed burning will probably be necessary to complete the historic 2-4 year burn frequency. Varying timing and frequency of prescribed burns within marsh units increases plant community diversity (Fredrickson and Reid 1990).

USFWS management activities proposed to achieve this objective for emergent and open water wetlands:

- Upon completion of major hydrologic watershed-scale restoration projects, replace structural management infrastructure in selected marsh semi-impoundments on the Refuge Complex with more passive hydrological control using rock weirs.
- Where feasible, utilize natural lightning starts to accomplish burning objectives by allowing natural wildfires to burn within Refuge Complex boundaries until they naturally extinguish.
- Conduct a rotational prescribed burning program in emergent marsh habitats with an annual burning objective of 5,000 to 6,000 acres annually. Integrate prescribed burning location and frequency with natural fire occurrences.
- Apply controlled cattle grazing in marsh units only in recently burned areas, at reduced intensity and only from October through April.

b. Freshwater Prairie Wetlands (Palustrine)

The objective for freshwater prairie wetlands (Palustrine) is to, within 15 years, create or restore 500 acres of shallow freshwater prairie "pothole" wetlands to reduce impacts of discontinuing the Anahuac NWR cooperative rice farming program, and maintain 500 acres of shallow freshwater wetlands annually using moist soil management. Loss of palustrine emergent wetlands has been the most pronounced among all coastal wetland types on the Texas Coast (Moulton *et al.* 1997). These wetlands provided extremely valuable habitat for many species of migratory birds and other native wildlife. Very few natural prairie wetlands remain on or adjacent to the Refuge Complex. Moist soil management also provides valuable shallow freshwater wetland habitat. The cooperative rice farming program would be phased out under this Alternative, resulting in a loss of 500-700 acres of farmed freshwater wetland habitat.

USFWS management activities proposed to achieve this objective for freshwater prairie wetlands:

- On Anahuac NWR, and restore approximately 500 acres of shallow depressional "pothole" prairie wetlands in the following management units: East Unit -300 acres, Granberry – 92 acres, Onion Bayou Prairie – 17 acres, East Bay Bayou Tract – 32 acres, and Middleton Tract – 60 acres.
- On Anahuac NWR, maintain moist soil management acreage at 500 acres annually.

2. Upland Specific Management and Restoration

a. Native Prairie and other Grasslands

The objective for native prairie and other grasslands is to protect and manage all of the 5,744 acres of non-saline grassland habitats on the Refuge Complex, including "prairie remnants", permanently fallowed former croplands which are naturally revegetating, and sites previously restored to native prairie using intensive restoration techniques. Prescribed burning, controlled grazing, mowing (and haying) and exotic/invasive plant control would be the primarily management tools employed. A second objective is to within 15 years, restore 4,535 acres of former cropland on Anahuac NWR to native prairie using intensive restoration techniques. Of the five Refuge Management Alternatives, the most extensive native prairie restoration would occur under this Alternative.

It is now estimated that 99.8% and 99.6 % of little bluestem and eastern gamma grass/switch grass prairies, respectfully, have been lost in Texas (McFarland 1995). Nine of the 13 avian species listed as

Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in grasslands on the Refuge Complex. In 2005, the USFWS listed 7 avian species occurring in prairie habitats on the Refuge Complex as Species of Conservation Concern in the Gulf Prairies Bird Conservation Region. Topography, soils, fire and grazing and trampling actions of herbivores, all in association with climate, are natural functions controlling grassland development. The use of prescribed fire, grazing, mowing, and herbicides at different sites with varying soil moisture can produce the variety of habitats needed to support a diverse prairie avifauna (Ryan 1990). Restoration of native prairie, an integrated management approach utilizing prescribed fire, exotic plant control, and controlled grazing is needed on the Refuge Complex to provide large blocks of nesting and wintering habitat for prairie-dependent avian and other wildlife species.

Current USFWS management activities to achieve objectives for native prairie and other grassland habitats would continue as in Refuge Management Alternative A. Proposed modifications and additional activities include:

- On Anahuac NWR, following phase out cooperative rice farming program, restore 2,312 acres of fallowed cropland and associated infrastructure on the East Unit to native prairie using intensive restoration techniques.
- On Anahuac NWR, restore an additional 2,223 acres of native prairie using intensive restoration techniques on the following management units: Gator Marsh – 97 acres, North Gator Marsh – 204 acres, Longtom Prairie – 186 acres, Pintail Marsh – 120 acres, Airstrip Prairie and East Bay Bayou Marsh – 1,000 acres, Middleton – 370 acres.
- Construct a 5-acre native prairie grass propagation area on the East Unit to increase native grass seeds for use in the prairie restoration program.
- Modify the controlled grazing program on upland prairie units to include more short-duration/high-stocking rate grazing episodes.
- Continue to conduct prescribed burns in prairie units in the spring, and initiate limited summer burning to help control invasive and exotic woody vegetation.

b. Coastal Woodlands

The objective for coastal woodlands is to, within 15 years, create 29 acres of new coastal woodlots on the Refuge Complex, and protect and diversify the 127 acres of existing woodlots and riparian woodlands. Coastal woodlots in the Chenier Plain region are extremely important to migrating songbirds (Rappole 1974, Sprunt 1975, Mueller 1981). Refuge Complex woodlands mark the first landfall for hundreds of thousands neo-tropical migratory birds making the trans-Gulf flights from Mexico, Central and South America during the spring migration. These birds spend one to several days in woodlands resting and foraging to help replenish fat reserves before continuing their migration to breeding habitats. During the fall migration, coastal woodlots provide the last opportunity for trans-Gulf migrants to increase their fat levels necessary for crossing the Gulf of Mexico (Caldwell *et al.* 1963). Migrant landbirds made greater use of woodlots with larger trees and denser under stories (Mueller and Sears 1987). Increasing the quality of habitat in Refuge Complex woodlots for migratory landbirds requires removing exotic plants and increasing under story density and species diversity.

Current USWS management activities to achieve objectives for coastal woodlands would continue as in Refuge Management Alternative A. Proposed additional activities include:

- On Anahuac NWR, create two 1-acre woodlots, one near the VIS and one at the Volunteer housing area. Create a 27-acre woodlot (green tree reservoir) on the East Unit along East Bay Bayou.
- Increase feral hog control efforts.

B. USFWS Biological Program – Surveys, Monitoring, and Research

The USFWS habitat management and restoration activities benefit many species of native fish, wildlife and plants on the Refuge Complex. The USFWS biological program on the Refuge Complex includes monitoring, field surveys and research studies of fish and wildlife population status, population trends and

habitat utilization. The information obtained allows the USFWS to adapt management efforts on the Refuge Complex as needed to achieve Refuge purposes and to maintain and restore natural biological diversity and ecological integrity. Data are also used in support of international, national and regional conservation initiatives.

These wildlife conservation efforts focus on achieving the following refuge goal:

- GOAL 3. A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.

1. Waterfowl, Shorebirds, and other Wetland-Dependent Migratory Birds

The biological program objective for waterfowl, shorebirds and other wetland-dependent migratory birds is to maintain healthy populations and document population trends, status and habitat utilization of waterfowl and other priority wetland-dependent migratory bird species on the Refuge Complex. The objective for Mottled Ducks is to maintain favorable habitat conditions for the year-round needs of the Mottled Duck on the Refuge Complex, including nesting, brood-rearing, molting and wintering habitats.

No Change from biological program activities in Refuge Management Alternative A.

2. Migratory and Resident Landbirds

The biological program objective for migratory and resident landbirds is to help maintain healthy populations, document population trends, status, and habitat utilization of priority species on the Refuge Complex.

No Change from biological program activities in Refuge Management Alternative A.

3. Fish and other Aquatic Species

The biological program objective for fish and other aquatic species is to help maintain healthy populations and document population trends, status and habitat utilization of priority species on the Refuge Complex. A second objective is to incorporate fisheries and aquatic resource management into the management of all estuarine marshes on the Refuge Complex.

No Change from biological program activities in Refuge Management Alternative A.

4. Threatened and Endangered Species, Species of Conservation Concern

The biological program objective for Threatened and Endangered species, Species of Conservation Concern, and other “watch species” is to support recovery efforts and to obtain information on population trends, status and habitat utilization of sensitive and/or declining species utilizing the Refuge Complex. Eight federally-listed Threatened and Endangered species occur on or adjacent to the Refuge Complex: Bald Eagle, Piping Plover, Brown Pelican, Loggerhead sea turtle, Kemp’s Ridley sea turtle, Green sea turtle, Hawksbill sea turtle, and Leatherback sea turtle.

No Change from biological program activities in Refuge Management Alternative A.

5. Mammals

The biological program objective for mammals is to maintain healthy populations and to document population trends, status and habitat utilization of priority species on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

6. Reptiles and Amphibians

The biological program objective for reptiles and amphibians is to maintain healthy populations and natural diversity, and to document population status and trends. The objective for alligators is to maintain alligator populations at self-sustaining levels, but at densities consistent with migratory bird management objectives.

No change from biological program activities in Refuge Management Alternative A.

7. Invertebrates

The biological program objective for invertebrates is to maintain healthy populations and natural diversity, and document species occurrence on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

8. Plant Resources

The biological program objective for plant resources is to maintain native plant species diversity and to document native species composition and plant community changes over time on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

C. Addressing Threats to the Ecosystem

Under Refuge Management Alternative C, the USFWS would increase efforts aimed at reversing trends of loss and degradation of native habitats by increasing efforts to address the effects of relative sea level rise and reduced sediment supply, altered hydrologic processes, exotic and invasive species and environmental contaminants. These efforts would include expanded coordination with other agencies and conservation organizations with a goal of implementing large-scale shoreline protection and hydrologic restoration projects. The USFWS would also implement smaller scale erosion abatement projects along the Gulf, Galveston Bay, and the GIWW and hydrologic restoration projects throughout the Refuge Complex.

These efforts addressing threats to ecosystem health focus on achieving the following Refuge goal:

- GOAL 4. By working with others locally and on a landscape level, threats to natural biological diversity, ecological integrity, and environmental health on the Texas Chenier Plain Refuge Complex will be addressed.

1. Coastal Land Loss

The objective for the threat from relative sea level rise and reduced sediment supply is to decrease rates of coastal land loss due to shoreline erosion along the Gulf of Mexico, East Galveston Bay, and the GIWW. Along the Texas Coast, wetland losses between the mid-1950's and mid-1990's were most substantial for estuarine emergent marshes (Moulton *et al.* 1997). Relative sea level rise and reduced coarse sediment supply to Gulf and bay nearshore littoral systems are resulting in significant loss of coastal habitats. Average rates of shoreline retreat along the Gulf adjacent to the refuges are as high as 50 feet per year on Texas Point NWR, and 10-15 feet per year along most of McFaddin NWR (Bureau of Economic Geology unpublished data, Morton 1998). Over 800 acres of dunes and emergent marsh has been lost due to Gulf shoreline erosion on these refuges during the last 25 years, and remaining inland marshes are increasingly threatened by more frequent inundation during high tidal events. Although less severe, erosion along the East Galveston Bay shoreline is also causing wetland loss on Anahuac NWR, and also threatens remaining marshes with saltwater intrusion. Erosion along the GIWW is also causing direct loss of wetlands and poses a significant threat to marshes from saltwater intrusion on both

McFaddin and Anahuac NWRs. Levees created when the GIWW was constructed have almost entirely eroded away along significant portions of its length within these refuges.

Current USWS efforts to address threats from relative sea level rise and reduced sediment supply would continue as in Refuge Management Alternative A. Proposed additional activities and modifications include:

- Increase coordination with the U.S. Army Corps of Engineers, National Marine Fisheries Service, Texas General Land Office, Texas Parks and Wildlife Department, Galveston Bay Estuary Program, Texas Department of Transportation and other local, state and federal agencies to develop and implement long-term inter-jurisdictional strategies to reduce coastal land loss along the Gulf of Mexico, East Galveston Bay and the GIWW. Goals would include implementing major projects to restore the Gulf barrier beach/dune complex on McFaddin NWR (dependent upon the results of ongoing sand source investigations, possibly using off-shore sand supplies), to restore sediment supply to the Gulf's nearshore littoral zone on Texas Point NWR through the beneficial use of dredge material, and to construct structural protection (rock breakwaters) and restore emergent marshes along shorelines of Galveston Bay (Anahuac NWR) and the GIWW (Anahuac and McFaddin NWRs).
- Participate in the U.S. Army Corps of Engineers new Regional Sediment Management program.
- Increase coordination among state, federal and local agencies on the issue of relative sea level rise and promote advanced conservation planning to address threats.
- Develop partnerships with universities and the U.S. Geological Survey, and facilitate and support new research and monitoring on marsh accretion and its relation to management practices including burning and structural marsh management.
- Install an additional 7,500 linear feet of shoreline erosion abatement (offshore rock wave breaks) and restore 10 acres of undershore emergent marsh (smooth cordgrass plantings) along East Galveston Bay shoreline on Anahuac NWR.
- Restore an additional 5,000 linear feet of the dunes along the Gulf of Mexico on McFaddin NWR.
- Protect an additional 10,000 linear feet of GIWW shoreline on McFaddin and Anahuac NWRs using offshore wave breaks, shoreline armoring, and/or emergent plantings (smooth cordgrass).

2. Altered Hydrologic Processes

The objective for the threat from altered hydrologic processes and resulting interior marsh loss is to protect existing and restore emergent coastal marsh habitat on the Refuge Complex by reducing saltwater intrusion, increasing freshwater and inflows and mineral sediment supply to marshes, and maintaining natural marsh hydroperiods. Land subsidence and sea level rise, channel construction, and channelization of natural waterways has had significant hydrologic impacts including saltwater intrusion, increased tidal energies causing erosion of organic marsh substrates, loss of freshwater inflows and reduced mineral sediment supply to marshes, and excessive flooding or drainage/drying of marshes. Over the last century, these factors have gradually converted extensive areas of fresh and intermediate marshes to a more brackish regime thereby decreasing natural biological diversity, and in some areas have resulted in conversion of vegetated emergent marshes to open water (marsh loss). Relative sea level rise threatens further loss of vegetated marsh due to submergence and increased saltwater intrusion. To survive, remaining marshes must accrete or gain elevation at a rate that keeps up with relative sea level rise. Maintaining plant productivity and preventing loss of organic marsh soils by restricting saltwater intrusion and tidal energies, increasing freshwater inflows, and beneficially using dredge materials to increase mineral sediment supply appear to offer the most realistic options for reversing current trends of interior marsh loss in the Chenier Plain region.

USFWS activities addressing altered hydrologic processes in Refuge Management Alternative A would continue. Proposed additional activities and modifications include:

- Expand coordination with local, state and federal agencies to develop and implement watershed-scale hydrologic restoration projects. A key component would be assessing the feasibility of and identifying options for restoring freshwater inflows to coastal marshes within the Salt Bayou watershed south of the GIWW.

- Expand coordination with the U.S. Army Corps of Engineers, Texas General Land Office, Texas Parks and Wildlife Department, Texas Department of Transportation and others to develop strategies to restore and enhance wetlands on the Refuge Complex through the beneficial use of dredged materials. This will include participation in the U.S. Army Corps of Engineers new Regional Sediment Management program.
- Throughout the Refuge Complex, replace selected water control structures with rock weirs following completion of watershed hydrologic restoration projects which reduce saltwater intrusion and increase freshwater inflows.
- Develop partnerships with universities and the U.S. Geological Survey, and facilitate and support new research and monitoring on marsh accretion and its relation to management practices including burning and structural marsh management.
- Monitor status and trends of Refuge Complex wetlands through enhanced Geographic Information System capabilities.
- Research the availability of, and if possible, acquire additional water rights to facilitate increasing freshwater inflows to the Anahuac NWR's East Unit from East Bay Bayou and Onion Bayou and to the Middleton Tract from Elm Bayou.
- Coordinate with Trinity Bay Conservation District and other partners to repair saltwater barriers and water control structures on East Bay, Elm and Onion bayous.
- On Anahuac NWR, construct a passive overflow spillway structures East Bay and Elm bayous to restore over bank flooding and freshwater inflows into East Unit marshes.
- On Anahuac NWR, construct rock weirs in constructed channels in northern portion of Pace Tract to reduce saltwater intrusion and decrease tidal energies.
- On Anahuac NWR, enhance water management by replacing water control structures and restoring levees along East Bay Bayou on the East Unit and Middleton Unit.
- On McFaddin NWR, restore hydrology by reducing saltwater intrusion and restoring marsh hydroperiods through construction of rock weirs and/or earthen plugs in constructed channels in the Willow/Barnett Lake Unit.
- Research the availability of and need for acquiring water rights to ensure that freshwater inflows remain adequate to maintain the natural diversity and productivity of the Willow Slough marsh on the McFaddin NWR North Unit.
- Restore natural hydrology to western marshes on McFaddin NWR by restoring Mud Bayou to its historic dimensions through construction of a rock weir.
- Coordinate with state and federal agencies and others to develop and implement comprehensive hydrological restoration on Texas Point NWR. Reducing saltwater intrusion and tidal energies by restoring Texas Bayou to historic dimensions and reducing the influence of constructed channels will be key components of this project.
- Throughout the Refuge Complex, restore surface hydrology by removing barriers formed by abandoned roads, levees and well pads remaining from past oil and gas development and agricultural activities.

3. Invasive Species

The objective for the threat from invasive species is to implement a comprehensive invasive species control program utilizing Integrated Pest Management strategies which will: 1) reduce current infestations by 50% within 15 years; and 2) prevent any new infestations. Monocultures of invasive plants reduce natural biological diversity, increase erosion, alter nutrient cycling and displace macro- and micro-fauna that depend on native plants for habitat and food (Sheley and Petroff 1999). Refuge habitats are currently significantly impacted by exotic plants and animals including: Chinese tallow (*Sapium sebiferum*), water hyacinth (*Eichhornia crassipes*), alligator weed (*Alternanthera ohilcoeroides*), water lettuce (*Pistia stratiotes*), McCartney rose (*Rosa bracteata*), vasey grass (*Paspalum urvillei*), Johnson grass (*Sorghum halepense*), *Cyperus entrerianus*, Eurasian water milfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), *Salvinia minima*, Japanese honeysuckle (*Lonicera japonica*) red imported fire ants, nutria, and feral hogs. Giant salvinia (*S. molesta*), to date documented on the Refuge Complex only once and in small amounts near a refuge boat ramp, has been found nearby and poses a significant threat to freshwater wetlands. Invasive native plant species include eastern baccharis (*Baccharis halimifolia*), big-

leaf sumpweed (*Iva frutescens*), rattlebox (*Sesbania drummondii*), common reed (*Phragmites communis*) and cattail (*Typha* spp.).

USFWS efforts addressing invasive species in Refuge Management Alternative A would continue. Proposed activities through an expanded Integrated Pest Management program would include:

- Throughout the Refuge Complex, expand field monitoring to provide early detection of new infestations, and develop enhanced GIS capabilities to map existing and new stands of upland and aquatic exotic and invasive plants.
- Develop new partnerships with universities and the U.S. Geological Survey Biological Resources Division to evaluate exotic and invasive species control strategies.
- On Anahuac NWR, evaluate control strategies for deep-rooted sedge and several exotic grasses currently impacting upland prairie habitats.
- On Anahuac NWR, mechanically remove Chinese tallow along the GIWW, Oyster Bayou, East Bay Bayou, Onion Bayou, and State Highway 124.
- On Anahuac NWR, increase coordination with the Trinity Bay Conservation District and the Chambers-Liberty Counties Navigation District on control of aquatic and terrestrial invasive exotic plants on waterways, canals and ditches and on banks and levees within drainage and irrigation easements throughout the Anahuac NWR.
- Evaluate use of approved and permitted biological control agents as they become available, for use in IPM program for exotic and invasive species control. An approved biological control agent for *Salvinia* spp. is now available for release in Texas, and its use on the Refuge Complex will be evaluated.
- Expand integrated control activities for water hyacinth in the Willow Slough Marsh on the North Unit of McFaddin NWR.
- On Texas Point NWR, utilize spot herbicide treatments to help control McCartney rose on non-saline prairie habitats.
- On the Refuge Complex, expand control efforts for invasive emergent marsh plants such as cattail and common rush where encroachment has resulted in loss of desirable open water habitats.
- Develop exotic aquatic plant interpretive signs and install them at all Refuge Complex boat ramps.
- Develop step-down Feral Hog Management and Nuisance Animal Management plans. Expand control efforts for feral hogs and nutria as necessary.

4. Contaminants

The objective for the threat from contaminants is to, within 15 years, identify and monitor all potential point and non-point source pollution impacts to the Refuge Complex and develop a strategy to clean up contaminants and protect refuge resources from those impacts. Contaminant issues affecting the Refuge Complex include potential petroleum and petrochemical spills from: 1) on-Refuge oilfield operations; 2) shipping on the GIWW; and 3) offshore production in the Gulf. The potential for petrochemical and petroleum spills affecting the Refuge Complex is high. Over 20 active oil and gas wells are currently producing on the Refuge Complex. Significant drilling and production activity occurs in Gulf waters offshore of McFaddin and Texas Point NWRs. The GIWW between Houston and Lake Charles, Louisiana is one of the busiest reaches of this waterway for shipping petrochemical and petroleum products. The GIWW parallels much of McFaddin and Anahuac NWRs, and the Sabine-Neches Ship Channel parallels Texas Point NWR. Former and current oil and gas production areas on the Refuge Complex contain extensive infrastructure which is no longer in use, including flow lines, pipelines, oil pits, well pads, and brine disposal areas. Many of these lines, pits, and pads may contain contaminants including heavy metals, normal occurring radio-active material, brine, and petroleum products. In addition, Refuge Complex marshes comprise the downstream end of at least 10 waterways. Factories, refineries, solid waste disposal sites, oil field sludge disposal areas, feedlot operations, agricultural operations and housing developments are potential pollution sources in upstream reaches of these watersheds. Finally, high levels of lead shotgun pellets likely occur over much of the Refuge Complex. Incidence of lead shot in Mottled Duck gizzards remains relatively high to the present in birds harvested

on the Anahuac and McFaddin NWRs, even after over 15 years of implementation of non-toxic ammunition regulations.

Current USFWS activities addressing threats from contaminants in Refuge Management Alternative A would continue. Proposed additional activities would include:

- Develop a comprehensive spill response plan for incidents occurring off-refuge which threaten Refuge Complex resources.
- Increase coordination with the interagency spill response programs. Integrate Refuge Complex spill response activities with interagency programs.
- Assemble and maintain a qualified first responder team comprised of Refuge Complex staff through training and participation in interagency spill response drills.
- Throughout the Refuge Complex, conduct contaminant investigations in current and former oil and gas production areas and develop clean up plans for any contaminated areas which pose threats to habitats and fish and wildlife resources.
- Conduct a thorough inventory and assessment of abandoned oil and gas infrastructure on the Refuge Complex, and develop plans for removal of abandoned facilities and habitat restoration.
- Facilitate and support water quality monitoring in Taylors Bayou, Willow Slough, Spindletop Bayou, Mud Bayou, Oyster Bayou, Robinson Bayou, East Bay Bayou, Onion Bayou, Elm Bayou and the GIWW.
- Facilitate and support field assessment to identify any potential “hot spots” of lead contamination on the Refuge Complex. Develop and implement management actions for remediating any areas with high levels of lead.

5. New Oil and Gas Exploration and Development

Minerals underlying the refuges are privately held and the USFWS must allow reasonable use of the surface of refuges to explore for and develop oil and gas reserves. The objective for managing new oil and gas exploration and development is to ensure that new oil and gas exploration and development on the Refuge Complex is conducted in the most environmentally-sensitive manner possible by defining a process which facilitates close coordination with industry and timely processing of requests to conduct activities, and which mandates the use of scientifically-accepted “best management practices” for these activities in sensitive coastal environments.

Current USFWS activities addressing management of new oil and gas exploration and development in Refuge Management Alternative A would continue. Proposed additional activities include:

- Develop a step-down Oil and Gas Management Plan for the Refuge Complex.
- Establish an Oil and Gas Management Specialist position.

D. USFWS Public Use Program

The Texas Chenier Plain Refuge Complex offers a wide variety of recreational opportunities and received over 172,000 visitors during Fiscal Year 2002. Through the use of existing programs and facilities, the Refuge Complex provides opportunities for all six of the Refuge System’s priority wildlife-dependent recreational uses, which are:

- Hunting
- Fishing
- Wildlife Observation and Photography
- Environmental Education and Interpretation

These visitor and recreational opportunities focus on achieving the following refuge goal:

- GOAL 5. All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex’ role in conserving the region’s coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast.

1. Hunting

The objective for hunting is to provide safe and high quality waterfowl hunting opportunities on the Refuge Complex. Waterfowl hunting is a traditional and still very popular outdoor recreational pursuit in the region. Refuges and other public lands along the Gulf Coast play a key role in providing hunting opportunity to the public at large.

Current USFWS public use program activities in support of hunting would continue with no change from Refuge Management Alternative A.

2. Fishing

The objective for fishing is to provide safe and high quality fishing opportunities on the Refuge Complex. The Refuge Complex offers exceptional recreational fishing and crabbing opportunities in both saltwater and freshwater environments. Catfish, bass and brim in freshwater environments and speckled trout, flounder and red drum in saltwater environments are among the popular game fish species on the refuges. Crabbing for blue crabs is also a popular recreational pursuit along refuge waterway and lake shorelines.

Current USFWS public use program activities in support of fishing would continue with no change from Refuge Management Alternative A.

3. Wildlife Observation and Photography

The objective for wildlife observation and photography is to provide safe and high quality opportunities for wildlife observation and photography on the Refuge Complex; and, within 15 years, Refuge Complex visitors will be provided with several new, high-quality opportunities to view and photograph wildlife in restored native habitats. Because overall management of the Refuge Complex under this Alternative will emphasize native habitat restoration, new wildlife viewing and photographic opportunities would be developed for these habitats and the species they support.

Current USFWS public use program activities in support of wildlife observation and photography in Refuge Management Alternative A would continue, with the following additional facility development:

- On Anahuac NWR, develop a trail/wildlife viewing area in restored prairie habitat on the Granberry Tract unit.
- Develop a connecting trail, boardwalk and observation platform on Texas Point NWR, through woodlot, prairie and marsh habitats.
- Develop a canoe trail for wildlife observation in Star Lake/Five Mile Cut on McFaddin NWR.

4. Environmental Education and Interpretation

The objective for environmental education and interpretation is to, within 15 years, have 90% of visitors feel that they have increased their knowledge of the region's native habitats, native fish and wildlife, native habitat restoration methods, and the major threats to ecosystem health. Because overall management of the Refuge Complex under this Alternative will emphasize native habitat restoration and addressing threats to the ecosystem, educational and interpretive programs and materials should focus on restoring native habitats, native fish and wildlife and some of the major threats. Educating visitors about these resources and issues and about the Refuge Complex' conservation role in restoring and maintaining native biological diversity will lead to support and responsible stewardship.

Current USFWS public use program activities in support of environmental education and interpretation in Refuge Management Alternative A would continue; with the development of the following additional facilities and programs:

- On Anahuac NWR, develop four seasonally changing displays for the Visitor Information Station, focusing on native habitats and native biological diversity of the Refuge.
- On Anahuac NWR, develop invasive species monitoring program with local high school.

- On Anahuac NWR, develop two educational activities (one high school, one middle school level) describing neotropical migratory bird migration and the importance of protecting breeding, wintering and stopover habitat, for use in school classrooms, and followed by a field trip to the Refuge during spring migration.
- On Anahuac NWR, develop interpretive exhibits on wetland, prairie and woodlot restoration. Conduct monthly interpretive programs, for adults and youth, focusing on native habitat restoration and native biological diversity.
- On Anahuac NWR, develop an environmental education activity/program focused on native habitats, restoration methodologies, and threats to the ecosystem's natural biological diversity for older students and presentations to the general public.
- On Anahuac NWR, establish a program to work with local elementary schools to propagate native plant species for use in restoration efforts. Follow up with a designated 'planting' day and educational tour of the Refuge.
- Develop interpretive facilities on Texas Point NWR to interpret woodlot, prairie, and wetland habitats and associated fish and wildlife.
- Conduct monthly beach walks on McFaddin NWR, focusing on human impacts to natural systems.
- On Anahuac NWR, conduct teacher training workshop annually to facilitate school field trips led by school teachers, focusing on native habitats, the species those habitats support, and the role of the refuges in conserving those resources.
- Produce standardized presentation emphasizing the importance of the Refuge Complex in protecting and restoring native wetland and upland habitats.
- Develop brochures for butterflies, dragonflies/damselflies, wildflowers, reptiles and amphibians, mammals and invasive/exotic species found on the Refuge Complex.
- Develop videos interpreting Refuge Complex fish, wildlife, plants, cultural resources and restoration practices.
- Revise general brochures and websites to emphasize the Refuge Complex' role in restoring native upland and wetland habitats.

5. Beach Uses on McFaddin NWR

The objective for beach uses on McFaddin NWR is to protect public safety and natural resources along the Gulf of Mexico shoreline within the refuge.

No Change from current USFWS activities to protect public safety and natural resources on McFaddin NWR in Refuge Management Alternative A.

E. Community Outreach and Partnerships

The objective for community outreach and partnerships is to promote conservation of natural resources by working effectively with partners in support of USFWS management programs on the Refuge Complex including habitat management and restoration, fish and wildlife population management, and providing public recreational and educational opportunities. Partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, two citizen support groups, with state agencies such as the Texas Parks and Wildlife Department, the Texas General Land Office and the Galveston Bay Estuary Program, and with conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters have been particularly effective. Volunteers on the Refuge Complex provide over 10,000 hours of service annually. In addition, the USFWS is working with private landowners to enhance or restore coastal marsh and prairie wetlands habitat on private lands, by providing technical assistance and helping to coordinate use of several private lands programs (such as the USFWS Partners for Fish and Wildlife Program and the multi-partner Texas Prairie Wetland Project). Many private lands in the region are successfully managed to provide habitat for wintering waterfowl and other migratory birds. The objective for Private Lands Partnerships is to, within 15 years, restore or enhance 500 acres of native prairie and 10 acres of woodland habitat on private lands in the Texas Chenier Plain region through coordination with interested private landowners and the use of USFWS private lands programs.

Current USFWS community outreach and partnership activities in Refuge Management Alternative A would continue, with the following efforts to expand partnerships with private landowners to enhance upland habitats:

- On Anahuac NWR, hold two on-refuge workshops for private landowners and other agency personnel to demonstrate prairie restoration and management techniques, and to highlight available USFWS private lands programs and grant opportunities.
- Provide technical assistance to private landowners in Chambers, Jefferson and Galveston counties wishing to enhance grassland and woodland habitats for wildlife.

F. Administration and Staffing

In addition to the already existing staff positions under Refuge Management Alternative A, three essential staffing positions would be filled to implement Refuge Management Alternative C:

- Geographic Information Systems specialist
- Natural resource specialist - oil & gas management
- Plant ecologist

IV. REFUGE MANAGEMENT ALTERNATIVE D (PREFERRED ALTERNATIVE) - EMPHASIS ON AN INTEGRATED MANAGEMENT APPROACH COMBINING: 1) EXPANDED HABITAT MANAGEMENT AND RESTORATION PROGRAMS, 2) NEW RESEARCH AND WILDLIFE POPULATION MONITORING, & 3) INCREASED EFFORTS TO ADDRESS MAJOR THREATS TO THE ECOSYSTEM

Alternative D Concept

Management Focus

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 and increased beneficial use of dredge material to restore mineral sediment supply to marshes. The USFWS would also implement several smaller hydrologic restoration and shoreline protection projects on the Refuge Complex. Control and monitoring programs for exotic and invasive species would be intensified, and additional efforts to monitor and reduce impacts of contaminants implemented.

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 invasive plant species, including research to assess the efficacy of ongoing and new control techniques, would be conducted. Additional research on effects of environmental contaminants on fish and wildlife 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.

USFWS habitat management and restoration and biological program activities on the Refuge Complex under this Alternative will support conservation objectives and informational needs for priority species identified in regional, national and international avian conservation plans. These include plans for waterfowl and avian conservation under the North American Waterfowl Management Plan (the Gulf Coast Joint Venture's Chenier Plain Initiative Plan, Mottled Duck Conservation Plan and all-bird conservation initiative), the U.S. Shorebird Conservation Plan and step-down Lower Mississippi/Western Gulf Coast Regional Shorebird Plan, the North American Waterbird Conservation Plan, and the Partners in Flight Regional Conservation Plan for the Gulf Coast Prairies Bird Conservation Region (BCR 37) (currently in preparation).

The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. The Refuge Complex would seek to provide additional recreational opportunities and improve the quality of visitor services and of the visitor experience through construction of additional public use facilities including a Refuge Complex Administrative Headquarters and Wildlife Interpretive Center in Chambers County, expanding law enforcement efforts to protect public safety and natural resources, providing additional hunting and fishing opportunities, and developing additional educational programs. Expanded outreach to local communities and private landowners would be aimed at developing new partnerships to further conservation and promote awareness of the region's natural resources.

Rationale for this Management Focus

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as Avian Species of Conservation Concern. Coastal prairie and coastal woodlots support over 150 migratory and resident land bird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region.

The high degree of alteration in this ecosystem has resulted in loss and degradation of native habitats, loss of biological diversity, and decreased habitat quality for migratory birds and other native wildlife. Alterations of historic hydrology including loss of freshwater inflows and increased saltwater intrusion, coastal erosion, land subsidence and sea level rise are contributing to ongoing coastal land loss and marsh degradation. Almost all of the region's historic native tallgrass coastal prairie and its associated prairie wetlands have disappeared, and remaining coastal woodlots are imminently threatened by development and other land use changes. Several highly invasive exotic plant species are replacing native habitats and severely impacting native biological diversity. Air and water quality issues in the region pose a potential contaminant threat to fish and wildlife, as do accidental spills and discharges from the major petrochemical shipping, storage and processing facilities located in close proximity to sensitive Refuge Complex habitats. Habitat losses to date and ongoing threats in this ecosystem are such that intensive management of remaining habitats in combination with habitat restoration where feasible is required to conserve fish and wildlife resources.

The Refuge Complex provides over 170,000 annual visitors opportunities to waterfowl hunt, fish for fresh and saltwater species, observe and photograph wildlife, and learn about this coastal ecosystem through interpretive and environmental education programs. Southeast Texas has a long and rich tradition of outdoor recreation. Demand for these recreational opportunities on public lands and waters are increasing. The human population in the 8-county area surrounding Houston now exceeds 6 million people. The Texas Gulf Coast has become a popular destination for national and international nature tourists. Improving visitor services and the quality of the visitor experience on these refuges is a critical component of future management.

A. USFWS Habitat Management and Restoration

The primary focus of USFWS land management activities on the Refuge Complex is to fulfill the establishment purpose(s) for the Refuges, i.e., for the conservation and management of migratory birds and their habitats. Under Refuge Management Alternative D, the USFWS 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 benefiting priority avian species.

These habitat management activities focus on achieving the two following Refuge goals:

- GOAL 1. Conserve, enhance and restore the Texas Chenier Plain region's coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent birds, and habitat for other native fish and wildlife.
- GOAL 2. Conserve, enhance and restore the Texas Chenier Plain region's coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/nearctic migratory birds, and habitat for other native wildlife species.

1. Wetland Specific Management and Restoration

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

a. Emergent Wetlands

The objective for emergent wetlands (estuarine and palustrine) is to maintain the historic continuum of fresh, intermediate, brackish and saline coastal marshes on the Refuge Complex and its diverse mosaic of plant communities, and on an annual basis, to manage and maintain 30 to 40% of fresh and intermediate emergent coastal marshes on the Refuge Complex in target plant communities which contain several early and mid-successional emergent plant species. Meeting the habitat needs of the region's diversity of wetland dependent resident and migratory birds requires maintaining a range of coastal marsh habitat types and plant community successional stages within these marsh types. Providing freshwater inflows and restricting saltwater intrusion are critical to maintaining the Chenier Plain's historic continuum of fresh, intermediate, brackish saline marshes. Habitat values for waterfowl, shorebirds and many wading bird species are greatly enhanced in intermediate marshes with early successional plant communities containing several perennial and annual plant species (primarily grasses and sedges) which provide important food resources, and where disturbance reduces the height and/or density of vegetation. Perennial emergent plants important to wintering waterfowl include seashore paspalum (*Paspalum vaginatum*) and Olney bulrush (*Scirpus olneyi*). Early successional emergent plant species important to waterfowl include annual grasses such as millet (*Echinochloa* spp.) and sprangle-top (*Leptichloa fascicularis*) and forbs such as water hyssop (*Bacopa monnieri*) and purple ammania (*Ammania coccinea*). Migratory bird species such as rails require denser vegetation and plant species composition typical of later successional stages (Fredrickson and Taylor 1982). Coastal marshes have evolved with disturbance regime which includes fire, herbivory by native wildlife, and infusion of saline waters during tidal surges associated with tropical storms. Natural fire and herbivory by native species now occur less frequently or at reduced levels due to human influences on the ecosystem (Stutzenbaker and Weller 1989). Water level and salinity management, prescribed burning, and controlled grazing are available tools for influencing plant communities (species composition and physical structure) in marsh habitats.

USFWS management activities for emergent wetlands in Refuge Management Alternative A would continue; with the following modifications and additional activities:

- On Anahuac NWR, ensure adequate freshwater in-flows and reduce saltwater intrusion through annual water purchases and enhanced water management infrastructure including new pumps and delivery systems.
- Maintain current rotational prescribed burning program in marsh units on the Refuge Complex, conducted from late September to late-November (to the extent permitted by environmental/climatic conditions and air quality parameters) to maximize the benefits of integrated burning/grazing/water management programs. Initiate limited summer prescribed burning to control invasive woody vegetation including *Baccharis* (*Baccharis halimifolia*) and big-leaf sumpweed (*Iva frutescens*) in portions of targeted marsh management units.
- Modify controlled grazing program on the Refuge Complex increasing grazing intensity (given favorable forage and water conditions) in several intermediate and fresh marsh units.
- Reconfigure grazing units on the Refuge Complex through additional fencing and development of additional watering sites to increase the effectiveness and efficiency of the control grazing program.
- Increase herbivory by native wildlife on McFaddin NWR by developing new grit sites and maintaining sanctuary areas for geese through the special white goose conservation season (in effect since 1999) which follows the regular waterfowl season.
- Initiate and conduct short and long-term ecological fire effects monitoring on the Refuge Complex and use results to guide an adaptive approach to implementing the prescribed burning program.
- Facilitate and support ongoing and new research studies to determine fire effects on marsh accretion, soils, vegetation, and wildlife.
- Develop a step-down Nuisance Animal Management Plan to protect emergent marshes from excessive herbivory by nutria (an exotic species) and by high populations of muskrats.

b. Open Water Wetlands (Estuarine and Palustrine)

The objective for open water wetlands (estuarine and palustrine) is to increase species diversity and production of submerged aquatic vegetation in marsh habitats and increase open water habitat by 10% in the fresh and intermediate marshes within the Refuge Complex. The submerged aquatic plant community serves as a direct source of important waterfowl foods (e.g., seeds and tubers), and indirectly, as a rich environment for aquatic macroinvertebrates, which are heavily utilized by waterfowl and many other wetland birds (Baldassarre and Bolen 1994). These habitats are extremely important for brood-rearing and molting Mottled Ducks (Stutzenbaker 1988); and, these habitats are important to fishery resources providing vital nursery habitat for many species of marine fish and shellfish (Stutzenbaker and Weller 1989). The diversity and productivity of aquatic plant communities are also dependent upon maintenance of the historic continuum of fresh to saline marsh types. Water level and salinity management within marsh semi-impoundments are important tools for restoring and maintaining submerged aquatic vegetation production and species diversity. Construction of artificial barriers in larger open water wetlands to reduce wave fetch and turbidity can promote the establishment and growth of submerged aquatic vegetation. Common reed (*Phragmites communis*), cattail (*Typha* spp.) and California bulrush (*Scirpus californicus*) are aggressive plant invaders which can form dense homogeneous stands in open water habitats in brackish to fresh marshes. In fresh marsh environments, establishment and expansion of maiden cane (*Panicum hemitomen*) and giant cutgrass (*Zizaniopsis miliacea*) can also result in loss of open water habitats. Submerged aquatic vegetation production is substantially reduced due to shading and loss of substrate when extensive encroachment by these species occurs.

USFWS management activities for open water wetlands in Refuge Management Alternative A would continue, with the following modifications and additional activities:

- On Anahuac NWR, improve water level management capabilities in Shoveler Pond, Rail Reservoir, Moccasin Pond, Otter Pond, and East Unit South Reservoir of Anahuac NWR by modifying existing and installing new water control structures.
- On McFaddin NWR, enhance water level and salinity management in Wild Cow Bayou Management Unit by installing additional water control structures along the GIWW and

rehabilitating levees (LeBlanc's Reservoir, Pond 11, Pond 13), and modifying the existing western levee system to prevent saltwater intrusion.

- On McFaddin NWR, enhance water management in Willow and Barnett Lake units of McFaddin NWR through design and construction of new water control structures along the GIWW.
- On McFaddin NWR, enhance water management in Willow Slough (North Unit of McFaddin NWR) through design and construction of new water control structures/spillways and associated management infrastructure.
- On McFaddin NWR, construct marsh terraces to reduce fetch and turbidity and increase production of submerged aquatic vegetation in Willow/Barnett Lake area and Ponds 28 and 29 on McFaddin NWR, and as needed in open water areas on Texas Point NWR and Anahuac NWR.
- Throughout the Refuge Complex, implement an integrated control program for common reed, cattail and other emergent plants resulting in loss of open water habitats using herbicide application, mechanical removal, salinity control, prescribed burning and controlled grazing on selected units including the Deep Marsh, East Unit and Middleton Tract units of Anahuac NWR, and the White's Fee, Wild Cow Bayou, White's Pasture and North Unit of McFaddin NWR. Expand control efforts over the life of the CCP using the most effective strategies.
- Develop enhanced Geographic Information System capabilities to monitor status and trends of Refuge Complex wetlands. Use GIS technology, remote sensing, LIDAR surveys and other tools to map micro-topography and define watersheds, quantify water usage, and detect trends in open water to emergent marsh ratios and large-scale vegetative changes.
- Facilitate and support a research study to identify causative factors of the "black water phenomenon" which negatively impacts submerged aquatic vegetation production in marsh habitats, and to guide development of adaptive management strategies to prevent or minimize these impacts.

c. Freshwater Prairie Wetlands (Palustrine)

The objective for freshwater prairie wetlands (palustrine) is to, within 15 years, maintain approximately 1,900 acres of managed and natural shallow freshwater wetlands on the Refuge Complex; and, actively manage adjacent prairie habitat for Mottled Ducks and other ground nesting migratory birds. The loss of native prairie habitats and their associated shallow prairie wetlands have been substantial along the Texas Coast (Moulton *et al.* 1997). A large portion of the upper Texas Coast prairie habitats have been cultivated for rice production, which provides valuable habitat for waterfowl, shorebirds, and many other migratory birds (Hobaugh *et al.* 1989, Wilson 2001). However, rice production has declined significantly during the last decade in counties surrounding the Refuge Complex, reducing available prairie wetland habitat for waterfowl, shorebirds and other wetland-dependent species. Mottled ducks heavily utilize prairie habitats adjacent to freshwater wetlands for nesting (Stutzenbaker 1988).

USFWS management activities for freshwater prairie wetlands in Refuge Management Alternative A would continue; with the following modifications and additional activities:

- On Anahuac NWR, maintain annual rice farming acreage at 500-700 acres per year, while increasing acreage which is organically farmed.
- On Anahuac NWR, increase moist soil management acreage to 1,100 acres annually by developing 590 acres of new moist soil management units on the Old Anahuac, East Unit, and Middleton Tract units.
- On Anahuac NWR, restore 100 acres of shallow depressional prairie wetlands on the Granberry Tract Unit and the East Unit.
- Restore 100 acres of shallow freshwater wetland habitat on McFaddin NWR by developing moist soil management units.
- Create shallow freshwater wetland habitat in dredge material disposal sites along the GIWW on McFaddin NWR by installing levees and water control structures during future maintenance dredging cycles. This will involve development of cooperative projects with the U.S. Army Corps of Engineers. .

2. Upland Specific Management and Restoration

a. Native Prairie and other Grasslands

The objective for native prairie and other grasslands is to protect and manage all of the 5,744 acres of non-saline grassland habitats on the Refuge Complex, including “prairie remnants”, permanently fallowed former croplands which are naturally revegetating, and sites previously restored to native prairie using intensive restoration techniques. Prescribed burning, controlled grazing, mowing (and haying) and exotic/invasive plant control would be the primary management tools employed. A second objective is to within 15 years, restore an additional 2,223 acres of fallowed former cropland to native prairie on Anahuac NWR using intensive restoration techniques.

It is now estimated that 99.8% and 99.6% of little bluestem and eastern gamma grass/switch grass prairies, respectively, have been lost in Texas (McFarland 1995). Nine of the 13 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in grasslands on the Refuge Complex. In 2005, the USFWS listed 7 avian species occurring in prairie habitats on the Refuge Complex as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region. Restoration of native prairie and an integrated management approach utilizing prescribed fire, exotic plant control and controlled grazing is needed on the Refuge Complex to provide large blocks of nesting and wintering habitat for prairie-dependent avian and other wildlife species.

USFWS management activities for native prairie and other grassland habitats in Refuge Management Alternative A would continue; with the following modifications and additional activities:

- On Anahuac NWR, restore an additional 2,223 acres of native prairie using intensive restoration techniques on the following management units: Gator Marsh – 97 acres, North Gator Marsh – 204 acres, Longtom Prairie – 186 acres, Pintail Marsh – 120 acres, Airstrip Prairie and East Bay Bayou Marsh – 1,000 acres, Middleton – 370 acres.
- On Anahuac NWR, construct a 5-acre native prairie grass propagation area on the East Unit to increase native grass seeds for use in the prairie restoration program.
- Modify the controlled grazing program on the Refuge Complex on upland units to include more short-duration/high-stocking rate grazing episodes.
- On the Refuge Complex, continue to conduct prescribed burns in prairie units in the spring, and initiate limited summer burning to help control invasive and exotic woody vegetation.

b. Coastal Woodlands

The objective for coastal woodlands is to, within 15 years, create 29 acres of new coastal woodlots on the Refuge Complex, and protect and diversify the 127 acres of existing woodlots and riparian woodlands. Coastal woodlots in the Chenier Plain region are extremely important to migrating songbirds (Rappole 1974, Sprunt 1975, Mueller 1981). Refuge Complex woodlands mark the first landfall for hundreds of thousands neotropical migratory birds making the trans-Gulf flights from Mexico, Central and South America during the spring migration. These birds spend one to several days in woodlands resting and foraging to help replenish fat reserves before continuing their migration to breeding habitats. During the fall migration, coastal woodlots provide the last opportunity for trans-Gulf migrants to increase their fat levels necessary for crossing the Gulf of Mexico (Caldwell *et al.* 1963). Migrant landbirds made greater use of woodlots with larger trees and denser under stories (Mueller and Sears 1987). Increasing the quality of habitat in Refuge Complex woodlots for migratory landbirds requires removing exotic plants and increasing under story density and species diversity.

Current USFWS management activities to achieve objectives for coastal woodlands would continue as in Refuge Management Alternative A. Proposed additional activities include:

- On Anahuac NWR, create two 1-acre woodlots, one near the VIS and one at the Volunteer housing area. Create a 27-acre woodlot on the East Unit along East Bay Bayou.

- Conduct site suitability assessment of additional areas on the Refuge Complex and work with partners to create additional woodlot habitats on suitable sites.
- Expand feral hog control efforts.

B. USFWS Biological Program – Surveys, Monitoring, and Research

The USFWS habitat management and restoration activities benefit many species of native fish, wildlife and plants on the Refuge Complex. The USFWS biological program on the Refuge Complex includes monitoring, field surveys and research studies of fish and wildlife population status, population trends and habitat utilization. The information obtained allows the USFWS to adapt management efforts on the Refuge Complex as needed to achieve Refuge purposes and to maintain and restore natural biological diversity, biological integrity and environmental health. Data collection will be integrated with and support regional, national and international conservation initiatives for priority species whenever possible.

These wildlife conservation efforts focus on achieving the following Refuge goal:

- GOAL 3. A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.

1. Waterfowl, Shorebirds, and other Wetland-Dependent Migratory Birds

The objective for waterfowl, shorebirds and other wetland-dependent migratory birds is to help maintain healthy populations of species utilizing the Refuge Complex and to document population status and trends and habitat utilization of priority species. Coastal habitats of the Texas Chenier Plain region provide important wintering and migrating habitat for waterfowl of the Central Flyway, and for millions of shorebirds, wading birds, colonial nesting waterbirds, and other wetland-dependent migratory birds. Monitoring and studies of population trends and habitat utilization provide information to assess management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

USFWS biological program and management activities for waterfowl, shorebirds and other wetland-dependent migratory birds under Refuge Management Alternative A would continue. Proposed additional activities supporting conservation of wetland-dependent migratory birds on the Refuge Complex include:

- Conduct new surveys and studies for sensitive/declining species (see objective for Threatened and Endangered Species).
- On Anahuac NWR, provide migrational habitat for shorebirds annually during March/April/May on 300 acres of the refuge's moist soil units.
- Develop step-down Inventory and Monitoring Plan to guide the Refuge Complex biological program.

The objective for Mottled Ducks, an important resident waterfowl species, is to increase breeding pair densities in suitable habitats on the Refuge Complex to at least 11 breeding pairs per square mile (the 15-year average for the period 1988-2002); and, gather additional information on the factors impacting Mottled Duck populations in the Texas Chenier Plain region through applied research and monitoring. Both spring breeding pair and September aerial surveys conducted by the USFWS indicate a steady decline in Mottled Duck populations on coastal national wildlife refuges in Texas over the last 16 years. While drought conditions along much of the Texas Coast during late 1990's undoubtedly contributed to this decline, other potential causative factors include loss of freshwater wetlands and upland nesting habitat due to land use changes, loss of pair bond, brood rearing and molting habitats due to invasive plant encroachment in open water habitats, brush encroachment in nesting habitats, increased predation by alligators, mammalian predators and fire ants, and lead shot ingestion rates that have remained high in some areas.

USFWS biological program and management activities for Mottled Ducks described in Refuge Management Alternative A would continue. Proposed additional USFWS biological program and management activities supporting conservation of Mottled Ducks on the Refuge Complex include:

- Expand and refine annual Mottled Duck breeding pair index survey on the Refuge Complex to include an assessment of Mottled Duck use by habitat type (fresh, intermediate, and brackish marshes).
- Facilitate and support new research including studies to: 1) evaluate Mottled Duck nesting success and brood survival and identify factors affecting these vital rates; 2) determine habitat utilization and preferences during nesting, brood rearing, and molting periods; and 3) evaluate effects of predation by alligators, mammalian predators and fire ants on Mottled Duck survival. This would include removing alligators and mammalian predators from key Mottled Duck nesting and brood-rearing habitats, and assessing impacts on nest success and duckling survival.
- Manage 400 acres of moist soil units annually on Anahuac NWR specifically to provide brood-rearing habitat for Mottled Ducks during summer.
- Enhance management capabilities for Mottled Ducks on 300 acres of freshwater impoundments within the Wild Cow Bayou Management Unit on McFaddin NWR by rehabilitating existing levees and installing new water control structures. Intensively manage approximately 400 hundred acres of marsh habitat located adjacent to freshwater impoundments as optimum brood-rearing habitat.
- Develop and maintain at least two grit sites for Mottled Ducks within the Wild Cow Bayou Management Unit of McFaddin NWR.
- Restore pair pond and brood rearing habitats in key management units on the Refuge Complex (those currently supporting breeding Mottled Ducks) by restoring open water habitats lost to invasive plant encroachment, using an integrated approach (an intensified program involving prescribed burning, controlled grazing, water level and salinity management, mechanical removal, and spot herbicide treatments).
- Provide additional open, shallow freshwater habitat in and adjacent to key management units (those currently supporting breeding Mottled Ducks).
- Maintain optimal nesting cover in salty prairie habitats by applying prescribed fire and grazing at designated frequencies and intensities, based on ongoing site-specific assessments. Manage fire occurrence in salty prairie and other optimum nesting cover using mowed green fire breaks and other innovative techniques.

2. Migratory and Resident Landbirds

The biological program objective for migratory and resident landbirds is to help maintain healthy populations of species utilizing the Refuge Complex, and to document population trends, status and habitat utilization of priority species. Monitoring and study of population trends and habitat utilization provides information used to assess and improve management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

USFWS biological program and management activities for migratory and resident landbirds under Refuge Management Alternative A would continue. Proposed additional activities supporting conservation of landbirds on the Refuge Complex include:

- Conduct new surveys and studies for sensitive/declining species (see objective for Threatened and Endangered Species).
- Develop step-down Inventory and Monitoring Plan to guide the Refuge Complex biological program.

3. Fish and other Aquatic Species

The biological program objective for fish and other aquatic species is to ensure healthy populations and document population trends, status and habitat utilization of priority species on the Refuge Complex. A

second objective is to incorporate fisheries and aquatic resource management into the management of all estuarine marshes on the Refuge Complex.

No Change from biological program activities in Refuge Management Alternative A.

4. Threatened and Endangered Species, Species of Conservation Concern

The biological program objective for Threatened and Endangered species, Species of Conservation Concern, and other “watch species” is to support recovery efforts and to obtain information on population trends, status and habitat utilization of sensitive and/or declining species utilizing the Refuge Complex. Eight federally-listed Threatened and Endangered species occur on or adjacent to the Refuge Complex: Bald Eagle, Piping Plover, Brown Pelican, Loggerhead sea turtle, Kemp’s Ridley sea turtle, Green sea turtle, Hawksbill sea turtle, and Leatherback sea turtle. The sea turtles are found offshore in the Gulf and in Galveston Bay, but no nesting on beaches has been documented on the Refuge Complex. The Refuge Complex also provides important habitat for 33 avian species identified by the USFWS as Species of Conservation Concern within the Gulf Prairies Bird Conservation Region. Nine out of the 13 avian species listed by the Texas Parks and Wildlife Department as rare and declining species in coastal prairies and marshes in Texas are found on the Refuge Complex. .

The Texas Parks and Wildlife Department lists three species of reptiles which occur or potentially occur on the Refuge Complex as threatened: the 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 Nature Conservancy’s Texas Conservation Data Center. Little or no information about the relative abundance, distribution and habitat utilization of any of these species on the Refuge Complex is currently available.

USFWS biological program and management activities for Threatened and Endangered species and Species of Conservation Concern under Refuge Management Alternative A would continue. Proposed additional activities supporting conservation of sensitive species on the Refuge Complex include:

- Conduct fall, winter and spring beach and bay surveys on the Refuge Complex for the following priority shorebird and colonial waterbird species: Piping Plover, Snowy Plover, Long-billed Curlew, Wilson’s Plover, American Golden Plover, Short-billed Dowitcher, Reddish Egret, Least Tern, Black Skimmer, and Gull-billed Tern.
- Conduct bi-weekly surveys in marsh and prairie wetland habitats (rice fields, moist soil units) on the Refuge Complex from February to May and July through September, to document relative abundance and habitat utilization and monitor population trends of the following priority shorebird and colonial waterbird species: Buff-breasted Sandpiper, Hudsonian Godwit, American Golden Plover, American Bittern, Least Bittern, Wood Stork.
- Initiate field surveys to monitor population trends of rail species on the Refuge Complex, including yellow rails and black rails.
- Initiate surveys to determine the relative abundance and habitat use of the following priority grassland birds which utilize Refuge Complex habitats during winter and/or migration periods: LeConte’s Sparrow, Sprague’s Pipit, Loggerhead Shrike, White-tailed Hawk, Northern Harrier, and Short-eared Owl.
- Expand Project Prairie Birds monitoring to include salty prairie and marsh habitats.
- Develop and maintain a database which documents the occurrence of rare species on the Refuge Complex.
- Facilitate and support new monitoring/research studies to determine the breeding, migrational and wintering distribution and habitat utilization of Black and Yellow rails.
- Facilitate and support new monitoring/research studies to determine the breeding, migrational and wintering distribution and habitat utilization of American Bitterns.
- Facilitate and support new research studies to determine the effects of prescribed burning and controlled grazing on sensitive or declining avian species.
- Facilitate and support new monitoring/research which evaluates the population status and habitat use of the following sensitive or declining reptile and amphibian species: pig frog, smooth green

snake, alligator snapping turtle, Texas diamondback terrapin, Texas horned lizard, slender glass lizard, and crayfish snake.

- Facilitate and support new research study to determine occurrence, relative abundance and habitat use of Short-eared and Burrowing Owls during wintering and migration periods.
- Facilitate and support new research study to determine relative abundance and habitat use of White-faced and White Ibis on the Refuge Complex.
- Following the successful restoration of coastal prairie habitat on the Refuge, evaluate the potential to reintroduce Attwater's Prairie Chicken on Anahuac NWR.

5. Mammals

The objective for mammals is to document population status and trends and habitat utilization of priority species on the Refuge Complex. Coastal habitats of the Texas Chenier Plain region support a diverse mammalian community.

USFWS biological program activities for mammals under Refuge Management Alternative A would continue. Proposed additional activities supporting conservation of mammals on the Refuge Complex include:

- Initiate monitoring of status and trends of muskrat populations on the Refuge Complex utilizing field surveys and GIS technology.
- Facilitate and supports research/monitoring to document species composition, habitat use and relative abundance of small mammal populations on the Refuge Complex.
- Develop a step-down Nuisance Animal Control Management Plan. Manage muskrat and nutria populations utilizing trapping under Special Use Permit when necessary to prevent damage to emergent marsh habitats. Manage mesopredator populations (raccoons, striped skunk, grey and red foxes) as necessary to reduce predation on Mottled Ducks and their nests, and on other ground-nesting migratory bird species.

6. Reptiles and Amphibians

The biological program objective for reptiles and amphibians is to maintain healthy populations and natural diversity, and to document population status and trends. Within 15 years, the objective for Alligators is to maintain alligator populations at self-sustaining levels, but at densities consistent with migratory bird management objectives. In addition, harvest management will increasingly be directed at maintaining a natural age structure within Refuge Complex alligator populations.

USFWS biological program activities for reptiles and amphibians under Refuge Management Alternative A would continue. Proposed additional activities supporting conservation of reptiles and amphibians on the Refuge Complex include:

- Facilitate and support new surveys and studies for sensitive/declining species (see Threatened and Endangered species, above).
- Facilitate and support baseline monitoring to determine species composition and relative abundance of herptofaunal assemblages across all Refuge Complex habitat types. Baseline information on reptiles and amphibians on the Refuge Complex is lacking.
- Facilitate and support research to determine nesting frequencies of adult female alligators through monitoring of mitochondrial DNA within egg membranes. These data will be used to improve population estimates generated from aerial nest counts.
- Facilitate and support new research to determine the diet of alligators during spring and summer to evaluate influences of predation on Mottled Ducks and other native wildlife. This will be a cooperative project with the Texas Parks and Wildlife Department.

7. Invertebrates

The biological program objective for invertebrates is to maintain healthy populations and natural diversity, and document species occurrence on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A

8. Plant Resources

The biological program objective for plant resources is to maintain native plant diversity and to document species composition and plant community changes over time on the Refuge Complex. Natural disturbances such as drought and floods, fire and herbivory by wildlife, and management activities such as grazing, prescribed burning, water level and salinity management all impact plant communities on the Refuge Complex. Sea level rise, subsidence and exotic plant and animal species are now also impacting native plant communities. Understanding how these events, processes and management activities affect plant community dynamics is essential to ensure long-term conservation of plant resources.

USFWS biological program activities for plant resources under Refuge Management Alternative A would continue. Proposed additional activities supporting conservation of plant resources on the Refuge Complex include:

- Implement a systematic fire effects monitoring program in representative habitats on the Refuge Complex.
- Facilitate and support new research to determine the effects of fire, fire seasonality and fire intensity on marsh surface elevation change and vegetative response.
- Develop enhanced Geographic Information System capabilities and use in combination with remote imaging data to track and monitor vegetation changes in Refuge Complex habitats.
- Develop and implement step-down Habitat Management Plans for each Refuge.

C. Addressing Threats to the Ecosystem

Under Refuge Management Alternative D, the USFWS would increase efforts aimed at reversing trends of loss and degradation of native habitats by increasing efforts to address the effects of relative sea level rise and reduced sediment supply, altered hydrologic processes, exotic and invasive species and environmental contaminants. These efforts would include expanded coordination with other agencies and conservation organizations with a goal of implementing large-scale shoreline protection and hydrologic and marsh restoration projects. The USFWS would also implement smaller scale erosion abatement projects along the Gulf, Galveston Bay, and the GIWW and hydrologic restoration projects throughout the Refuge Complex.

These efforts addressing threats to ecosystem health focus on achieving the following Refuge goal:

- GOAL 4. By working with others locally and on a landscape level, threats to biological integrity, diversity, and environmental health on the Texas Chenier Plain Refuge Complex will be addressed.

1. Coastal Land Loss

The objective for the threat from relative sea level rise and reduced sediment supply is to decrease rates of coastal land loss due to shoreline erosion along the Gulf of Mexico, East Galveston Bay, and the GIWW. Along the Texas Coast, wetland losses between the mid-1950's and mid-1990's were most substantial for estuarine emergent marshes (Moulton *et al.* 1997). Relative sea level rise and reduced coarse sediment supply to Gulf and bay nearshore littoral systems are resulting in significant loss of coastal habitats. Average rates of shoreline retreat along the Gulf adjacent to the refuges are as high as 50 feet per year on Texas Point NWR, and 10-15 feet per year along most of McFaddin NWR (Bureau of Economic Geology unpublished data, Morton 1998). Over 800 acres of dunes and emergent marsh has been lost due to Gulf shoreline erosion on these refuges during the last 25 years, and remaining inland

marshes are increasingly threatened by more frequent inundation during high tidal events. Although less severe, erosion along the East Galveston Bay shoreline is also causing wetland loss on Anahuac NWR, and also threatens remaining marshes with saltwater intrusion. Erosion along the GIWW is also causing direct loss of wetlands and poses a significant threat to marshes from saltwater intrusion on both McFaddin and Anahuac NWRs. Levees created when the GIWW was constructed have almost entirely eroded away along significant portions of its length within these refuges.

Current USFWS efforts to address threats from relative sea level rise and reduced sediment supply would continue as in Refuge Management Alternative A. Proposed additional activities and modifications include:

- Increase coordination with the U.S. Army Corps of Engineers, National Marine Fisheries Service, Texas General Land Office, Texas Parks and Wildlife Department, Galveston Bay Estuary Program, Texas Department of Transportation and other local, state and federal agencies to develop and implement long-term inter-jurisdictional strategies to reduce coastal land loss along the Gulf of Mexico, East Galveston Bay and the GIWW. Goals would include implementing major projects to restore the Gulf barrier beach/dune complex on McFaddin NWR (dependent upon the results of ongoing sand source investigations, possibly using off-shore sand supplies), to restore sediment supply to the Gulf's nearshore littoral zone on Texas Point NWR through the beneficial use of dredge material, and to construct structural protection (rock breakwaters) and restore emergent marshes along shorelines of Galveston Bay (Anahuac NWR) and the GIWW (Anahuac and McFaddin NWRs).
- Participate in U.S. Army Corps of Engineers new Regional Sediment Management program.
- Increase coordination among state, federal and local agencies on the issue of relative sea level rise and promote advanced conservation planning to address threats.
- Develop partnerships with universities and the U.S. Geological Survey, and facilitate and support new research and monitoring on marsh accretion and its relation to management practices including burning and structural marsh management.
- Install an additional 7,500 linear feet of shoreline erosion abatement (offshore rock wave breaks) and restore 10 acres of under shore emergent marsh (smooth cordgrass plantings) along East Galveston Bay shoreline on Anahuac NWR. Install 10,000 linear feet of shoreline protection along the GIWW on Anahuac NWR.
- Restore an additional 5,000 linear feet of the dunes along the Gulf of Mexico on McFaddin NWR.
- Protect an additional 10,000 linear feet of GIWW shoreline on McFaddin NWR using offshore wave breaks, shoreline armoring, and/or emergent plantings (smooth cordgrass).
- Increase coordination with landowners, USFWS Partners for Fish and Wildlife and Coastal programs to enhance shoreline protection on Moody NWR.

2. Altered Hydrologic Processes

The objective for the threat from altered hydrologic processes and resulting interior marsh loss is to protect existing and restore emergent coastal marsh habitat on the Refuge Complex by reducing saltwater intrusion, increasing freshwater and inflows and mineral sediment supply to marshes, and maintaining natural marsh hydroperiods. Land subsidence and sea level rise, channel construction, and channelization of natural waterways has had significant hydrologic impacts including saltwater intrusion, increased tidal energies causing erosion of organic marsh substrates, loss of freshwater inflows and reduced mineral sediment supply to marshes, and excessive flooding or drainage/drying of marshes. Over the last century, these factors have gradually converted extensive areas of fresh and intermediate marshes to a more brackish regime thereby decreasing natural biological diversity, and in some areas have resulted in conversion of vegetated emergent marshes to open water (marsh loss). Relative sea level rise further threatens vegetated marshes through increased saltwater intrusion and submergence. To survive, remaining marshes must accrete or gain elevation at a rate that keeps up with relative sea level rise. Maintaining plant productivity and preventing loss of organic marsh soils by restricting saltwater intrusion and tidal energies, increasing freshwater inflows, and beneficially using dredge materials to increase mineral sediment supply appear to offer the most realistic options for reversing current trends of interior marsh loss in the Chenier Plain region.

USFWS activities addressing altered hydrologic processes in Refuge Management Alternative A would continue. Proposed additional activities and modifications include:

- Expand coordination with local, state and federal agencies to develop and implement watershed-scale hydrologic restoration project. A key component would be assessing the feasibility of and identifying options for restoring freshwater inflows to coastal marshes within the Salt Bayou watershed south of the GIWW.
- Expand coordination with the U.S. Army Corps of Engineers, Texas General Land Office, Texas Parks and Wildlife Department, Texas Department of Transportation and other local, State and Federal agencies to develop strategies to restore and enhance wetlands on the Refuge Complex through the beneficial use of dredged materials. This will include participating in the U.S. Army Corps of Engineers new Regional Sediment Management program.
- Develop partnerships with universities and the U.S. Geological Survey, and facilitate and support new research and monitoring on marsh accretion and its relation to management practices including burning and structural marsh management.
- Monitor status and trends of Refuge Complex wetlands on all four refuges through enhanced Geographic Information System capabilities.
- Research the availability of, and if possible, acquire additional water rights to facilitate increasing freshwater inflows to the Anahuac NWR's East Unit from East Bay Bayou and Onion Bayou and to the Middleton Tract from Elm Bayou.
- Coordinate with Trinity Bay Conservation District and other partners to repair saltwater barriers and water control structures on East Bay, Elm and Onion bayous on Anahuac NWR and on the Moody NWR.
- On Anahuac NWR, construct a passive overflow spillway structures East Bay and Elm bayous to restore over bank flooding and freshwater inflows into East Unit and Middleton Tract marshes.
- On Anahuac NWR, construct rock weirs in constructed channels in northern portion of Pace Tract to reduce saltwater intrusion and decrease tidal energies.
- On Anahuac NWR, enhance water management by replacing water control structures and restoring levees along East Bay Bayou on the East Unit and Middleton Unit.
- On McFaddin NWR, restore hydrology by reducing saltwater intrusion and restoring marsh hydroperiods through construction of rock weirs and/or earthen plugs in constructed channels in the Willow/Barnett Lake Unit.
- Research the availability of and need for acquiring water rights to ensure that freshwater inflows remain adequate to maintain the natural diversity and productivity of the Willow Slough marsh on the McFaddin NWR North Unit.
- Restore natural hydrology to western marshes on McFaddin NWR by restoring Mud Bayou to its historic dimensions through construction of a rock weir.
- Coordinate with state and federal agencies and others to develop and implement a comprehensive hydrological restoration on Texas Point NWR. Reducing saltwater intrusion and tidal energies by restoring Texas Bayou to historic dimensions and reducing the influence of constructed channels will be key components of this project.
- On Moody NWR, increase coordination with landowners, other USFWS divisions and state and federal agencies to restore hydrology by reducing saltwater intrusion.
- Throughout the Refuge Complex, restore surface hydrology by removing barriers formed by abandoned roads, levees and well pads remaining from past oil and gas development and agricultural activities.

3. Invasive Species

The objective for the threat invasive species is to, utilizing Integrated Pest Management strategies, implement a comprehensive invasive species (exotic and native species) control program which will: 1) reduce current infestations by 50% within 15 years; and 2) prevent any new infestations. Monocultures of exotic and invasive plants reduce natural biological diversity, increase erosion, alter nutrient cycling and displace macro- and micro-fauna that depend on native plants for habitat and food (Sheley and Petroff 1999). Refuge habitats are currently significantly impacted by exotic plants and animals including:

Chinese tallow (*Sapium sebiferum*), water hyacinth (*Eichhornia crassipes*), alligator weed (*Alternanthera philoceroides*), water lettuce (*Pistia stratiotes*), McCartney rose (*Rosa bracteata*), vasey grass (*Paspalum urvillei*), Johnson grass (*Sorghum halepense*), *Cyperus entrerianus*, Eurasian water milfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), *Salvinia minima*, Japanese honeysuckle (*Lonicera japonica*) red imported fire ants, nutria, and feral hogs. Giant salvinia (*S. molesta*), to date documented on the Refuge Complex only once and in small amounts near a refuge boat ramp, has been found nearby and poses a significant threat to freshwater wetlands. Invasive native plant species include eastern baccharis (*Baccharis halimifolia*), big-leaf sumpweed (*Iva frutescens*), rattlebox (*Sesbania drummondii*), common reed (*Phragmites communis*) and cattail (*Typha* spp.).

USFWS efforts addressing invasive species in Refuge Management Alternative A would continue. Proposed activities through an expanded Integrated Pest Management program include:

- Throughout the Refuge Complex, expand field monitoring to provide early detection of new infestations, and develop enhanced GIS capabilities to map existing and new stands of upland and aquatic invasive plants.
- Develop new partnerships with universities and the U.S. Geological Survey Biological Resources Division to evaluate invasive species control strategies.
- On Anahuac NWR, evaluate control strategies for deep-rooted sedge and several exotic grasses including the newly discovered King Ranch bluestem currently impacting upland prairie habitats.
- On Anahuac NWR, mechanically remove Chinese tallow along the GIWW, Oyster Bayou, East Bay Bayou, Onion Bayou, and State Highway 124.
- On Anahuac NWR, increase coordination with the Trinity Bay Conservation District and the Chambers-Liberty Counties Navigation District on control of aquatic and terrestrial invasive plants on waterways, canals and ditches and on banks and levees within drainage and irrigation easements throughout the Anahuac NWR.
- Evaluate use of approved and permitted biological control agents as they become available, for use in IPM program for invasive species control. An approved biological control agent for *Salvinia* spp. is now available for release in Texas, and its use on the Refuge Complex will be evaluated.
- Expand integrated control activities for water hyacinth in the Willow Slough Marsh on the North Unit of McFaddin NWR.
- On Texas Point NWR, utilize spot herbicide treatments to control McCartney rose on non-saline prairie habitats.
- On the Refuge Complex, expand control efforts for invasive emergent marsh plants such as cattail and common rush where encroachment has resulted in loss of desirable open water habitats.
- Develop exotic aquatic plant interpretive signs and install them at all Refuge Complex boat ramps.
- Develop step-down Feral Hog Management and Nuisance Animal Management plans. Expand control efforts for feral hogs and nutria as necessary.

4. Contaminants

The objective for the threat from contaminants is to, within 15 years, identify and monitor all potential point and non-point source pollution impacts to the Refuge Complex and develop a strategy to clean up contaminants and protect refuge resources from those impacts. Contaminant issues affecting the Refuge Complex include potential petroleum and petrochemical spills from: 1) on-Refuge oilfield operations; 2) shipping on the GIWW; and 3) offshore production in the Gulf. The potential for petrochemical and petroleum spills affecting the Refuge Complex is high. Over 20 active oil and gas wells are currently producing on the Refuge Complex. Significant drilling and production activity occurs in Gulf waters offshore of McFaddin and Texas Point NWRs. The GIWW between Houston and Lake Charles, Louisiana is one of the busiest reaches of this waterway for shipping petrochemical and petroleum products. The GIWW parallels much of McFaddin and Anahuac NWRs, and the Sabine-Neches Ship Channel parallels Texas Point NWR. Former and current oil and gas production areas on the Refuge Complex contain extensive infrastructure which is no longer in use, including flow lines, pipelines, oil pits,

well pads, and brine disposal areas. Many of these lines, pits, and pads may contain contaminants including heavy metals, normal occurring radio-active material, brine, and petroleum products. In addition, Refuge Complex marshes comprise the downstream end of at least 10 waterways. Factories, refineries, solid waste disposal sites, oil field sludge disposal areas, feedlot operations, agricultural operations and housing developments are potential pollution sources in upstream reaches of these watersheds. Finally, spent lead shotgun pellets may still pose a threat to waterfowl and other wildlife in the region. Incidence of lead shot in Mottled Duck gizzards remains relatively high to the present in birds harvested on the Anahuac and McFaddin NWRs, even after over 15 years of implementation of non-toxic ammunition regulations.

Current USFWS activities addressing threats from contaminants in Refuge Management Alternative A would continue. Proposed additional activities include:

- Develop a comprehensive spill response plan for incidents occurring off-refuge which threaten Refuge Complex resources.
- Increase coordination with the interagency spill response programs. Integrate Refuge Complex spill response activities with interagency programs.
- Assemble and maintain a qualified first responder team comprised of Refuge Complex staff through training and participation in interagency spill response drills.
- Throughout the Refuge Complex, conduct contaminant investigations in current and former oil and gas production areas and develop clean up plans for any contaminated areas which pose threats to habitats and fish and wildlife resources.
- Conduct a thorough inventory and assessment of abandoned oil and gas infrastructure on the Refuge Complex, and develop plans for removal of abandoned facilities and habitat restoration.
- Facilitate and support water quality monitoring in Taylors Bayou, Willow Slough, Spindletop Bayou, Mud Bayou, Oyster Bayou, Robinson Bayou, East Bay Bayou, Onion Bayou, Elm Bayou and the GIWW.
- Facilitate and support field assessment to identify any potential “hot spots” of lead contamination on the Refuge Complex. Develop and implement management actions for remediating any areas with high levels of lead.

5. New Oil and Gas Exploration and Development

Minerals underlying the refuges are privately held and the USFWS must allow reasonable use of the surface of refuges to explore for and develop oil and gas reserves. The objective for managing new oil and gas exploration and development is to ensure that new oil and gas exploration and development on the Refuge Complex is conducted in the most environmentally-sensitive manner possible by defining a process which facilitates close coordination with industry and timely processing of requests to conduct activities, and which mandates the use of scientifically-accepted “best management practices” for these activities in sensitive coastal environments.

Current USFWS activities addressing new oil and gas development in Refuge Management Alternative A would continue. Proposed additional activities would include:

- Develop a step-down Oil and Gas Management Plan for the Refuge Complex.
- Establish an Oil and Gas Management Specialist position.

D. USFWS Public Use Program

The Texas Chenier Plain Refuge Complex offers a wide variety of recreational opportunities and received over 172,000 visitors during Fiscal Year 2002. Through the use of existing programs and facilities, the Refuge Complex provides opportunities for all six of the Refuge System’s priority wildlife-dependent recreational uses, which are:

- Hunting
- Fishing
- Wildlife Observation and Photography
- Environmental Education and Interpretation

These visitor and recreational opportunities focus on achieving the following Refuge goal:

- GOAL 5. All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex' role in conserving the region's coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast

Development of new public use program facilities and programs will focus on partnership opportunities with local, county and state agencies and with our Refuge Friends groups and other conservation and outdoor recreation organizations.

1. Hunting

The objective for hunting is that, within 15 years, 90% of all hunting visits on the Refuge Complex will qualify as high-quality hunting experiences. Waterfowl hunting is a traditional and still very popular outdoor recreational pursuit in the region. Refuges and other public lands along the Gulf Coast play a key role in providing hunting opportunity to the public at large. Due to the remoteness and wetland environment of these refuges, hunting access is challenging and is a key factor when providing for hunting opportunities. Improving and managing hunting access will facilitate high-quality hunting experiences. Providing more information to hunters, increasing "designated hunt area" opportunities to reduce crowding problems, and providing additional hunting opportunities will also contribute to an overall high-quality hunting experience.

We define "a high-quality hunting experience" as one that: 1) promotes safety of participants, other visitors, and facilities; 2) promotes compliance with applicable laws and regulations and responsible behavior; 3) minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan; 4) minimizes or eliminates conflicts with other compatible wildlife-dependent recreation; 5) minimizes conflicts with neighboring landowners; 6) promotes accessibility and availability to a broad spectrum of the American people; 7) promotes resource stewardship and conservation; 8) promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources; 9) provides reliable/reasonable opportunities to experience wildlife; 10) uses facilities that are accessible to people and blend into the natural setting; and 11) uses visitor satisfaction to help define and evaluate programs.(USFWS Service Manual 605 FW 1).

Our objective will be met if 90% or more of hunting visits meet the standards set for a high-quality hunting experience, as determined annually by hunter comments collected by the check station operator. As such, 1) less than 10% of hunters will report feeling unsafe; 2) less than 10% of hunters will report feeling crowded; 3) no hunter will report unfairness in obtaining access to hunt; 4) less than 5% of hunters contacted will be cited for hunting violations during routine enforcement; and 5) there will be no hunting-related safety incidents.

Current USFWS public use program activities in support of hunting in Refuge Management Alternative A would continue; with the development of the following additional facilities and programs:

- Construct foot bridges across Onion Bayou and over canals to the North Reservoir on the East Unit of Anahuac NWR.
- Enhance boat access within Anahuac NWR's East Unit and the Middleton Tract Unit through improved maintenance of access ditches.
- Provide additional "Designated Hunt Areas" on a first-come, first-serve on the East Unit of Anahuac NWR.
- Open designated portion of the Anahuac NWR East Unit during the September teal season.
- Open designated area(s) on Anahuac NWR to dove hunting, potentially through implementation of a Cooperative Agreement with the Texas Parks and Wildlife Department to include open areas in their "Short Term Public Hunting Lease Program."
- Install information kiosks at the Oyster Bayou boat ramp, providing orientation map to hunting units, access points, hunt regulations, and safety information on Anahuac NWR.

- Develop directional signage to refuge hunting areas for hunters accessing the Anahuac NWR via navigable waters.
- Improve the Boat Canal/Oyster Bayou boat launch and parking area on Anahuac NWR.
- Provide seasonally-open primitive access (4-wheel drive trail) on the Gulf of Mexico beach ridge on McFaddin NWR (permanent or temporary action dependent upon ultimate disposition of State Highway 87 project), for access to hunt areas during waterfowl seasons.
- Reduce conflicts between waterfowl hunters on the Star Lake/Clam Lake Hunt Unit during the regular waterfowl season by requiring all hunters hunting this unit to register at the check station, including those accessing the unit from the beach along the Brine Line or Perkins Levee. All hunters accessing Star Lake and associated waters via boat must access via the Refuge's Star Lake boat launch.
- Provide additional "designated hunt area" duck hunting opportunities on McFaddin NWR.
- Maintain the shallow ditch system for boat access from the GIWW within the Central Hunt Unit of McFaddin NWR.
- Construct a new hunter check station at McFaddin NWR.
- Install an information kiosk at McFaddin and Texas Point NWRs providing orientation map to hunting units, access points, hunt regulations, and safety information.
- Develop improved boat access off the GIWW to the McFaddin NWR Central Hunt Unit.
- Develop detailed step-down Hunt Management Plans for the Anahuac, McFaddin and Texas Point refuges.
- Revise the hunting permit fee system to provide for a Refuge Complex-wide annual waterfowl hunting permit.
- Develop an Internet-based system for obtaining fee area hunting permits.
- Improve public safety and education and outreach with an expanded and enhanced law enforcement program.
- Develop and produce hunting area maps that provide detailed information on locations, access, special features, safety and ethical behavior.
- Within 5 years, implement a 25-hp restriction on inland waters in designated Hunt Units on Anahuac, McFaddin and Texas Point NWRs to improve public safety and protect habitats.

2. Fishing

The objective for fishing is that, within 15 years, 90% of all fishing visits on the Refuge Complex will qualify as high-quality fishing experiences, as determined by angler comments documented during routine visitor contacts. The Refuge Complex offers exceptional recreational fishing and crabbing opportunities in both saltwater and freshwater environments. Catfish, bass and brim in freshwater environments and speckled trout, flounder and red drum in saltwater environments are among the popular game fish species on the refuges. Crabbing for blue crabs is also a popular recreational pursuit along refuge waterway and lake shorelines. Improving access for fishing and providing additional education on fishing and fishing opportunities on the Refuge Complex will help facilitate high-quality fishing experiences.

We define a high-quality fishing experience as one that: 1) is available to a broad spectrum of the fishing public; 2) provides an opportunity to use various angling techniques; 3) provides opportunities in both freshwater and saltwater environments; and 4) reflects positively on the individual Refuge, the Refuge System and the USFWS.

Current USFWS public use program activities in support of fishing in Refuge Management Alternative A would continue; with the development of the following additional facilities and programs:

- On Anahuac NWR, improve access for fishing on East Galveston Bay by constructing a boardwalk from Frozen Point Road to the Bay.
- Develop walk-in access for fishing at Coon Creek, Oyster Bayou, and between Shoveler Pond and Westline Road on Anahuac NWR.
- Extend open hours on McFaddin NWR (designated areas accessible via Clam Lake Road) to one hour before sunrise to one hour after sunset on weekdays and open this portion of the Refuge on

weekends to facilitate additional recreational fishing and other wildlife-dependent recreational opportunities.

- On McFaddin NWR, construct additional fishing facilities including a fishing/crabbing pier on 10-Mile Cut/Clam Lake, boat launch and parking facilities on 10-Mile Cut and fishing platform on Star Lake.
- Develop freshwater fishing opportunities in Pond 13 on McFaddin NWR.
- Coordinate and partner with local, county and state agencies to improve a primitive boat launching area off Pilot Station Road in Sabine Pass, to improve boat access to Texas Bayou and Texas Point NWR.
- Develop step-down Fishing Plans for the Anahuac, McFaddin and Texas Point NWRs.
- Develop a brochure clearly defining fishing areas, including maps of access points for fishing opportunities, regulations and providing information on some of the more popular game fish species.
- Develop Internet-based availability of fishing information.

3. Wildlife Observation and Photography

The objective for wildlife observation and photography is to, within 15 years, provide Refuge Complex visitors with several new high quality opportunities to view and photograph wildlife in managed and restored habitats. Because overall management of the Refuge Complex under this Alternative will emphasize active habitat management and habitat restoration, new wildlife viewing and photography opportunities would be developed for both managed and restored habitats such as marsh semi-impoundments and moist soil units, and in restored native habitats including wetlands, prairies and woodlots. These facilities will improve viewing opportunities for wetland-dependent migratory birds, grassland birds and neotropical migratory birds, butterflies and other native wildlife.

The Refuge Complex provides local, regional, national and international visitors with a wide range of wildlife observation and photography opportunities, supporting a rapidly growing nature tourism industry in Texas. Migratory bird and alligator viewing are the main attractions. The refuges are highlighted Upper Texas Gulf Coast sites on the Great Texas Birding Trail. Anahuac NWR is an internationally known birding destination, receiving visitors each year from all 50 states and over 20 countries.

Current USFWS public use program activities in support of wildlife observation and photography in Refuge Management Alternative A would continue; with the development of the following additional facilities and programs:

- Complete the butterfly habitat and native habitat demonstration area adjacent to the Anahuac NWR Visitor Information Station.
- On Anahuac NWR, construct a new observation platform overlooking the Oyster Bayou Moist Soil Units, and construct a tree-canopy height observation platform on the East Bay Bayou Trail.
- Develop a levee trail and boardwalk for wildlife observation near the Refuge Headquarters on McFaddin NWR.
- Construct a parking area and observation platform at the McFaddin NWR Clam Lake Road entrance.
- Maintain a seasonal levee trail along Perkins Levee outside of the waterfowl season on McFaddin NWR.
- Construct a photography blind on McFaddin NWR.
- Develop a self-guided canoe and kayak trail along 10-Mile Cut from McFaddin NWR to Sea Rim State Park.
- Develop a self-guided canoe and kayak trail on East Bay Bayou on Anahuac NWR.
- Construct a connecting trail and observation platform on Texas Point NWR.
- Institute an entry fee program at Anahuac NWR (see below) for refuge visitors, available as day passes or annual entry permits (Refuge Complex annual hunting permit will also serve as annual entry permit).
- Develop step-down Wildlife Observation and Photography Plans for the Anahuac, McFaddin and Texas Point NWRs.

The Anahuac NWR was approved for the collection of a general entrance fee (for that portion of the Refuge which is open to the public 365 days per year) under the Recreation Fee Demonstration Program (Fee Demo Program) in 1997. In addition to collecting a general entrance fee, the Refuge concurrently proposed to make an annual \$40 permit for waterfowl hunting on the East Unit hunt unit available to refuge hunters (as an option in addition to the existing \$10 per day user fee). Participation by the Service in the Fee Demo Program was authorized under the Omnibus Consolidated Recission and Appropriations Act (P.L. 104-154) of 1996. This law was superceded by the passage of the Federal Lands Recreation Enhancement Act in 2004, which rolled all approved programs under the Fee Demo Program into the new Recreation Fee Program. Although the Refuge was approved to collect both the entrance fee and the annual hunting permit fee under the Fee Demo Program in 1997, to date only the East Unit annual waterfowl hunting permit has been implemented. The goals of initiating an entrance fee on Anahuac NWR would be to continue to enhance the experience of refuge visitors and to expand wildlife-dependent recreational and educational opportunities. Specifically, Refuge entrance fees would be used to help maintain and expand existing visitor facilities and programs, as well as to develop new facilities and programs, including trails, boardwalks, observation platforms and photography blinds, fishing piers, and environmental education and interpretive materials and programs.

4. Environmental Education and Interpretation

The objective for environmental education and interpretation is that, within 15 years, 90% of visitors will feel that they have increased their knowledge of native fish, wildlife and plants and of the Refuge Complex's role in conserving these resources through habitat management and restoration and addressing threats to ecosystem health. Because overall management of the Refuge Complex under this Alternative will emphasize active habitat management, native habitat restoration, and addressing threats to ecosystem health, educational and interpretive programs and materials would focus on managed and restored habitats, management and restoration methodology, and the fish, wildlife and plant species they support. Educating visitors about the importance of our coastal resources and on the role of the Refuge Complex in managing, restoring and maintaining biological integrity and biological diversity will lead to support and responsible stewardship action.

The implementation of environmental education and interpretive programs for students and visitors on the Refuge Complex is important to increase the quality of the visitor experience and to further public awareness of the benefits, issues and challenges associated with natural resource conservation in this productive and diverse coastal ecosystem. Many excellent opportunities exist to expand partnerships with local school districts to incorporate environmental education in their science curricula.

Current USFWS public use program activities in support of environmental education and interpretation in Refuge Management Alternative A would continue; with the development of the following additional facilities and programs:

- Construct Refuge Complex Administrative Headquarters and Wildlife Interpretive Center in Chambers County.
- Complete interpretive facility development in the Anahuac NWR Visitor Information Station including: 1) two interactive multi-media audio-visual programs; 2) digital imaging displays of coastal habitats and fish and wildlife species representing all four seasons; and 3) a hanging display of life-sized marsh and waterbird carvings.
- Develop interpretive exhibits for the Anahuac NWR butterfly habitat and native prairie demonstration site, including exhibits which highlight native butterflies and native plants which provide important habitat for butterflies.
- Develop interpretive exhibits on waterfowl and waterfowl management for the East Unit Hunter Check Station of Anahuac NWR.
- Initiate weekly interpretive walks during spring, focusing on butterfly identification and habitat use on Anahuac NWR.
- Construct an interpretive kiosk at the East Bay Bayou Tract trailhead, and produce self-guided brochure/trail guide for East Bay Bayou Tract on Anahuac NWR.

- Conduct naturalist-led interpretive walks during fall and winter on Anahuac NWR, focusing on wintering waterfowl and the habitats they utilize.
- Develop 4 mobile interpretive displays on 1) habitat management practices for waterfowl, shorebirds, and other wetland-dependent migratory birds; 2) native coastal prairie and prairie restoration; 3) coastal woodlots; and 4) fire ecology.
- Develop interpretive signs on native habitats including coastal wetlands, coastal prairie, and coastal woodlots and the wildlife species they support, and strategically place throughout the Refuge.
- Develop interpretive exhibits on wetland and upland habitat management practices including prescribed burning, controlled grazing, water management and exotic species control and strategically place throughout the Refuge
- Develop interpretive signs for the Anahuac NWR Oyster Bayou Moist Soil Unit overlooks, emphasizing waterfowl and shorebird ecology and moist soil management.
- Install a microwave video camera in the field to project images of “real time” nature back to the Anahuac NWR Visitor Information Station and/or the Friends of Anahuac Refuge Web page.
- For Anahuac NWR, develop and produce a “Children’s Checklist” of common refuge plant, animal and fish species.
- Develop a self-guided radio interpretive program for the Willows- Shoveler Pond - Frozen Point auto tour route on Anahuac NWR.
- Develop a brochure on the role of fire in marsh and prairie ecology and its use as a management tool on the Refuge Complex.
- Develop interpretive facilities on McFaddin and Texas Point NWRs (kiosks, signage) to interpret coastal marsh and coastal woodlot habitats and native fish and wildlife resources.
- Develop interpretive exhibits on waterfowl and waterfowl management for the McFaddin NWR check station.
- Produce a video detailing the natural resources of the Chenier Plain region and the role of the Refuge Complex in conserving these resources.
- Revise the two refuge general brochures and websites to detail each Refuge’s role in managing and restoring native habitats and fish, wildlife, and plants.
- Develop presentations on wildflowers, butterflies, mammals and reptiles and amphibians found on the Refuge Complex.
- On Anahuac NWR, expand the environmental education program to include an advanced independent projects program for local scouting and 4H groups, an educational activity for middle school and high school students describing neo-tropical migratory bird migration and the importance of protecting breeding, wintering and stopover habitat. The activity would include a classroom session followed by a field trip to the Refuge during spring migration.
- On McFaddin and Texas Point NWRs, develop and initiate an on-refuge Environmental Education program for Sabine Pass schools and students.
- Develop step-down Environmental Education and Interpretation Plans for the Anahuac, McFaddin and Texas Point NWRs.

5. Beach Uses on McFaddin NWR

The objective for beach uses on McFaddin NWR is to protect public safety and natural resources along the Gulf of Mexico shoreline within the refuge. The beaches along the Gulf of Mexico on and adjacent to the McFaddin NWR support recreational uses including surf fishing, swimming, sunbathing, wildlife observation, and camping. The beaches on McFaddin NWR are considered an area of joint Federal and State of Texas jurisdiction. The beach inland of the Mean High water line lies within the Refuge. Motorized vehicular traffic occurs on the beach from the vegetation line seaward to mean low tide line, on the public beach easement established under the State of Texas “Open Beaches Act” (Texas Natural Resources Code, Chapter 61: Use and Maintenance of Public Beaches).

Current USFWS public use program activities related to beach use on McFaddin NWR under Refuge Management Alternative A would continue. Proposed additional USFWS activities include:

- Expand law enforcement activities to protect public safety and natural resources.
- Expand coordination with the Texas General Land Office and county agencies to enhance protection of public safety and natural resources.

E. Community Outreach and Partnerships

The objective for community outreach and partnerships is to promote conservation of natural resources on a landscape scale by working effectively with partners in support of USFWS management programs on the Refuge Complex, and by supporting community-based conservation and development of nature tourism opportunities region-wide. Partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, two citizen support groups, with state agencies such as the Texas Parks and Wildlife Department, the Texas General Land Office and the Galveston Bay Estuary Program, and with conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters have been particularly effective. Volunteers on the Refuge Complex provide over 10,000 hours of service annually. In addition the USFWS is working with private landowners to enhance or restore coastal marsh and prairie wetlands habitat on private lands, by providing technical assistance and helping to coordinate use of several private lands programs (such as the USFWS Partners for Fish and Wildlife Program and the multi-partner Texas Prairie Wetland Project). Many private lands in the region are successfully managed to provide habitat for wintering waterfowl and other migratory birds. The objective for Private Lands Partnerships is to, within 15 years, enhance or restore 1500 acres of coastal marsh and prairie wetlands habitat, 500 acres of coastal prairie habitat, and 10 acres of woodlot habitat on private lands in the Texas Chenier Plain region through coordination with interested private landowners and the use of USFWS private lands programs. Many private lands in the region are skillfully managed to provide habitat for wintering waterfowl and other migratory birds. Excellent opportunities and much interest among landowners exist to enhance, restore and manage wetland, grassland and woodlot habitats on private lands. A variety of private lands programs are available to private landowners to enhance fish and wildlife habitat.

Current USFWS community outreach and partnership activities in Refuge Management Alternative A would continue, with the following efforts to expand community outreach and partnerships with private landowners to enhance upland habitats:

- Work with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance to increase volunteerism and other partnership endeavors.
- Develop a "Refuge Update" news article, to be published regularly in local newspapers.
- Expand coordination with county agencies, Chambers of Commerce, nature tourism organizations and others to promote the outdoor recreational opportunities available on the Refuge Complex through mutual information sharing, development of promotional materials, and other partnership endeavors.
- On Anahuac NWR, hold three on-refuge workshops for private landowners and other agency personnel to demonstrate marsh management and restoration, prairie and woodlot restoration, moist soil management, and other wetland management techniques, and to highlight available USFWS private lands programs and grant opportunities.

F. Administration and Staffing

In addition to the already existing staff positions under Refuge Management Alternative A, staffing on the Refuge Complex would be expanded by seven positions during the 15-year planning horizon of the CCP. This would include six positions previously established by the USFWS as Essential Staffing on the Refuge Complex: 1) Wildlife Biologist; 2) Plant Ecologist; 3) Geographic Information Systems - Computer Specialist; 4) Natural Resource Specialist - Oil and Gas Management; 5) Refuge Operations Specialist; and 6) Heavy Equipment Operator. In addition, one Refuge Law Enforcement Officer position would be established to increase protection of refuge resources and public safety.

V. REFUGE MANAGEMENT ALTERNATIVE E - EMPHASIS ON A PASSIVE MANAGEMENT APPROACH

Alternative E Concept

Management Focus

Under this Alternative, the Refuge Complex would change its management focus from active habitat management and restoration to a more passive management approach, in which plant communities and wildlife populations are influenced primarily by natural events such as lightning-caused fires, herbivory by native wildlife, and tidal or stream flooding.

Active habitat management and restoration activities including prescribed burning, controlled cattle grazing, rice farming and moist soil management would be discontinued. Natural wildfire starts would be allowed to burn until naturally extinguished, with suppression occurring only to protect refuge facilities, adjacent private property, and/or public safety. Management of water levels and salinities through active manipulation of water control structures would be discontinued. Water management infrastructure including levees, delivery and drainage systems and water control structures would be removed over time.

Efforts to address threats to ecosystem health would focus on monitoring rather than active restoration or protection. By working with the scientific and academic communities and other agencies, monitoring programs would be implemented to document shoreline changes and land loss rates along the Gulf, GIWW and East Galveston Bay, changes in plant communities associated with salinity regimes created under passive management, plant community and fish and wildlife population changes caused by the spread of invasive species present or through the establishment of new species, and to track contaminant levels in fish and wildlife, water, soil and air.

The Refuge Complex would continue to provide opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, and environmental education and interpretation, but administrative oversight and management would occur at reduced levels. Areas open to waterfowl hunting would remain open on strictly a first-come, first-serve basis. Wildlife observation, photography, environmental education and interpretation programs and facility development would be aimed primarily at providing self-guided opportunities.

Implementing Refuge Management Alternative E would involve downsizing the Refuge Complex staff by 12 full-time positions.

Rationale for this Management Focus

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Refuge Complex' coastal marshes host hundreds of thousands of wintering and migrating Central Flyway waterfowl, shorebirds, wading birds and other wetland-dependent migratory birds. Coastal prairie and coastal woodlots on the Refuge Complex support over 150 migratory and resident land bird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (under the North American Bird Conservation Initiative).

The high degree of alteration in this ecosystem has resulted in loss and degradation of native habitats and loss of biological diversity. Alterations of historic hydrology including loss of freshwater inflows and increased saltwater intrusion, coastal erosion, land subsidence and sea level rise are contributing to ongoing coastal marsh loss and degradation. Almost all of the region's historic native tallgrass coastal prairie and its associated prairie wetlands have disappeared, and remaining coastal woodlots are

imminently threatened by development and other land use changes. Several highly invasive exotic plant species are replacing native habitats and severely impacting native biological diversity. Air and water quality issues in the region pose a potential contaminant threat to fish and wildlife, as do accidental spills and discharges from the major petrochemical shipping, storage and processing facilities located in close proximity to sensitive wetland habitats on the Refuge Complex.

Conservation of fish, wildlife and plant resources on the Refuge Complex under this Alternative would rely primarily on protecting existing wetland and upland habitats from land use changes such as development and reducing disturbance impacts from human presence. This level of protection could be afforded using less staff and financial resources.

A. USFWS Habitat Management and Restoration

Conservation and improvement of refuge habitats is largely accomplished by influencing the vegetation resources found on the different habitat types. Under Refuge Management Alternative E, the current habitat management activities consisting of water management, controlled grazing/mowing, prescribed burning, and other management or restoration activities would be discontinued in favor of a more passive management. Under this Alternative, plant communities and wildlife populations are influenced primarily by natural events such as lightning-caused fires, herbivory by native wildlife, and tidal or stream flooding.

This habitat management approach would focus on achieving the two following Refuge goals:

- GOAL 1. Conserve, enhance and restore the Texas Chenier Plain region's coastal wetlands to provide wintering, migrational, and nesting/brood-rearing habitat for waterfowl, shorebirds, marsh and wading birds, other wetland-dependent birds, and habitat for other native fish and wildlife.
- GOAL 2. Conserve, enhance and restore the Texas Chenier Plain region's coastal prairies and coastal woodlands to provide wintering, migrational, and nesting habitat for resident and migratory landbirds, including neotropical/nearctic migratory birds, and habitat for other native wildlife species.

1. Wetland Specific Management and Restoration

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

a. Emergent Wetlands

The objective for emergent wetlands (estuarine and palustrine) is that coastal marshes and their plant communities on the Refuge Complex will be influenced only by current hydrological conditions and natural climatic events and trends. Historically, disturbance events such as wildfire, tidal and stream flooding, and herbivory by native wildlife such as snow geese and muskrats were the primary influences on marsh plant communities in the region. The habitat diversity created by these events in turn supported a diverse wetland-dependent avifaunal community.

Proposed USFWS management activities in emergent wetlands:

- Discontinue water level and salinity management on the Refuge Complex by removing water management infrastructure including levees, water delivery and drainage systems and water control structures in managed marsh units.
- Where feasible, utilize natural lightning starts to accomplish burning objectives in marsh habitats by allowing natural wildfires to burn within Refuge Complex boundaries until they naturally extinguish. Suppress natural wildfires only when they threaten refuge facilities, adjacent private property, and/or public health and safety.

- Discontinue active marsh management practices including prescribed burning, controlled grazing, and exotic/invasive plant species control. Remove grazing program infrastructure including interior fences and water developments.

b. Freshwater Prairie Wetlands (Palustrine)

The objective for prairie wetlands is to maintain shallow freshwater prairie wetlands on the Refuge Complex subject to natural climatic cycles and other natural processes. Historically, depressionally freshwater wetlands dispersed throughout the region's coastal tallgrass prairie helped support a diverse avifaunal community. Ecological processes and function and plant and animal diversity within these habitats were influenced primarily by climatological events and trends.

Proposed USFWS management activities for prairie wetlands:

- Discontinue current habitat management and restoration activities on the Refuge Complex including moist soil management, rice farming and restoration of shallow freshwater wetlands.
- Allow the acreage of shallow freshwater prairie wetland habitat on the Refuge Complex to be dependent solely upon natural precipitation cycles.

2. Upland Specific Management and Restoration

a. Native Prairie and other Grasslands

The objective for native prairie and other grassland habitat is to allow natural successional changes and disturbance events to influence plant communities in the 5,744 acres of grassland habitats on the Refuge Complex, including "prairie remnants", permanently fallowed former croplands which are naturally revegetating, and sites previously restored to native prairie using intensive restoration techniques. Additional fallowed rice fields would be created under this Alternative with the discontinuation of the cooperative rice farming program on Anahuac NWR. Topography, soils, fire and grazing and trampling actions of herbivores, all in association with climate, are natural functions controlling grassland development (Ryan 1990). Fires in upland prairie prior to human occupation of the continent were started by lightning storms, primarily in mid-summer (Komarek 1964, Bragg 1982, Higgins 1984, Garbrey *et al.* 1999). Natural lightning starts continue to occur periodically in upland portions of the Refuge Complex. It is now estimated that 99.8% and 99.6 % of little bluestem and eastern gamma grass/switch grass prairies, respectfully, have been lost in Texas (McFarland 1995). Nine of the 13 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in grasslands on the Refuge Complex. In 2005, the USFWS listed 7 avian species occurring in prairie habitats on the Refuge Complex as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region.

Proposed USFWS management activities for native prairie and other grassland habitats:

- Where feasible, utilize natural lightning starts to accomplish burning objectives in prairie habitats by allowing natural wildfires to burn within Refuge Complex boundaries until they naturally extinguish. Suppress natural wildfires only when they threaten refuge facilities, adjacent private property, and/or public health and safety.
- Discontinue cooperative rice farming program on Anahuac NWR.
- Discontinue habitat management and restoration activities in prairie habitats including prescribed burning, controlled grazing, invasive species control, and restoration using intensive restoration techniques.
- Initiate a monitoring program to monitor and document plant community successional stages in the Refuge Complex' grassland habitats.

b. Coastal Woodlands

The objective for Coastal Woodlands is to allow existing woodland habitats on the Refuge Complex to be influenced only by natural events such as wildfires and climatic conditions and trends. Coastal woodlots

in the Chenier Plain region are extremely important to migrating songbirds, providing essential feeding and resting areas for numerous neo-tropical migratory birds crossing the Gulf of Mexico (Rappole 1974, Sprunt 1975, Mueller 1981).

Although comprising less than 1% of Refuge Complex acreage, woodland habitats are extremely important to overall avian diversity, including several sensitive species. Six of the 7 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas (Texas Parks and Wildlife Department 2000) are present in Refuge Complex woodlands. In 2005, the USFWS listed 4 species that occur in Refuge Complex woodlands as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region. The amount of native coastal woodlot habitat in the Chenier Plain region has been reduced mainly through development, conversion to pasture and logging of bottomland hardwoods (Mueller 1981). Although woody habitat has significantly increased in the region with the rapid expansion of exotic Chinese tallow trees, these new tallow tree woodlands provide poor habitat for migrant songbirds (Barrow 2001).

Proposed USFWS management activities for coastal woodlands:

- Where feasible, allow natural lightning starts within Refuge Complex boundaries to burn, including in woodland habitats, until they naturally extinguish. Suppress natural wildfires only when they threaten refuge facilities, adjacent private property, and/or public health and safety.
- Initiate a monitoring program to document plant successional changes in existing woodland habitats and monitor and document trends in the area coverage of woodland habitat utilizing GIS technology.

B. USFWS Biological Program – Surveys, Monitoring, and Research

USFWS habitat management and restoration activities benefit many species of native fish, wildlife and plants on the Refuge Complex. The USFWS biological program on the Refuge Complex includes monitoring, field surveys and research studies of fish and wildlife population status, population trends and habitat utilization. The information obtained allows the USFWS to adapt management efforts on the Refuge Complex as needed to achieve Refuge purposes and to maintain and restore natural biological diversity and ecological integrity. Data are also used in support of international, national and regional conservation initiatives. Under this Alternative, current biological program activities which focus primarily on monitoring status and trends of waterfowl and other migratory bird populations would continue.

These wildlife conservation efforts focus on achieving the following Refuge goal:

- GOAL 3. A comprehensive biological program will guide and support conservation efforts for all species of native fish, wildlife and plants on the Texas Chenier Plain Refuge Complex.

1. Waterfowl, Shorebirds and other Wetland-dependent Migratory Birds

The biological program objective for waterfowl, shorebirds and other wetland-dependent migratory birds is to help maintain healthy populations and document population status and trends and habitat utilization of priority species utilizing the Refuge Complex. Coastal habitats of the Texas Chenier Plain region provide important wintering and migrating habitat for waterfowl of the Central Flyway, and for millions of shorebirds, wading birds, colonial nesting waterbirds, and other wetland-dependent migratory birds. Monitoring and studies of population trends and habitat utilization provide information to assess management activities on the Refuge Complex. Data are also used in support of international, national and regional migratory bird conservation initiatives.

No Change in biological program activities in Refuge Management Alternative A.

The objective for Mottled Ducks is to maintain favorable habitat conditions for the year-round needs of the Mottled Duck on the Refuge Complex, including nesting, brood-rearing, molting and wintering habitats. Under this Alternative, habitats used by Mottled Ducks on the Refuge Complex will be influenced only by natural events such as wildfires and wildlife herbivory and not by specific habitat management activities.

Historically, disturbance events such as wildfire, tidal and stream flooding, and herbivory by native wildlife such as snow geese, muskrats, and bison were the primary influences on marsh and prairie plant communities in the region. The habitat diversity created by these events in turn supported a diverse wetland-dependent avifaunal community, including habitat for the resident waterfowl species, the Mottled Duck.

Current USFWS biological program activities supporting conservation of Mottled Ducks in Refuge Management Alternative A would continue. Proposed changes in USFWS management activities for habitats used by Mottled Ducks include:

- Discontinue habitat management directed towards maintaining and enhancing habitats for Mottled Ducks, including water level and salinity management, prescribed burning, controlled grazing, and brush control.

2. Migratory and Resident Landbirds

The biological program objective for migratory and resident landbirds is to help maintain healthy populations and document population trends, status and habitat utilization of priority species on the Refuge Complex.

No Change from biological program activities in Refuge Management Alternative A.

3. Fish and other Aquatic Species

The biological program objective for fish and other aquatic species is to document population trends, status and habitat utilization of priority species on the Refuge Complex.

*No Change from biological program activities in Refuge Management Alternative A.
Water management infrastructure would be removed in estuarine marshes under this Alternative.*

4. Threatened and Endangered Species, Species of Conservation Concern

The biological program objective for Threatened and Endangered species, Species of Conservation Concern, and other “watch species” is to support recovery efforts and to obtain information on population trends, status and habitat utilization of sensitive and/or declining species utilizing the Refuge Complex. Eight federally-listed Threatened and Endangered species occur on or adjacent to the Refuge Complex: Bald Eagle, Piping Plover, Brown Pelican, Loggerhead sea turtle, Kemp’s Ridley sea turtle, Green sea turtle, Hawksbill sea turtle, and Leatherback sea turtle.

No Change from biological program activities in Refuge Management Alternative A.

5. Mammals

The biological program objective for mammals is to document population trends, status and habitat utilization of priority species on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

6. Reptiles and Amphibians

The biological program objective for reptiles and amphibians is to document species occurrence and monitor population status and trends. The objective for alligators is to monitor population status and trends.

Current USFWS biological program activities supporting conservation of reptiles and amphibians in Refuge Management Alternative A would continue. A proposed change in biological program activities for alligators includes:

- Discontinue the alligator harvest program on Anahuac and McFaddin NWRs.

7. Invertebrates

The biological program objective for invertebrates is to document species occurrence on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A

8. Plant Resources

The biological program objective for plant resources is to document native species composition and plant community changes over time on the Refuge Complex.

No change from biological program activities in Refuge Management Alternative A.

C. Addressing Threats to the Ecosystem

The USFWS has ongoing efforts on the Refuge Complex to address threats to ecosystem health posed by coastal land loss, hydrological alterations, exotic species, and contaminants. These include coordination with other agencies and conservation organizations on ongoing planning processes and studies aimed at developing solutions to address coastal land loss due to erosion along the Gulf of Mexico; and to implement erosion abatement projects along the Gulf of Mexico, Galveston Bay, and the Gulf Intra-Coastal Waterway (GIWW). Under Refuge Management Alternative E, efforts to address threats to ecosystem health would focus on monitoring rather than active restoration or protection.

These efforts addressing threats to ecosystem health focus on achieving the following refuge goal:

- GOAL 4. By working with others locally and on a landscape level, threats to biological integrity, biological diversity and environmental health on the Texas Chenier Plain Refuge Complex will be addressed.

1. Coastal Land Loss

The objective for the threat from relative sea level rise and reduced sediment supply is to decrease rates of coastal land loss due to shoreline erosion along the Gulf of Mexico, East Galveston Bay, and the GIWW. Along the Texas Coast, wetland losses between the mid-1950's and mid-1990's were most substantial for estuarine emergent marshes (Moulton *et al.* 1997). Relative sea level rise and reduced coarse sediment supply to Gulf and bay nearshore littoral systems are resulting in significant loss of coastal habitats. Average rates of shoreline retreat along the Gulf adjacent to the refuges are as high as 50 feet per year on Texas Point NWR, and 10-15 feet per year along most of McFaddin NWR (Bureau of Economic Geology unpublished data, Morton 1998). Over 800 acres of dunes and emergent marsh has been lost due to Gulf shoreline erosion on these refuges during the last 25 years, and remaining inland marshes are increasingly threatened by more frequent inundation during high tidal events. Although less severe, erosion along the East Galveston Bay shoreline is also causing wetland loss on Anahuac NWR, and also threatens remaining marshes with saltwater intrusion. Erosion along the GIWW is also causing direct loss of wetlands and poses a significant threat to marshes from saltwater intrusion on both McFaddin and Anahuac NWRs. Levees created when the GIWW was constructed have almost entirely eroded away along significant portions of its length within these refuges.

Proposed USFWS activities to address threats from relative sea level rise and reduced sediment supply:

- Monitor shoreline changes and land loss rates on the Refuge Complex using Geographic Information Systems and remote sensing technologies.

2. Altered Hydrologic Processes

The objective for the threat from altered hydrologic processes is to, within 15 years, document rates of emergent marsh loss (conversion of emergent marsh to open water) on the Refuge Complex. Land subsidence, sea level rise, channel construction, and channelization of natural waterways have all had significant hydrologic impacts including saltwater intrusion, tidal scouring causing erosion of organic marsh substrates, loss of freshwater inflows and excessive flooding of marshes. Over the last century, these factors have gradually converted extensive areas of fresh and intermediate marshes to a more brackish regime thereby decreasing natural biological diversity. Relative sea level rise further threatens vegetated marshes through increased saltwater intrusion and submergence. To survive, remaining marshes must accrete or gain elevation at a rate that keeps up with sea level rise. Maintaining plant productivity and preventing loss of organic marsh soils by restricting saltwater intrusion and tidal energies, increasing freshwater inflows, and beneficially using dredge materials to raise marsh elevations appear to offer the most realistic options for reversing current trends of interior marsh loss in the Chenier Plain region.

Proposed USFWS activities to address threats from altered hydrologic processes:

- Monitor status and trends of Refuge Complex wetlands using Geographic Information System and remote sensing technologies.

3. Invasive Species

The objective for the threat from invasive species is to document occurrence and distribution of invasive species on the Refuge Complex. Monocultures of invasive plants reduce natural biological diversity, increase erosion, alter nutrient cycling and displace macro- and micro-fauna that depend on native plants for habitat and food (Sheley and Petroff. 1999). Refuge habitats are currently significantly impacted by exotic plants and animals including: Chinese tallow (*Sapium sebiferum*), water hyacinth (*Eichhornia crassipes*), alligator weed (*Alternanthera ohilocoeroides*), water lettuce (*Pistia stratiotes*), McCartney rose (*Rosa bracteata*), vasey grass (*Paspalum urvillei*), Johnson grass (*Sorghum halepense*), *Cyperus entrerianus*, Eurasian water milfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), *Salvinia minima*, Japanese honeysuckle (*Lonicera japonica*) red imported fire ants, nutria, and feral hogs. Giant salvinia (*S. molesta*), to date documented on the Refuge Complex only once and in small amounts near a refuge boat ramp, has been found nearby and poses a significant threat to freshwater wetlands. Invasive native plant species include eastern baccharis (*Baccharis halimifolia*), big-leaf sumpweed (*Iva frutescens*), rattlebox (*Sesbania drummondii*), common reed (*Phragmites communis*) and cattail (*Typha* spp.).

Proposed USFWS activities to address threats from exotic and invasive species:

- Utilize Geographic Information Systems technology and a field monitoring program to identify, survey and map existing and new stands of upland and aquatic invasive plants on the Refuge Complex.

4. Contaminants

The objective for the threat from contaminants is to document direct impacts to fish and wildlife and habitats on the Refuge Complex from oil and petrochemical spills and other contaminant sources. Contaminant issues affecting the Refuge Complex include potential petroleum and petrochemical spills from: 1) on-Refuge oilfield operations; 2) shipping on the GIWW; and 3) offshore production in the Gulf. The potential for petrochemical and petroleum spills affecting the Refuge Complex is high. Over 20 active oil and gas wells are currently producing on the Refuge Complex. Significant drilling and production activity occurs in Gulf waters offshore of McFaddin and Texas Point NWRs. The GIWW between Houston and Lake Charles, Louisiana is one of the busiest reaches of this waterway for shipping petrochemical and petroleum products. The GIWW parallels much of McFaddin and Anahuac NWRs, and the Sabine-Neches Ship Channel parallels Texas Point NWR. Former and current oil and gas production areas on the Refuge Complex contain extensive infrastructure which is no longer in use, including flow lines, pipelines, oil pits, well pads, and brine disposal areas. Many of these lines, pits, and pads may contain contaminants including heavy metals, normal occurring radio-active material, brine, and

petroleum products. In addition, Refuge Complex marshes comprise the downstream end of at least 10 waterways. Factories, refineries, solid waste disposal sites, oil field sludge disposal areas, feedlot operations, agricultural operations and housing developments are potential pollution sources in upstream reaches of these watersheds. Finally, high levels of lead shotgun pellets likely occur over much of the Refuge Complex. Incidence of lead shot in waterfowl gizzards reached all time high levels during the 1990's, even after implementation of non-toxic ammunition regulations.

Proposed USFWS activities to address threats from contaminants:

- Investigate, document and report all incidences of fish and wildlife mortalities resulting from contaminant impacts including oil and petrochemical spills, lead poisoning, and disease outbreaks which may be related to contaminants affecting air, soil and water quality.

D. USFWS Public Use Program

The Texas Chenier Plain Refuge Complex offers a wide variety of recreational opportunities and received over 172,000 visitors during Fiscal Year 2002. Through the use of existing programs and facilities, the Refuge Complex provides opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, which are:

- Hunting
- Fishing
- Wildlife Observation and Photography
- Environmental Education and Interpretation

Under Refuge Management Alternative E, the Refuge Complex would continue to provide opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses, but administrative oversight and management would occur at reduced levels.

These visitor and recreational opportunities focus on achieving the following Refuge goal:

- GOAL 5. All local, national and international visitors will enjoy safe and high quality outdoor experiences on the Refuge Complex, and learn of the Refuge Complex' role in conserving the region's coastal natural resources. New partnerships with our local communities will be forged to highlight, promote and conserve the unique natural assets of the upper Texas Gulf Coast

1. Hunting

The objective for hunting is to provide safe and high quality waterfowl hunting opportunities on the Refuge Complex. Waterfowl hunting is a traditional and still very popular outdoor recreational pursuit in the region. Refuges and other public lands along the Gulf Coast play a key role in providing hunting opportunity to the public at large.

Current USFWS public use program activities in support of hunting in Refuge Management Alternative A would continue, with the following administrative change:

- Waterfowl hunting on all hunt units will be administered on a first-come, first-serve basis, with no fee permit and no reservation and/or drawing required.

2. Fishing

The objective for fishing is to provide safe and high quality fishing opportunities on the Refuge Complex. The Refuge Complex offers exceptional recreational fishing and crabbing opportunities in both saltwater and freshwater environments. Catfish, bass and brim in freshwater environments and speckled trout, flounder and red drum in saltwater environments are among the popular game fish on the refuges. Crabbing for blue crabs is also a popular recreational pursuit along refuge waterway and lake shorelines.

No change from public use program activities in support of fishing in Refuge Management Alternative A.

3. Wildlife Observation and Photography

The objective for wildlife observation and photography is to provide safe and high quality opportunities for wildlife observation and photography on the Refuge Complex. The Refuge Complex provides local, regional, national and international visitors with a wide range of wildlife observation and photography opportunities, supporting a rapidly growing nature tourism industry in Texas. Migratory bird and alligator viewing are the main attractions. The refuges are highlighted Upper Texas Gulf Coast sites on the Great Texas Birding Trail. Anahuac NWR is an internationally known birding destination, receiving visitors each year from all 50 states and over 20 countries.

No change from public use program activities in support of wildlife observation and photography in Refuge Management Alternative A.

4. Environmental Education and Interpretation

The objective for environmental education and interpretation is to provide safe and high quality opportunities for environmental education and interpretation on the Refuge Complex. The implementation of environmental education and interpretive programs for students and visitors on the Refuge Complex is important to increase the quality of the visitor experience and to further public awareness of the benefits, issues and challenges associated with natural resource conservation in this productive and diverse coastal ecosystem.

Current USFWS public use program activities in support of environmental education and interpretation hunting in Refuge Management Alternative A would continue, with the following administrative change:

- Discontinue staff-led guided tours and education programs.
- Discontinue refuge-hosted special events and participation in local and regional festivals.

5. Beach Uses on McFaddin NWR

The objective for beach uses on McFaddin NWR is to protect public safety and natural resources along the Gulf of Mexico shoreline within the refuge. The beaches along the Gulf of Mexico on and adjacent to the McFaddin NWR support recreational uses including surf fishing, swimming, sunbathing, wildlife observation, and camping.

No Changes from current USFWS public use program activities to protect public safety and natural resources on McFaddin NWR under Refuge Management Alternative A.

E. Community Outreach and Partnerships

The objective for Community Outreach and Partnerships is to promote conservation of natural resources by working effectively with partners in support of USFWS management programs on the Refuge Complex including habitat management and restoration, fish and wildlife population management, and providing public recreational and educational opportunities. Partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, two citizen support groups, and with conservation organizations such as the Galveston Bay Foundation and local Audubon Society chapters have been particularly effective. Volunteers on the Refuge Complex currently provide over 10,000 hours of service annually.

Under this Alternative, the USFWS would discontinue working with private landowners on habitat restoration and enhancement projects. Current community outreach and partnership efforts would continue, but at reduced levels.

F. Administration and Staffing

Implementing Refuge Management Alternative E would involve downsizing the Refuge Complex staff by 12 full-time positions.

PART B: REFUGE BOUNDARY EXPANSION ALTERNATIVES

The second proposal addressed in this EIS is that of expanding the acquisition boundary of the four constituent refuges. The purpose of implementing a refuge boundary expansion proposal is to help the USFWS achieve larger mandates provided by law and treaty that are related to the protection of migratory birds and other Trust resources. Implementation of a boundary expansion proposal is expected to assist the USFWS meet its goals and objectives of the ecosystem plan for the Texas Gulf Coast. Although achievement of the refuge purposes is not necessarily dependent upon additional land acquisition, the possible inclusion of other lands within the refuges would assist the USFWS in more effectively managing existing refuges in this Refuge Complex and achieving its larger ecosystem-wide goals and objectives to ensure the long-term sustainability of migratory bird populations. Expansion of any of the Refuge Complex' constituent refuge acquisition boundaries would thereby authorize the USFWS to work with willing sellers using the acquisition standard and parameters defined in USFWS law, policy, and government regulations. Lands acquired by the USFWS would be managed as part of the National Wildlife Refuge System. Since the USFWS is considering conducting a new action, expansion of refuge boundaries, the NEPA "No Action" alternative is the agency not acting at all. Therefore, the "No Action" Alternative proposes no change from existing refuge boundaries.

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

The areas identified in the Refuge Boundary Expansion Alternatives lie within the Gulf Coast Prairie (GCP) Region under the U.S. Shorebird Conservation Plan (USSCP). Thirty-nine shorebird species occur in this Region, and it is considered to be of "extremely high importance" to 14 species and of "considerable importance" for 21 additional species. Of these 35 species, 17 are considered to be species of conservation concern under the USSCP. Four are considered "Highly Imperiled" – Snowy Plover, Piping Plover, Long-billed Curlew, and Eskimo Curlew (believed extirpated). Thirteen species are considered "Species of High Concern" – American Golden Plover, Wilson's Plover, Mountain Plover, American Oystercatcher, Whimbrel, Hudsonian Godwit, Marbled Godwit, Ruddy Turnstone, Red Knot, Sanderling, Buff-breasted Sandpiper, American Woodcock, and Wilson's Phalarope. Wetland habitats within the areas identified in the Refuge Boundary Expansion Alternatives provide important migrational and wintering habitat for many of the shorebird species identified as needing conservation attention within the GCP Region, including for three of the "Highly Imperiled" species: Piping Plover, Long-billed Curlew, and Snowy Plover, and for ten "Species of High Concern": American Golden Plover, Whimbrel, Hudsonian Godwit, Marbled Godwit, Ruddy Turnstone, Red Knot, Sanderling, Buff-breasted Sandpiper, American Woodcock, and Wilson's Phalarope. The GCP Region Shorebird Plan recommends several

management actions for maritime and non-maritime shorebirds including increased protection and enhanced management of beach nesting areas, additional habitat protection through land acquisition, restoration of beach and barrier island habitat, incorporation of shorebird conservation into U.S. Army Corps of Engineers projects, addressing freshwater inflow needs of estuaries as part of water resources planning and development, expansion and enhancement of exotic/invasive species management efforts (Chinese tallow), continued use of prescribed burning to enhance shorebird habitat in wetland and prairie habitats, and expanded and enhanced management of rice agriculture, crawfish impoundments, and moist soil units to benefit shorebirds. Standardization and coordination of systematic population monitoring of priority shorebird species is also recommended.

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

The Partners in Flight (PIF) Conservation Program is an international, multi-agency and multi-organization conservation initiative for North American landbirds and waterbirds. PIF recently completed an assessment of the status and conservation needs of all North American land and waterbirds. This assessment included consideration of population trends, habitat trends, and threats on breeding and wintering grounds. National, regional, and more local conservation priorities were determined. These species represent conservation priorities for the USFWS and other PIF partners including state wildlife agencies, the U.S. Forest Service, and other governmental and private partners. Multi-agency PIF conservation strategies for Texas are currently under development, and these strategies will guide management activities at the local and regional scale. In Texas, the PIF partners have identified priority species for conservation, monitoring and management in relation to specific habitat types and seasons within the Texas Coastal Prairies region (Texas Parks and Wildlife Department 2000), which includes the areas identified under the Refuge Boundary Expansion alternatives. Habitats on areas identified under the Refuge Expansion alternatives provide wintering, migrational and/or nesting habitat for 16 species of wetland-associated birds, 10 species of grassland birds, and 13 species utilizing woodland habitats which are listed as Rare and Declining within the Texas Coastal Prairies Region.

Summary of Refuge Boundary Expansion Alternatives

The four Refuge Boundary Expansion Alternatives (A-D) are listed below with a short summary for each.

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

This Alternative assumes no change from the existing refuge boundaries within the Refuge Complex. This is the “no action” alternative as required under NEPA and is considered the base from which to compare the other expansion alternatives. There would be no expansion of any of the four refuge boundaries within the Refuge Complex.

Refuge Boundary Expansion Alternative B - 33,590 Acre Expansion

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

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

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

*Refuge Boundary Expansion Alternative D - 104,120 Acre Expansion**

***Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative C.** Similar to Refuge Boundary Expansion Alternative C, this Alternative continues the four refuge's historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetlands portions of this expansion alternative concentrate on high-value wintering waterfowl habitats near the coast which are contiguous to existing refuges. In addition to these primarily wetland areas, this Alternative again includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. This Alternative also includes an important near-coast bottomland hardwood area, which is an acquisition target new to this Refuge Complex. The primary habitat type in this area is forested wetlands which provide high quality wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species and important migration and nesting habitat for neotropical migratory songbirds. And finally, in addition to these various kinds of high biological value habitats, this Alternative also includes areas identified as necessary for refuge management. Expansion is proposed for each of the four refuges in the Refuge Complex.

Each of these four Refuge Boundary Expansion Alternatives are described in much more detail starting below with *Section I. Refuge Boundary Expansion Alternative A (NEPA No Action Alternative)*. Before describing each alternative in detail, the next section describes the elements which are common to all of the Refuge Boundary Expansion Alternatives.

Elements Common to All Refuge Boundary Expansion Alternatives

Although the Refuge Boundary Expansion Alternatives all differ in the areas proposed for acquisition, the land acquisition program for each of the Alternatives has a number of elements or features common to all. The following is a list and description of those elements or features common to all of the Refuge Boundary Expansion Alternatives.

Willing Sellers Only

Although the USFWS, like all agencies of the United States Government, has condemnation authority, it is USFWS policy to acquire land and interests in land from **willing sellers only**. No lands have been condemned in the past for any refuge in the Texas Chenier Plain Refuge Complex and the USFWS does not propose condemnation of any lands in the future. The USFWS can acquire land or interests in land **only within an approved refuge boundary**. In fact, the USFWS can't even accept a donation of land outside of an approved refuge boundary. Lands in any of the refuge boundary expansions would be acquired only from willing sellers as funding becomes available. Landowners within an expanded refuge boundary would be completely free to keep their land, to sell their land to whoever they wished, to leave their land to their heirs, or to change uses of their land.

Including lands within a NWR boundary does not require the landowner to sell only to the USFWS nor does it limit that landowner's other conservation options and opportunities. The USFWS actively encourages all private landowners who are interested in wildlife or environmental conservation, whether their lands are within an approved refuge boundary or not, to avail themselves of the many conservation program and options available. A list and detailed description of many of the other conservation programs and options available to private landowners in the Texas Chenier Plain region is located in Appendix C.

Since 1971, the acquisition of land for a variety of Federal government programs and projects has been subject to the Uniform Relocation and Assistance and Real Property Acquisition Policies Act of 1970, as amended in 1987 (the Uniform Act). The full rules for the Uniform Act can be found in the Code of Federal Regulations, Title 49, Part 24. The Uniform Act applies to the USFWS acquisition program and two very important provisions of this Act affect willing sellers: 1) relocation assistance for sellers of land, and 2) the requirement to offer to purchase for the full fair market value as established by an approved appraisal. The relocation provisions provide financial assistance to landowners, tenants, and small businesses that are required to move because of the sale of real property, in whole or part, to the USFWS. The relocation assistance is provided so that displaced persons will not suffer disproportionate injuries as a result of programs designed for the benefit of the public as a whole. Fair market value appraisals are done to ensure that potential sellers will be treated fairly, consistently, and equitably. The appraisal is independent, impartial, prepared by a qualified appraiser, and reviewed to ensure that all applicable appraisal standards and requirements were met. The amount the USFWS offers to purchase the land will never be less than the fair market value established by the approved appraisal. The USFWS also pays all of the incidental expenses incurred in transferring title; such as recording fees, title insurance costs, necessary surveys, escrow fees, and other similar expenses.

Acquisition methods

For all land and interests in land acquired by the USFWS, title is taken by the United States of America. The USFWS acquires most land in one of two ways: 1) in fee, or 2) conservation easement. The "fee" means virtually all of the rights and interests in the land, that which would be generally recognized as "ownership of the land". Fee acquisition removes the land from the tax rolls. Fee acquisition gives the USFWS exclusive possession and use of the land which would allow for compatible public recreational activities. Fee acquisition allows the USFWS to perform any of the management activities (i.e., water management, prescribed burning) deemed necessary for habitat conservation on that land. The fee acquisitions are typically subject to reserved or outstanding subsurface mineral interests and other existing surface easements, such as pipelines or other rights-of-way. The purchase of a conservation easement is the acquisition of a much lesser interest in the land. "Ownership of the land" does not transfer to the United States and the land remains on the tax rolls with the underlying private landowner having the tax obligations. Conservation easements can consist of one or more of the two following categories of interests in land: 1) negative covenants, which prevent a specific use (i.e., no development); and 2) possessory interests, which grant a specific use right (i.e., public hunting). Conservation easements are an acquisition option when adequate habitat conservation can be achieved without the USFWS acquiring full ownership of the land. Conservation easements are not always a viable option with willing sellers because some sellers wish to dispose of all of their interests in the land for various reasons.

Conservation easements are appraised and purchased in the same way as fee acquisitions. Also, the USFWS generally accepts donations of both fee and conservation easements.

Both fee acquisition and the acquisition of conservation easements have been used in the past on the refuges in the Texas Chenier Plain Refuge Complex. A detailed acquisition history for each of the refuges is located in the description of Refuge Boundary Expansion Alternative A: No Action. At Moody NWR, all of the USFWS' interests in land are in the form of a conservation easement. At Anahuac NWR, all of the USFWS' interests in land are in fee except for a public access road easement. At McFaddin NWR, the mix of the USFWS' interest in land is 86% fee and 14% conservation easement. At Texas Point NWR, all of the USFWS' interests in land are in fee. The USFWS will consider both fee and conservation easement for future acquisitions dependent upon the habitat conservation requirements and the willing seller's agreement.

In a few instances, the USFWS acquires interests in land by lease, right-of-way easement, or agreement. These are typically either for a shorter period of time or for more limited use purposes compared to fee and conservation easements.

Acquisition funding sources

The USFWS has only two primary land acquisition funding sources: 1) the Migratory Bird Conservation Fund, and 2) the Land and Water Conservation Fund. The Migratory Bird Hunting and Conservation Stamp Act of 1934, as amended (16 U.S.C. 718-718h) requires all waterfowl hunters 16 years of age and over to annually purchase and carry a Federal Duck Stamp. Approximately 98 cents of every Duck Stamp dollar goes directly into the Migratory Bird Conservation Fund to purchase wetlands and wildlife habitat for inclusion into the National Wildlife Refuge System. Since 1934, more than \$500 million has gone into this Fund to purchase more than 5 million acres of primarily waterfowl habitat. The Fund is administered by the Migratory Bird Conservation Commission and acquisition expenditures from this Fund require the approval of the governor of the state where the land to be purchased is located. This Fund has been the primary source of funding for land acquisition for all of the refuges within the Texas Chenier Plain Refuge Complex and it is expected that it will remain the primary source of funding in the future. This discretionary land acquisition funding source is very actively competed for on a national level within the USFWS.

The other primary land acquisition funding source was authorized by the Land Water Conservation Fund Act of 1965, as amended (16 U.S.C. 4601-11). The Land and Water Conservation Fund (LWCF) appropriations are derived from Outer Continental Shelf oil and gas leases, tax on motorboat fuels, and the sale of certain surplus Federal lands. Forty per cent or more of Land and Water Conservation Funds are appropriated for Federal land acquisition for the National Park System, the National Forest System, the National Wildlife Refuge System, and the Bureau of Land Management. The balance of the Funds provide financial assistance to the States for planning, land acquisition and development of outdoor recreation opportunities. The LWCF is not a discretionary funding source and Congress appropriates money to a specific project or refuge for land acquisition. Some LWCF money has been appropriated to purchase land at McFaddin NWR, but it has been a minor amount compared to the amount of Migratory Bird Conservation Funds used for land acquisition on the Refuge Complex.

Refuge Revenue Sharing

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

The net income the USFWS receives from the sale of products or privileges on refuges (like timber sales, grazing fees, right-of-way permit fees, etc.) is deposited in the National Wildlife Refuge Fund for revenue sharing payments. Originally, 25% of the net receipts collected from the sale of various products or privileges from refuge lands were paid to the counties in which they were located. However, if no revenue was generated from the refuge lands the county received no payment. The Refuge Revenue Sharing Act was amended in 1964 to allow a payment of either: 1) 25% of the net receipts, 2) $\frac{3}{4}$ of 1% of the adjusted purchase price of refuge land, or 3) 75 cents per acre, whichever was greater, on acquired lands. Payments still had to be made out of refuge receipts in the National Wildlife Refuge Fund. Beginning in Fiscal Year 1976, the refuge receipts were not sufficient to make the county payments and the payments were reduced accordingly. Partly because of this, the Refuge Revenue Sharing Act was again amended in 1978. This amendment allowed Congress to appropriate funds to make up any shortfall in the revenue sharing fund. It also approved use of the payments for any governmental purpose; whereas, before, the payments could only be used for roads and schools.

Because refuge receipts have not kept up with the general increase in property values, the $\frac{3}{4}$ of 1% of market value of refuge lands has effectively become the largest amount of refuge revenue sharing payment allowable under the Act since 1976. Initially, Congress appropriated the additional funds necessary to make the largest payment, but only through Fiscal Year 1980. Since that time Congress has not appropriated sufficient additional funds to make the largest payment allowed by law. If the amount Congress appropriates is not enough to match the largest payment allowable, the units of local government receive a pro-rata share. Even without the full supplemental appropriations, the dollar amount of Refuge Revenue Sharing payments is substantial and significantly offsets the local tax losses. In some instances, largely for lands subject to the agricultural exemption, the Refuge Revenue Sharing payments have been equal to or even greater than the amount paid in taxes while in private ownership. The USFWS supports full Congressional appropriations to achieve the maximum Refuge Revenue Sharing payments.

Table 3-52, representing the ten-year history of refuge revenue sharing payments for the Refuge Complex, is located in Chapter 3, *Affected Environment*. The table breaks down the payments by refuge and county for each year. All lands acquired in the future or lands donated in the future to the refuges would be included in the calculation and payment of Refuge Revenue Sharing payments. The market value for newly acquired lands is initially the purchase price; however, the USFWS reappraises the market value of all the lands in a refuge once every 5 years to keep the market value of the lands updated for revenue sharing purposes. The Refuge Revenue Sharing payments are usually made during the first quarter of each calendar year. By law the USFWS makes the payments to the unit of local government that levies and collects general purpose real property taxes, which in Texas, is the county government.

Habitat and public use management on newly acquired lands

Lands which are acquired in the future within the expanded refuge boundaries will be managed under the concepts expressed in the Preferred Refuge Management Alternative (Refuge Management Alternative D) in the first part of this Chapter. Also, this management concept is developed in detail in the Comprehensive Conservation Plan (CCP) in Appendix D of this document. This concept's emphasis is on an integrated management approach combining: expanded habitat management and restoration programs; new research and wildlife population monitoring; and, increased efforts to address major threats to ecosystem health. The management activities proposed for specific habitat types in the Preferred Refuge Management Alternative would be implemented in the same or similar habitat types on newly acquired lands. The six priority wildlife-dependent uses, which include hunting, fishing, wildlife observation and photography, and environmental education and interpretation, would be administered on newly acquired lands utilizing facilities and programs similar to those described in the Preferred Refuge Management Alternative D.

I. REFUGE BOUNDARY EXPANSION ALTERNATIVE A (NEPA NO ACTION ALTERNATIVE) – NO EXPANSION, CURRENT STATUS

Alternative A Concept with Map

Alternative Focus

This Alternative assumes no change from the existing refuge boundaries within the Refuge Complex. This is the “No Action” alternative as required under NEPA and is considered the base from which to compare the other Refuge Boundary Expansion alternatives. There would be no expansion of any of the four refuge boundaries within the Refuge Complex. The acreage figures for the current approved boundaries of the four refuges are as follows: [acreage figures are approximate]

Current Approved Refuge Boundaries

Moody NWR	3,516 acres
Anahuac NWR	34,339 acres
McFaddin NWR	70,710 acres
Texas Point NWR	8,952 acres

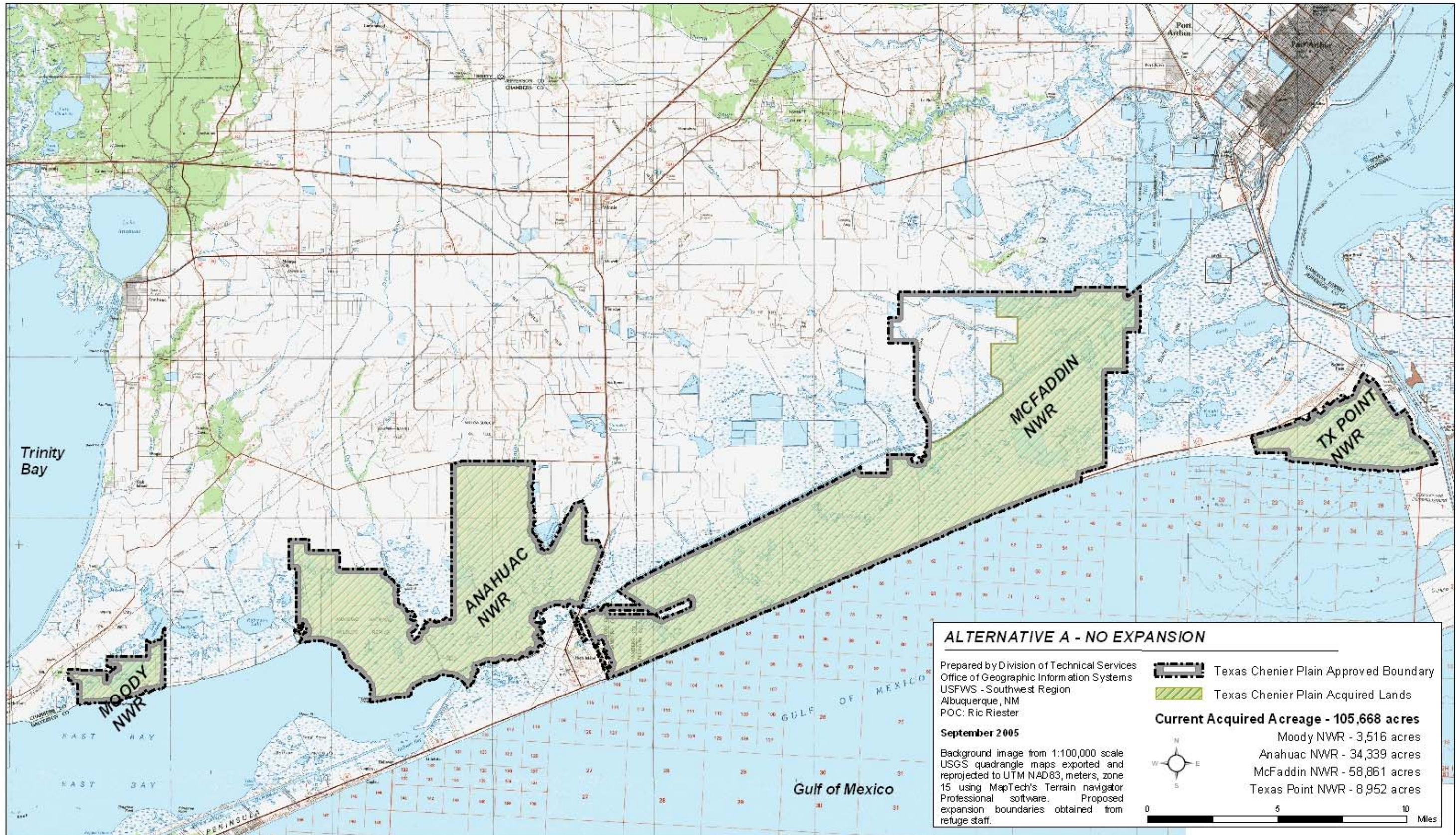
There would be no land acquisition outside of these already existing boundaries. Most, but not all, of the lands within the current approved boundaries for the four refuges has already been acquired. However, acquisition, on a willing seller only basis, of the remaining lands within the current approved refuge boundaries would continue. The land acquisition status within current boundaries for each refuge is as follows:

- Moody NWR: A conservation easement on all lands within the approved boundary has already been acquired.
- Anahuac NWR: All lands within the approved boundary have already been acquired.
- McFaddin NWR: All lands within the approved boundary have already been acquired, except for one major ownership. That ownership, locally known as the Sabine Ranch, is approximately 11,850 acres and was included in the original refuge boundary established in 1977. The USFWS has been unable to purchase this property since the Refuge was established in 1977.
- Texas Point NWR: All lands within the approved boundary have already been acquired.

Summary of Current Land Acquisition Status

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

See map of existing refuge boundaries on the following page.



Rationale for Alternative

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as avian Species of Conservation Concern. Coastal prairie and coastal woodlots support over 150 migratory and resident landbird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005).

Wetland habitats, including coastal marsh and prairie wetlands, on acquired lands within the current approved boundaries would be managed to benefit waterfowl, shorebirds, wading birds and other wetland-dependent migratory birds using prescribed burning, grazing, water level and salinity management, rice farming, moist soil management, mowing, and haying. Restoration and protection of native habitats including wetlands, prairie, and woodlands would continue as planned on acquired lands within existing boundaries. The Refuge Complex biological program involving systematic field surveys to monitor population status and trends of various species and habitats would continue on Refuge Complex lands. Planned efforts to address threats to ecosystem health posed by coastal land loss, hydrological alterations, exotic species and contaminants would continue on Refuge Complex lands. The Refuge Complex would continue to provide opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation through the use of existing programs and facilities. Refuge Complex staff would continue to provide technical assistance to private landowners wishing to enhance wetland and upland habitats on private lands for waterfowl and other wildlife.

Land Acquisition History for Moody National Wildlife Refuge, 1961-Present

<u>Unit or Tract</u>	<u>Date</u>	<u>Acres</u>
Original Refuge, fee donation	1961	714
Exchange, Conservation Easement	1982	<u>3516</u>
	Total Acres	3516

Land Acquisition History for Anahuac National Wildlife Refuge, 1963 – Present

<u>Unit or Tract</u>	<u>Date</u>	<u>Acres*</u>
Original Refuge	1963	9835.48
Easement Road (Easement)	unknown	63.09
Mitigation Area	1978	185.474
Pace Tract	1979	1508.864
Barrow Ranch (East Unit)	1985	12779.50
Roberts Mueller	1989	3069.80
Galveston County Donation	1989	167.10
Jackson Granberry	1990	575.60
Barrow SW (East Bay Bayou)	1991	315.06
Alice Jackson White	1994	2017.82
Middleton Marsh Tract	1996	3718.57
Cade Estate	2005	<u>43.00</u>
	Total Acres	34279.358

Land Acquisition History for McFaddin National Wildlife Refuge, 1980 – Present

<u>Unit or Tract</u>	<u>Date</u>	<u>Acres*</u>
Original refuge	1980	1,682.382
Sea Rim Professionals Easement	1980	881.894
Cordts Easement	1980	420.00
White Fee Tract	1995	4,960.07
White Easement	1995	6,475.23
Middleton Tract	1996	1,293.00
Way Tract	1996	491.37
Cade Estate	2005	<u>2681.059</u>
	Total Acres	58,885.639

Land Acquisition History for Texas Point National Wildlife Refuge, 1979-Present

<u>Unit or Tract</u>	<u>Date</u>	<u>Acres</u>
Original refuge	1979	<u>8952</u>
	Total Acres	8952

*Recited acreage figures from property descriptions in deeds varies from acreage figures used else where.

II. REFUGE BOUNDARY EXPANSION ALTERNATIVE B - 33,590 ACRE EXPANSION

Alternative Concept with Map

Alternative Focus

This Alternative continues the four refuges' historic focus on land acquisition primarily in the coastal marsh and the adjacent agricultural uplands. Acquisition would continue to focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. This Refuge Boundary Expansion Alternative concentrates on high-value wintering waterfowl habitats near the coast that are contiguous to existing refuges. This focus supports the goal of the Gulf Coast Joint Venture: Chenier Plain Initiative which is stated as follows: "The goal of the Chenier Plain Initiative is to provide wintering and migration habitat for significant numbers of dabbling ducks, diving ducks, and geese (especially lesser snow and greater white-fronted), as well as year-round habitat for Mottled Ducks." Priority is given to those wetland areas which have long been identified as high-priority areas for acquisition in USFWS documents such as the "Wetland Preservation Program, Category 8 – Texas Gulf Coast" and the "Emergency Wetlands Resources Act, Region 2 Wetlands, Regional Concept Plan".

In addition to these high biological value wetland habitats, this Alternative also includes areas identified by refuge management as necessary for the following reasons:

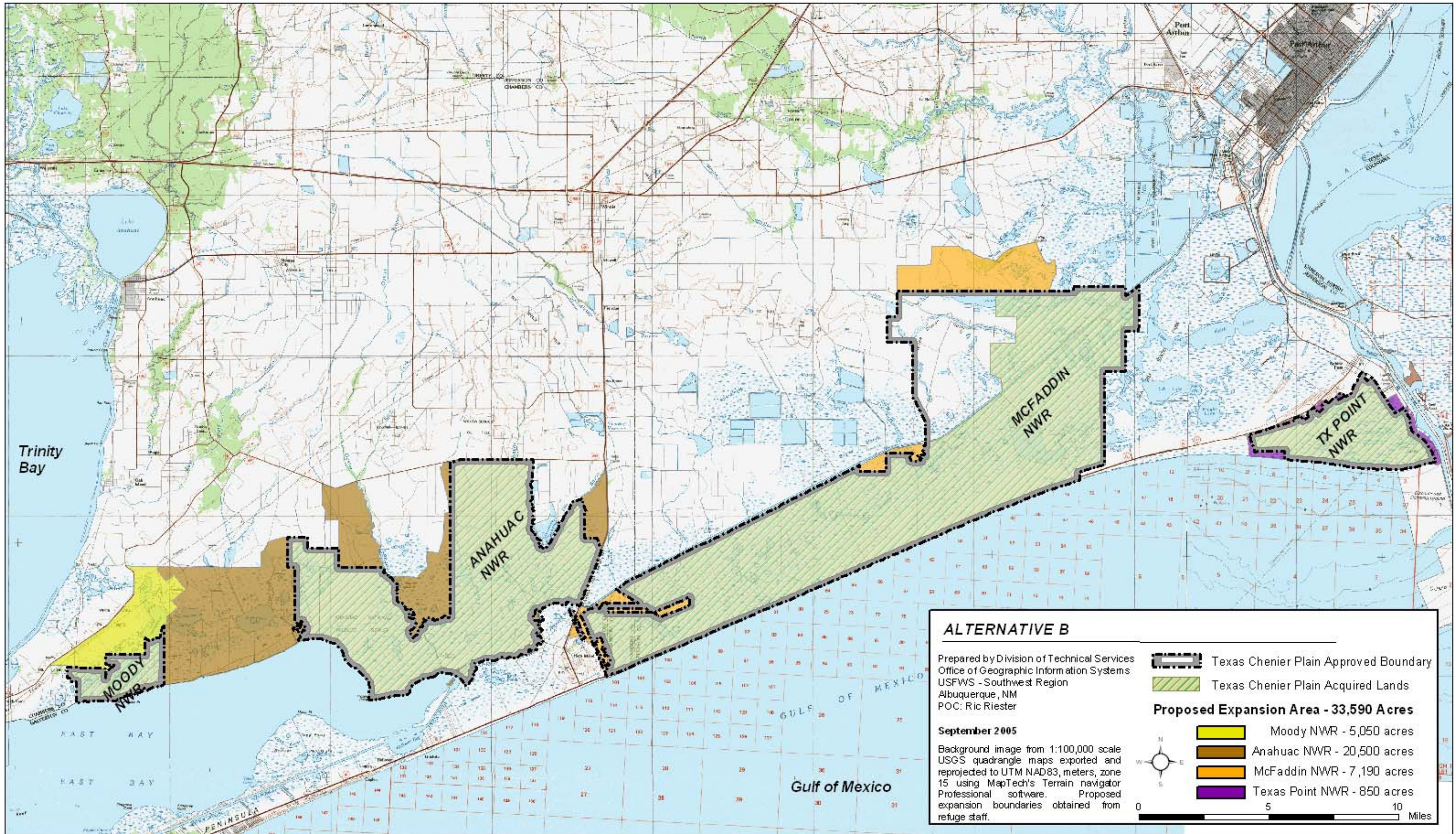
- lands that "fill in the gaps" in earlier single-ownership based expansions and complete logical biological/geographical boundaries,
- lands hydrologically linked to adjoining already-acquired refuge lands, lands whose acquisition would contribute to more effective management of the already acquired lands.

Expansion of the existing acquisition boundary is proposed for each of the four refuges in the Refuge Complex as follows:

<u>Refuge</u>	<u>Size of Boundary Expansion</u>
Moody NWR	5,050 acres*
Anahuac NWR	20,500 acres*
McFaddin NWR	7,190 acres*
Texas Point NWR	850 acres*

** All acreage figures are approximate*

The 33,590 acre expansion proposal for the entire Refuge Complex is depicted on the following page.



Rationale for Alternative

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America, including three species identified by the USFWS as Gamebirds Below Desired Condition (Northern Pintail, Lesser Scaup and Ring-necked Duck). These wetland habitats also provide year-round habitat for Mottled Ducks, an important resident waterfowl species. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as Avian Species of Conservation Concern and species listed as priorities for conservation action under the U.S. Shorebird Conservation Plan and the North American Waterbird Conservation Plan. Coastal prairie and coastal woodlots support over 150 migratory and resident landbird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005)

The “Wetland Preservation Program, Category 8 – Texas Gulf Coast” was a joint effort between Federal, State, and private participants to identify high-value wintering waterfowl habitat along the Texas coast that required little or no additional development. The USFWS had ranked the Texas Gulf Coast as Number 8 out of 33 categories on a national priority scale based on its importance to the Nation’s waterfowl resource. Further, the USFWS had ranked the Texas Gulf Coast Number 4 as a national “Important Resource Problem (IRP) area. In early 1977, a group of conservationists representing Ducks Unlimited, sportsmen, businessmen, Texas General Land Office, Texas Parks and Wildlife Department, and the USFWS delineated 25 key areas of habitat along the Texas Gulf coast having high value to the waterfowl resource. These 25 areas were ranked by a team of Texas Parks and Wildlife Department, Texas General Land Office, and USFWS personnel; and, acquisition of the private lands was recommended for the top 20 areas as being necessary for habitat preservation. This plan and report was “updated” in August of 1981. Within the Chenier Plain region of the upper Texas Gulf coast, the “Category 8 Plan” identified the following five high-value wintering waterfowl habitats: (#1) Oyster Bayou Marsh, (#4) Lake Surprise area, (#5) McFaddin Marsh, (#7) Sea Rim Marsh, and (#10) Robinson Bayou Marsh. (The numbers indicate that area’s “Preservation Effort Priority” ranking). All or parts of each of these five high-value wintering waterfowl habitats are included in this Refuge Boundary Expansion Alternative.

The Emergency Wetlands Resources Act of 1986 (Public Law 99-645) was enacted by the United States Congress to: “Promote the conservation of migratory waterfowl and to offset or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitat, and for other purposes”. In compliance with this Act, the USFWS has prepared the National Wetlands Priority Conservation Plan. The National Plan provides the framework, criteria, and guidance for identifying wetlands warranting priority attention for Federal and State acquisition. Its primary purpose is to help decision-makers focus their acquisition efforts on the more important, scarce, and vulnerable wetlands in the Nation. The National Plan requires each of the seven USFWS Regions to prepare Regional Wetlands Concept Plans that address the wetlands of each State within each Region.

The USFWS’ Region 2 encompasses the States of Arizona, New Mexico, Oklahoma and Texas. In 1990, Region 2 published its Regional Wetlands Concept Plan addressing the wetland issues of each State separately. The Regional Wetlands Concept Plan steps down the National Plan to the local, site-specific level and discusses the wetland functions, values, threats and other issues on a state by state basis. The Regional Plan contains a list of priority wetlands sites that have been evaluated through the wetlands assessment threshold criteria of the National Wetlands Priority Conservation Plan and qualify for acquisition under the Emergency Wetlands Resources Act. The wetlands in Texas were broadly grouped into six categories: 1) Gulf coast salt and freshwater marshes; 2) bottomland hardwood forests in the river

valleys of East Texas; 3) playa lakes of the Panhandle region; 4) freshwater springs and their headwater streams of Central and Southwest Texas; 5) West Texas riparian areas; and 6) coastal pothole wetlands of South Texas. Each group is addressed in terms of the following three criteria used for prioritization: 1) Wetland Loss, 2) Wetland Threats, and 3) Wetland Functions and Values. Within the Chenier Plain region of the upper Texas Gulf coast, the Regional Plan identified the following four areas as “Texas Priority Wetlands for Acquisition Consideration”: 1) Middleton Marsh, 2) Horseshoe Marsh, 3) Lower Marsh, and 4) Robinson Bayou Marsh. Each of these four wetland sites meets all threshold criteria and qualifies for acquisition consideration under provisions of the National Wetlands Conservation Plan. Two of these wetlands sites, Middleton and Robinson Bayou Marshes, are included in this expansion alternative.

The Emergency Wetlands Resources Act of 1986 also requires the USFWS to conduct wetland status and trend studies of the Nation’s wetlands at 10-year intervals and report the results to Congress. The latest report, published in December of 2000, is entitled; Status and Trends of Wetlands in the Conterminous United States 1986 to 1997. It reports that 98% of all losses recorded during its study were to freshwater wetlands. Freshwater emergent marshes and freshwater forested wetlands each lost an estimated 1,200,000 acres between 1986 and 1997. The net loss of all freshwater wetland types was 633,500 acres because the numeric losses of freshwater wetlands were partially offset by gains in freshwater shrub wetlands (1.1 million acres) and freshwater ponds (631 thousand acres). The long-term trends in freshwater wetlands since the 1950s, show that freshwater emergent wetlands have declined by the greatest percentage of all wetland types with nearly 24% lost (8 million acres) while freshwater forested wetlands have sustained the greatest overall loss in area (10.4 million acres).

The USFWS, in cooperation with the Texas Parks and Wildlife Department and the Texas General Land Office, reported on the status and trends of coastal Texas wetlands in accordance with the Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (Title III of Public Law 101-646). Their report, entitled Texas Coastal Wetlands, Status and Trends, Mid-1950s to Early 1990s, published in 1997, analyzed data from a 12.8 million acre coastal Texas study area. Aerial photographs from the mid-1950s and early 1990s were analyzed to detect changes in wetlands, deepwater habitats, and uplands acreage. Palustrine (freshwater) emergent wetlands (fresh marsh, wet prairie, etc.) declined by about 29 percent, with an estimated net loss of 235,100 acres. This was the largest acreage change for any wetland category studied. Most of the palustrine emergent loss was to upland agriculture and other upland land uses (i.e. development).

The USFWS defined the various wetland types in Classification of Wetlands and Deepwater Habitats of the United States (FWS/OBS-79/31, December, 1979). Further, the USFWS classified seven of these wetland types as “decreasing” in its Land Acquisition Priority System (LAPS). The “decreasing” wetland types are; 1) Palustrine Emergent, 2) Palustrine Forested, 3) Palustrine Scrub-Shrub, 4) Estuarine Intertidal Emergent, 5) Estuarine Intertidal Forested, 6) Estuarine Intertidal Scrub-Shrub, and 7) Marine Intertidal. Using National Wetlands Inventory data available at <http://nwi.fws.gov>, the USFWS’ Region 2 GIS Coordinator mapped the proposed acquisition areas identifying the wetland areas and the areas of aggregated decreasing wetland types (see Map # in Chapter 3, Affected Environment). Using the seven aggregated decreasing wetland types, he developed summary tables which compare decreasing wetland

types to non-decreasing wetland types and wetlands to uplands. A summary table is presented for each Alternative as a whole and a summary table is presented for each refuge’s separate boundary expansion.

	Acres	Percentage of Boundary Expansion
Refuge Boundary Expansion		
Alternative B	33,590	100%
Habitat Type (Upland or Wetland) of Alternative B Expansion		
Uplands	5,770	17%
Wetlands	27,820	83%
Declining Wetland Types	24,480	
Non-declining Wetland Types	3,340	

INDIVIDUAL REFUGE BOUNDARY EXPANSIONS FOR REFUGE BOUNDARY ALTERNATIVE B

Expansion of Moody NWR Boundary – 5,050 Acres

	Acres	Percent of Expansion
Moody NWR Boundary Expansion	5,050	100%
Total Uplands	1,760	35%
Total Wetlands	3,290	65%
Declining Wetland Types	2,590	
Non-declining Wetland Types	700	

The expansion area includes the areas immediately north of the current refuge boundary up to FM Road 562. The Lake Surprise area was identified in the “Category 8 Plan” as the #4 “Preservation Effort Priority”. The area is predominately marsh, being largely freshwater and intermediate marsh, and includes several lakes with Lake Stephenson being the largest. FM Road

562 runs along a low ridge between the 5 and 10 foot contours and separates the drainage between Trinity Bay and East Bay. The low ridge consists of coastal prairie with many pothole wetlands and ‘mima’ mounds. Mima mounds are a historic topographic feature in the region’s coastal prairies which provide the topographic and hydrological variability believed responsible for much of the floristic diversity found in high quality coastal prairies (Grace *et al.* 2000).

Expansion of Anahuac NWR Boundary – 20,500 Acres

	Acres	Percent of Expansion
Anahuac NWR Boundary Expansion	20,500	100%
Total Uplands	3,110	15%
Total Wetlands	17,390	85%
Declining Wetland Types	15,140	
Non-declining Wetland Types	2,250	

The expansion area consists primarily of three coastal marsh areas: Robinson Bayou Marsh, Oyster Bayou Marsh, and Middleton Marsh. All three of these marsh areas are high-value wintering waterfowl habitats and have been identified as high-priority acquisition areas in USFWS documents: The “Category 8 Plan” ranked Oyster Bayou Marsh as #1 and Robinson Bayou

Marsh as #10 in “Preservation Effort Priority”. The Regional Wetlands Concept Plan identified both Middleton Marsh and Robinson Bayou Marsh as “Texas Priority Wetlands for Acquisition Consideration”. All three of these marshes are high-value, largely intermediate marshes having some freshwater marsh components. The Robinson Bayou Marsh area, which is the largest area in the expansion, extends from the current western boundary of Anahuac NWR all the way along East Bay to the boundary of Moody NWR. This is the largest remaining coastal marsh along East Bay. The Oyster Bayou Marsh area consists of the lower marsh east of Oyster Bayou which is surrounded virtually on three sides by the current Anahuac NWR. The Middleton Marsh area consists of the rest of the upper marsh between Elm Bayou and State Highway 124.

The balance of the expansion is a small area west of Oyster Bayou from FM Road 1985 south to the existing refuge boundary. This area includes the main entrance road to Anahuac NWR used by both visitors and staff. This area consists of primarily of coastal prairie, much of which has been converted to agricultural uses, and includes some fresh marsh and riparian woodlands. Acquisition of this area would facilitate improved management of the main refuge entrance and provide opportunities to improve and expand recreational uses including hunting, wildlife observation and photography.

Expansion of McFaddin NWR Boundary - 7,190 Acres

	Acres	Percent of Expansion
McFaddin NWR Boundary Expansion	7,190	100%
Total Uplands	770	11%
Total Wetlands	6,420	89%
Declining Wetland Types	6,140	
Non-declining Wetland Types	280	

The expansion area consists of almost all coastal marsh which is included under two different rationales. First, there are two areas which are gaps in the refuge boundary from earlier single-ownership based expansions. One area consists of a number of separated tracts in the marsh just to the east of High Island. The other area is two separate marsh tracts on

the south side of the GIWW in the vicinity of Star Lake. Both areas would be considered part of McFaddin Marsh which was identified in the "Category 8 Plan" as the #5 "Preservation Effort Priority". Second, there is the northern part of Willow Slough marsh immediately adjacent to the current refuge boundary. This area is a very high quality freshwater marsh which is hydrologically linked to the rest of Willow Slough within our existing boundary. The entire Willow Slough marsh area would be best managed for wildlife habitat as a single unit.

Expansion of Texas Point NWR Boundary - 850 Acres

	Acres	Percent of Expansion
Texas Point NWR Boundary Expansion	850	100%
Total Uplands	130	15%
Total Wetlands	720	85%
Declining Wetland Types	610	
Non-declining Wetland Types	110	

The expansion area consists of a number of small tracts immediately adjacent to the current refuge boundary. These tracts are coastal marsh, small coastal woodlots, or a combination of the two. All of these tracts would fall within the Sea Rim Marsh which was identified in the "Category 8 Plan" as the #7 "Preservation Effort Priority".

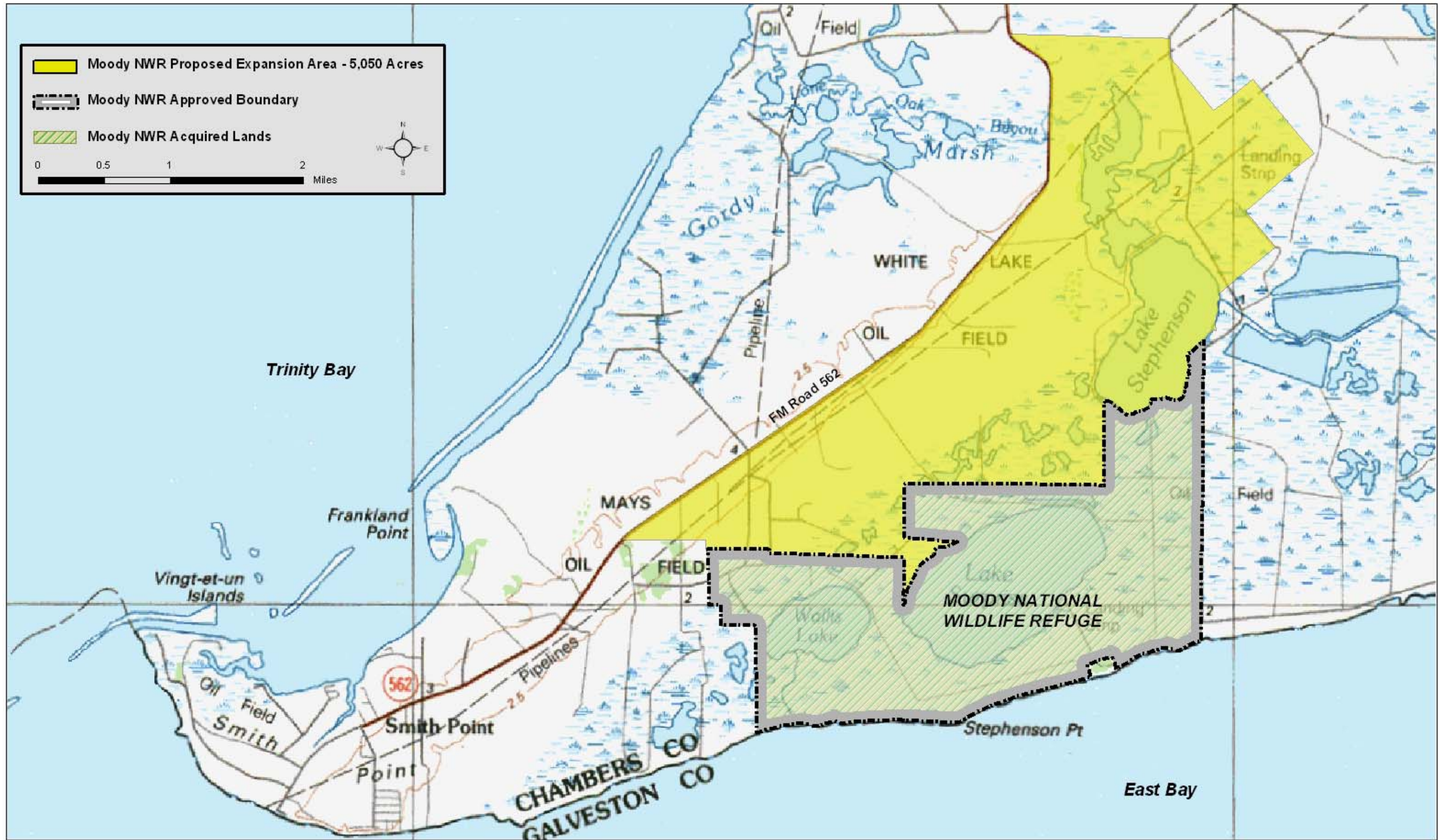
Acquisition of these tracts would provide the refuge with a much more manageable boundary and provide more much needed visitor access.

Maps for Individual Boundary Expansions for Refuge Boundary Alternative B

Maps depicting the individual boundary expansions for Alternative B for Moody, Anahuac, McFaddin and Texas Point NWRs are on the following pages.

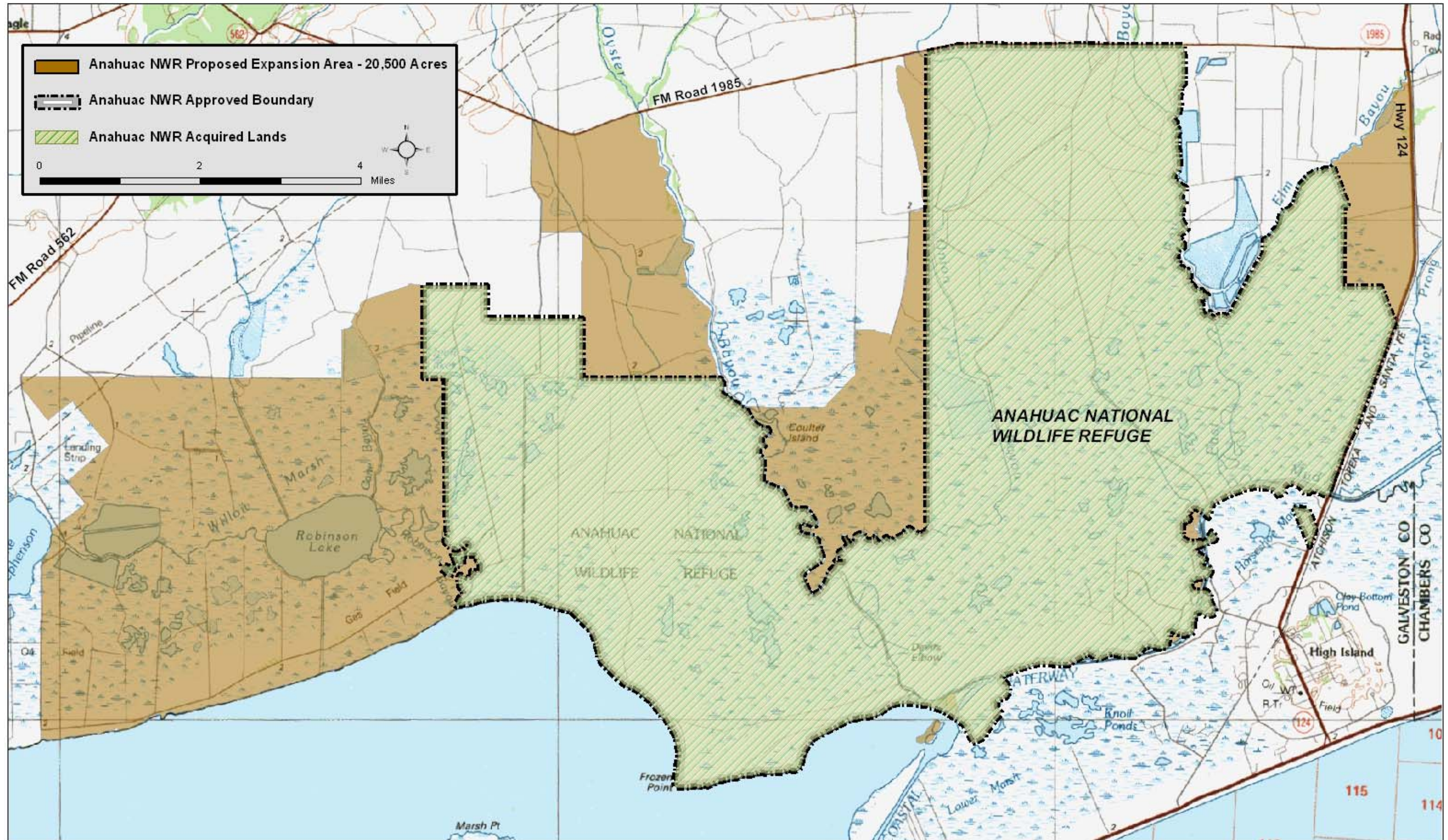


Moody National Wildlife Refuge Proposed Expansion - Alternative B



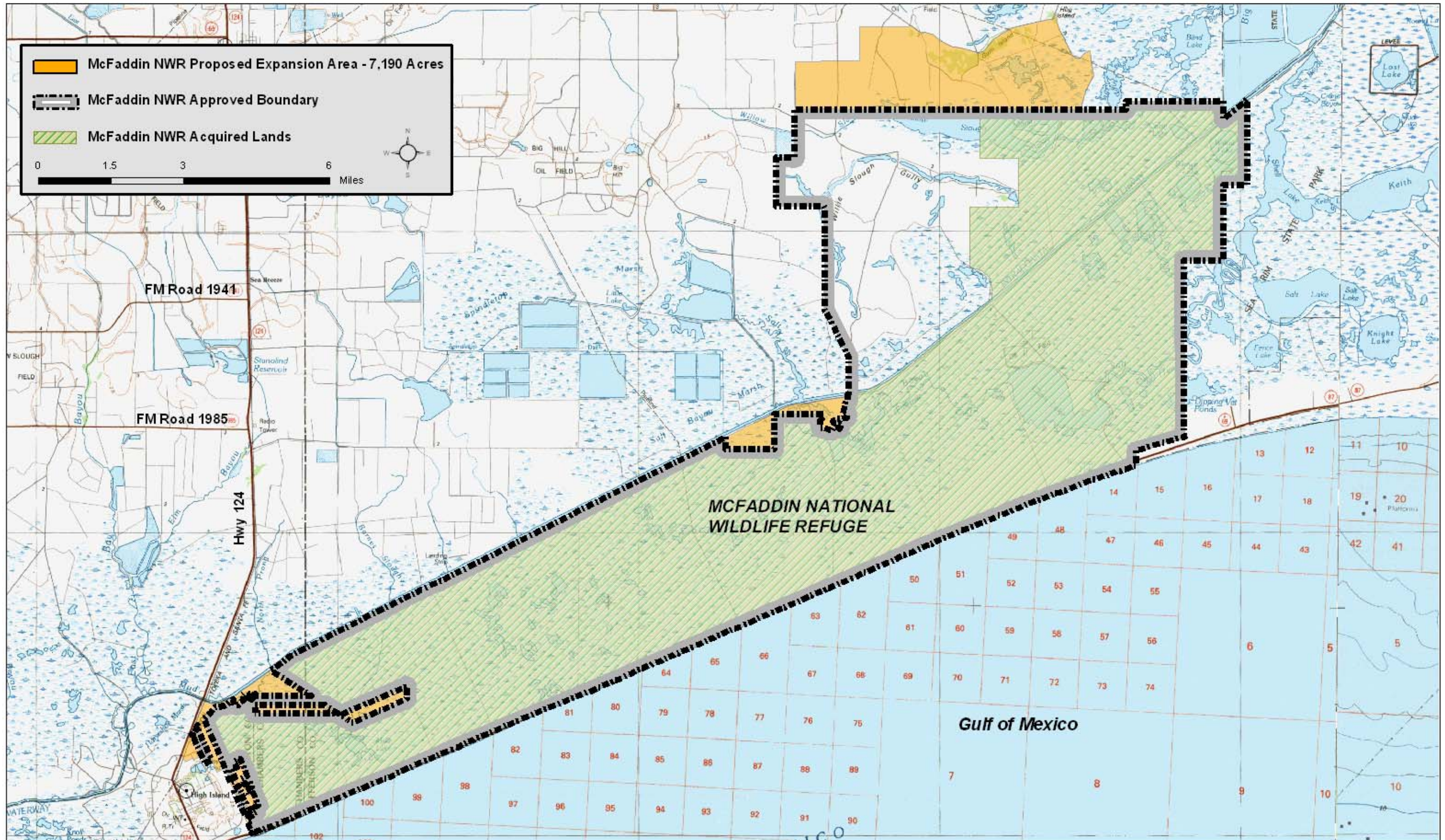


Anahuac National Wildlife Refuge Expansion - Alternative B



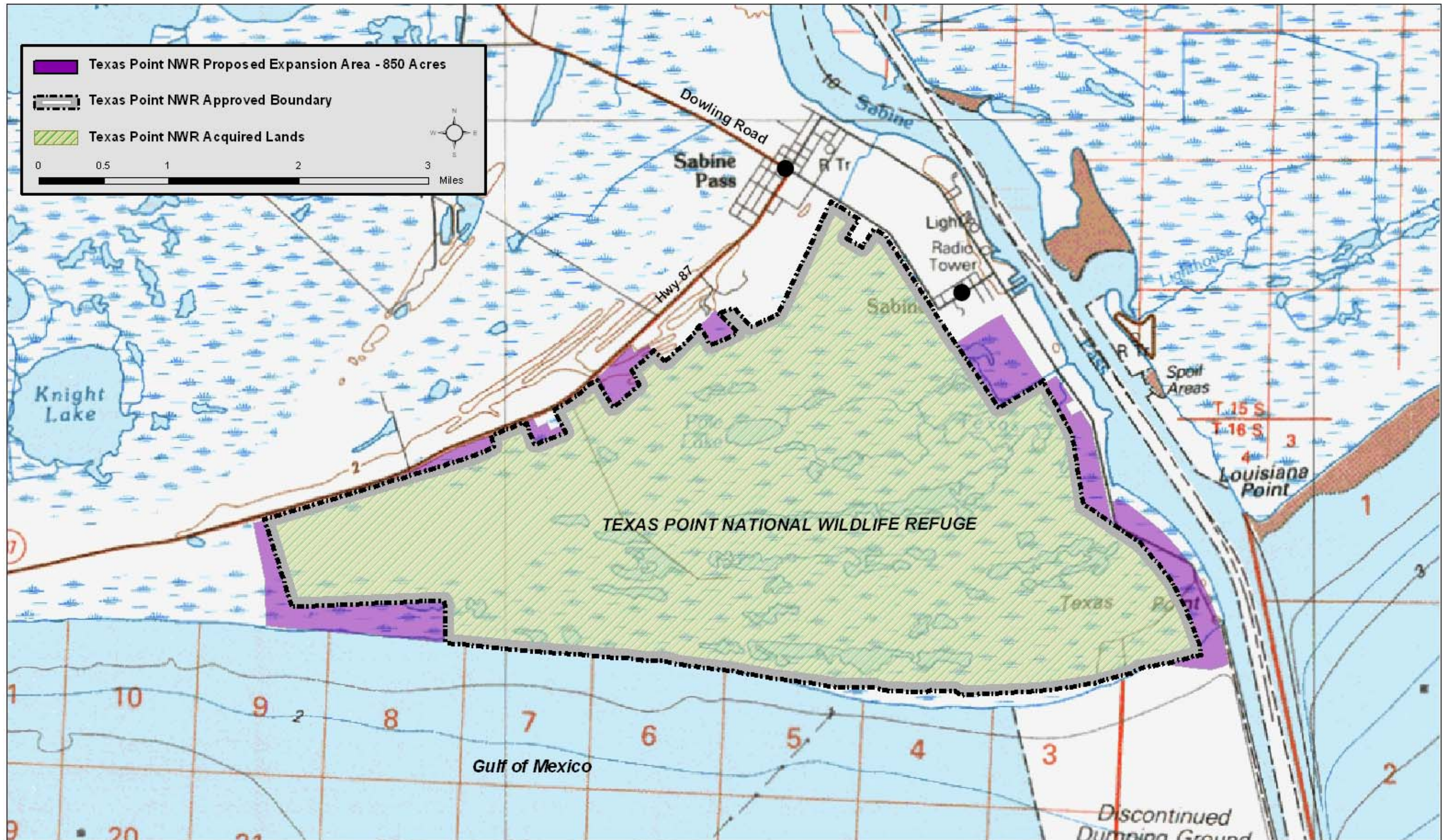


McFaddin National Wildlife Refuge Expansion - Alternative B





Texas Point National Wildlife Refuge Expansion - Alternative B



III. REFUGE BOUNDARY EXPANSION ALTERNATIVE C (PREFERRED ALTERNATIVE) – 64,260 ACRE EXPANSION

Alternative Concept with Map

Alternative Focus

Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative B. Similar to Alternative B, this Alternative continues the four refuge’s historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland dependent migratory birds. The wetlands portions of this expansion alternative concentrate on high-value wintering waterfowl habitats near the coast which are contiguous to existing refuges. This focus supports the goal of the Gulf Coast Joint Venture: Chenier Plain Initiative which is stated as follows: “The goal of the Chenier Plain Initiative is to provide wintering and migration habitat for significant numbers of dabbling ducks, diving ducks, and geese (especially lesser snow and greater white-fronted), as well as year-round habitat for Mottled Ducks.” Priority is given to those wetland areas which have long been identified as high-priority areas for acquisition in USFWS documents such as the “Wetland Preservation Program, Category 8 – Texas Gulf Coast” and the “Emergency Wetlands Resources Act, Region 2 Wetlands, Regional Concept Plan”.

In addition to these primarily wetland areas, this alternative includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. The primary habitat type for these areas is non-saline prairie, of which a significant component is prairie/grassland which is a unique community type within the Texas Chenier Plain region. One of these areas, “Middleton Prairie”, is probably the largest remnant native coastal tallgrass prairie remaining on the Upper Texas Coast.

Besides the two above-described types of high biological value habitats, this Alternative again contains those areas included in Refuge Boundary Expansion Alternative B which were identified by refuge management as necessary for the following reasons:

- lands that “fill in the gaps” in earlier single-ownership based expansions and complete logical biological/geographical boundaries
- lands hydrologically linked to adjoining already-acquired refuge lands
- lands whose acquisition would contribute to more effective management of the already acquired lands.

Expansion of the existing acquisition boundary is proposed for each of the four refuges in the Refuge Complex as follows:

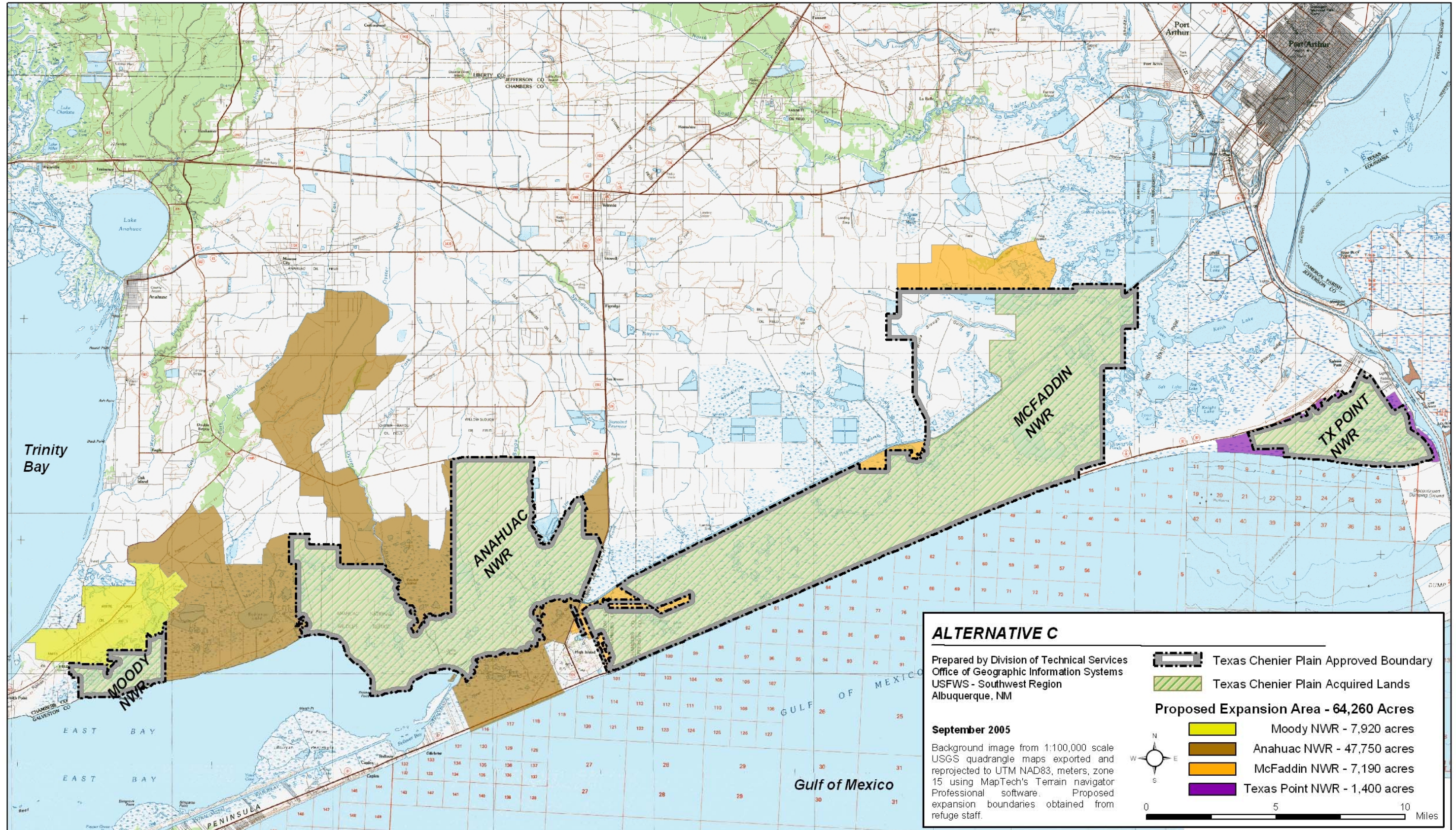
<u>Refuge</u>	<u>Size of Boundary Expansion</u>
Moody NWR	7,920 acres*
Anahuac NWR	47,750 acres*
McFaddin NWR	7,190 acres*
Texas Point NWR	1,400 acres*

** All acreage figures are approximate*

The 64,260 acre expansion proposal for the entire Refuge Complex is depicted on the following page.



Texas Chenier Plain Refuge Complex & Proposed Expansion Areas



Rationale for Alternative

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America, including three species identified by the USFWS as Gamebirds Below Desired Condition (Northern Pintail, Lesser Scaup and Ring-necked Duck). These wetland habitats also provide year-round habitat for Mottled Ducks, an important resident waterfowl species. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as Avian Species of Conservation Concern and species listed as priorities for conservation action under the U.S. Shorebird Conservation Plan and the North American Waterbird Conservation Plan. Coastal prairie and coastal woodlots support over 150 migratory and resident landbird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005).

The “Wetland Preservation Program, Category 8 – Texas Gulf Coast” was a joint effort between Federal, State, and private participants to identify high-value wintering waterfowl habitat along the Texas coast that required little or no additional development. The USFWS had ranked the Texas Gulf Coast as Number 8 out of 33 categories on a national priority scale based on its importance to the Nation’s waterfowl resource. Further, the USFWS had ranked the Texas Gulf Coast Number 4 as a national “Important Resource Problem (IRP) area. In early 1977, a group of conservationists representing Ducks Unlimited, sportsmen, businessmen, Texas General Land Office, Texas Parks and Wildlife Department, and the USFWS delineated 25 key areas of habitat along the Texas Gulf Coast having high value to the waterfowl resource. These 25 areas were ranked by a team of Texas Parks and Wildlife Department, Texas General Land Office, and USFWS personnel; and, acquisition of the private lands was recommended for the top 20 areas as being necessary for habitat preservation. This plan and report was “updated” in August of 1981. Within the Chenier Plain region of the upper Texas Gulf Coast, the “Category 8 Plan” identified the following five high-value wintering waterfowl habitats: (#1) Oyster Bayou Marsh, (#4) Lake Surprise area, (#5) McFaddin Marsh, (#7) Sea Rim Marsh, and (#10) Robinson Bayou Marsh. (The numbers indicate that area’s “Preservation Effort Priority” ranking). All of these five high-value wintering waterfowl habitats are included in this expansion alternative.

The Emergency Wetlands Resources Act of 1986 (Public Law 99-645) was enacted by the United States Congress to: “Promote the conservation of migratory waterfowl and to offset or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitat, and for other purposes”. In compliance with this Act, the USFWS has prepared the National Wetlands Priority Conservation Plan. The National Plan provides the framework, criteria, and guidance for identifying wetlands warranting priority attention for Federal and State acquisition. Its primary purpose is to help decision-makers focus their acquisition efforts on the more important, scarce, and vulnerable wetlands in the Nation. The National Plan requires each of the seven USFWS Regions to prepare Regional Wetlands Concept Plans that address the wetlands of each State within each Region.

The USFWS’ Region 2 encompasses the States of Arizona, New Mexico, Oklahoma and Texas. In 1990, Region 2 published its Regional Wetlands Concept Plan addressing the wetland issues of each State separately. The Regional Wetlands Concept Plan steps down the National Plan to the local, site-specific level and discusses the wetland functions, values, threats and other issues on a state by state basis. The Regional Plan contains a list of priority wetlands sites that have been evaluated through the wetlands assessment threshold criteria of the National Wetlands Priority Conservation Plan and qualify for acquisition under the Emergency Wetlands Resources Act. The wetlands in Texas were broadly grouped into six categories: 1) Gulf coast salt and freshwater marshes; 2) bottomland hardwood forests in the river

valleys of East Texas; 3) playa lakes of the Panhandle region; 4) freshwater springs and their headwater streams of Central and Southwest Texas; 5) West Texas riparian areas; and 6) coastal pothole wetlands of South Texas. Each group is addressed in terms of the following three criteria used for prioritization: 1) Wetland Loss, 2) Wetland Threats, and 3) Wetland Functions and Values. Within the Chenier Plain region of the upper Texas Gulf coast, the Regional Plan identified the following four areas as “Texas Priority Wetlands for Acquisition Consideration”: 1) Middleton Marsh, 2) Horseshoe Marsh, 3) Lower Marsh, and 4) Robinson Bayou Marsh. Each of these four wetland sites meets all threshold criteria and qualifies for acquisition consideration under provisions of the National Wetlands Conservation Plan. All four of these wetlands sites are included in this expansion alternative.

The Emergency Wetlands Resources Act of 1986 also requires the USFWS to conduct wetland status and trend studies of the Nation’s wetlands at 10-year intervals and report the results to Congress. The latest report, published in December of 2000, is entitled; Status and Trends of Wetlands in the Conterminous United States 1986 to 1997. It reports that 98% of all losses recorded during its study were to freshwater wetlands. Freshwater emergent marshes and freshwater forested wetlands each lost an estimated 1,200,000 acres between 1986 and 1997. The net loss of all freshwater wetland types was 633,500 acres because the numeric losses of freshwater wetlands were partially offset by gains in freshwater shrub wetlands (1.1 million acres) and freshwater ponds (631 thousand acres). The long-term trends in freshwater wetlands since the 1950s, show that freshwater emergent wetlands have declined by the greatest percentage of all wetland types with nearly 24% lost (8 million acres) while freshwater forested wetlands have sustained the greatest overall loss in area (10.4 million acres).

The USFWS, in cooperation with the Texas Parks and Wildlife Department and the Texas General Land Office, reported on the status and trends of coastal Texas wetlands in accordance with the Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (Title III of Public Law 101-646). Their report, published in 1997, analyzed data from a 12.8 million acre coastal Texas study area. Aerial photographs from the mid-1950s and early 1990s were analyzed to detect changes in wetlands, deepwater habitats, and uplands acreage. Palustrine (freshwater) emergent wetlands (fresh marsh, wet prairie, etc.) declined by about 29 percent, with an estimated net loss of 235,100 acres. This was the largest acreage change for any wetland category studied. Most of the palustrine emergent loss was to upland agriculture and other upland land uses (i.e. development).

The USFWS defined the various wetland types in Classification of Wetlands and Deepwater Habitats of the United States (FWS/OBS-79/31, December, 1979). Further, the USFWS classified seven of these wetland types as “decreasing” in its Land Acquisition Priority System (LAPS). The “decreasing” wetland types are; 1) Palustrine Emergent, 2) Palustrine Forested, 3) Palustrine Scrub-Shrub, 4) Estuarine Intertidal Emergent, 5) Estuarine Intertidal Forested, 6) Estuarine Intertidal Scrub-Shrub, and 7) Marine Intertidal. Using National Wetlands Inventory data available at <http://nwi.fws.gov>, the USFWS’ Region 2 GIS Coordinator mapped the proposed acquisition areas identifying the wetland areas and the areas of aggregated decreasing wetland types (see map in Chapter 3, Affected Environment). Using the seven aggregated decreasing wetland types, he developed summary tables which compare decreasing wetland types to non-decreasing wetland types and wetlands to uplands. A summary table is presented for each Alternative as a whole and a summary table is presented for each refuge’s separate boundary expansion.

	Acres	Percentage of Boundary Expansion
Boundary Expansion		
Alternative C	64,260	100%
Habitat Type (Upland or Wetland) of Alternative B Expansion		
Uplands	21,360	33%
Wetlands	42,900	67%
Declining Wetland Types	38,520	
Non-declining Wetland Types	4,380	

Over 9 million acres of native tallgrass prairie once occurred along the western Gulf Coast in Texas and Louisiana (Smeins *et al.* 1991). Based on remnant stands of native grasslands, prairies on the upper Texas coast were

characterized by little bluestem, brownseed paspalum, and Indiangrass or eastern gammagrass and switchgrass associations, depending on hydrology (Diamond and Smeins 1984). It is now estimated that 99.8% and 99.6% of little bluestem prairies and eastern gamma grass/switchgrass prairies, respectively, have been lost in Texas (McFarland 1995). The little bluestem-brownseed paspalum community has been identified as a “threatened natural community” and the eastern gammagrass-switchgrass community has been identified as an “endangered natural community” by the Texas Organization for Endangered Species (Diamond *et al.* 1992). The Texas Organization for Endangered Species (TOES) defines “threatened natural community” as any series-level natural community vulnerable to extirpation in Texas, with six to twenty occurrences in Texas and 100 or fewer occurrences globally. TOES defines “endangered natural community” as any series-level natural community in immediate danger of extirpation in Texas, with five or fewer known occurrences in Texas and 100 or fewer occurrences globally. Both communities are assigned a Global conservation status rank of “Critically Imperiled” (G1) by The Nature Conservancy (2002).

Many animal species typical of northern prairies, such as Henslow’s Sparrows, smooth green snakes, and prairie voles, were all found year-round in the Gulf coastal prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf coastal prairies as wintering and/or migratory habitat. Many of the birds that would benefit from protection and management of native coastal prairie habitats under this Alternative 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, Mottled Duck, White-tailed Hawk, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, and LeConte’s Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats.

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

Statewide in Texas, the coastal prairie has seen the greatest industrial development since World War II (Schmidly 2002). Most of the original coastal prairie has been lost because of direct conversion to other cover types, i.e. improved pasture, cultivated rice and other crops, and industrial, urban or suburban development. Additionally, remaining areas have been altered through a number of factors, primarily changes in fire, herbivory, and hydrology. Native prairies managed as pastures face such threats as homogenized burn regimes, overgrazing, and application of broadleaf herbicides. All these management practices are thought to reduce the floristic diversity that exemplifies coastal prairies (Allain and Johnson 1997). The introduction of non-native plant species has also impacted native coastal prairies on the Gulf Coast, and invasive exotic species such as Chinese tallow pose a significant threat to remnant prairies.

The USFWS’ proposed boundary expansions of the Moody and Anahuac NWRs under this Alternative contain important native coastal prairie habitats. The Nature Conservancy’s Gulf Coast Marshes and Prairies Ecoregional Conservation Plan identified the “Middleton Prairie” and “Robinson-Oyster Bayou” areas in Chambers County as important conservation areas because they contain remnants of both “Critically Imperiled” prairie plant communities (The Nature Conservancy 2002). Both areas contain an historical topographic feature called “mima mounds”. These mounds provide the topographic and hydrological variability believed responsible for much of the floristic diversity found in high quality coastal prairies (Grace *et al.* 2000).

INDIVIDUAL REFUGE BOUNDARY EXPANSIONS FOR REFUGE BOUNDARY EXPANSION ALTERNATIVE C (PREFERRED ALTERNATIVE)

Expansion of Moody NWR Boundary – 7,920 Acres

	Acres	Percent of Expansion
Moody NWR Boundary Expansion	7,920	100%
Total Uplands	3,260	41%
Total Wetlands	4,660	59%
Declining Wetland Types	3,810	
Non-declining Wetland Types	850	

The expansion area includes the areas immediately north of the current refuge boundary up to FM Road 562. The Lake Surprise area was identified in the “Category 8 Plan” as the #4 “Preservation Effort Priority”. The area is predominately marsh, being largely freshwater and intermediate marsh, and includes several lakes with Lake Stephenson being the

largest. FM Road 562 runs along a low ridge between the 5 and 10 foot contours and separates the drainage between Trinity Bay and East Bay. The low ridge consists of coastal prairie with many pothole wetlands and “mima” mounds. Mima mounds are a historic topographic feature in the region’s coastal prairies which provide the topographic and hydrological variability believed responsible for much of the floristic diversity found in high quality coastal prairies (Grace *et al.* 2000). This Alternative also includes an area to the west of FM Road 562 which drains into Trinity Bay. This area contains some coastal marsh but is largely coastal prairie with many pothole wetlands and “mima” mounds.

Expansion of Anahuac NWR Boundary – 47,750 Acres

	Acres	Percent of Expansion
Anahuac NWR Boundary Expansion	47,750	100%
Total Uplands	17,180	36%
Total Wetlands	30,570	64%
Declining Wetland Types	27,460	
Non-declining Wetland Types	3,110	

The wetlands portion of the expansion area consists primarily of five coastal marsh areas: Robinson Bayou Marsh, Oyster Bayou Marsh, Middleton Marsh, Horseshoe Marsh, and Lower Marsh. All five of these marsh areas are high-value wintering waterfowl habitats and have been identified as high-priority acquisition areas in USFWS documents: The “Category 8

Plan” ranked Oyster Bayou Marsh as #1 and Robinson Bayou Marsh as #10 in “Preservation Effort Priority”. The Regional Wetlands Concept Plan identified Middleton Marsh, Robinson Bayou Marsh, Horseshoe Marsh, and Lower Marsh as “Texas Priority Wetlands for Acquisition Consideration”. All five of these marshes are high-value, largely intermediate marshes having some freshwater marsh components. The Robinson Bayou Marsh area, which is the largest wetland area in the expansion, extends from the current western boundary of Anahuac NWR all the way along East Bay to the boundary of Moody NWR. This is the largest remaining coastal marsh along East Bay. The Oyster Bayou Marsh area consists of both the upper and lower marshes east of Oyster Bayou which is surrounded virtually on three sides by the current Anahuac NWR. The Middleton Marsh area consists of the rest of the upper marsh between Elm Bayou and State Highway 124. Horseshoe Marsh is on Bolivar Peninsula immediately north of High Island and west of State Highway 124. Lower Marsh is also on Bolivar Peninsula and is the large undeveloped marsh to the west of High Island. These two tidal influenced marshes are hydrologically separated by the GIWW from the existing Anahuac NWR.

Another portion of the expansion is in the area west of Oyster Bayou from FM Road 1985 south to the existing refuge boundary. This area includes the main entrance road to Anahuac NWR used by both visitors and staff. This area consists of primarily of coastal prairie, much of which has been converted to agricultural uses, and includes some fresh marsh and riparian woodlands. Acquisition of this area would

facilitate improved management of the main refuge entrance and provide opportunities to improve and expand recreational uses including hunting, wildlife observation and photography.

The last portion of the expansion consists of two major coastal prairie components. The largest area is the "Middleton Prairie" which contains a large contiguous block of native tallgrass prairie and some converted agricultural lands between Oyster Bayou and the East Fork of Double Bayou north of FM Road 1985. The other area is the coastal prairie to the northeast of the Robinson Bayou Marsh lying on the east side of FM Road 562. Both of these prairie areas contain small freshwater marshes and a large number of natural prairie "pothole" wetlands.

Expansion of McFaddin NWR Boundary - 7,190 Acres

	Acres	Percent of Expansion
McFaddin NWR Boundary Expansion	7,190	100%
Total Uplands	770	11%
Total Wetlands	6,420	89%
Declining Wetland Types	6,140	
Non-declining Wetland Types	280	

The expansion for McFaddin NWR is the same as proposed in Refuge Boundary Expansion Alternative B. The expansion area consists of almost all coastal marsh which is included under two different rationales. First, there are two areas which are gaps in the refuge boundary from earlier single-ownership based expansions. One area consists of a number of

separated tracts in the marsh just to the east of High Island. The other area is two separate marsh tracts on the south side of the GIWW in the vicinity of Star Lake. Both areas would be considered part of McFaddin Marsh which was identified in the "Category 8 Plan" as the #5 "Preservation Effort Priority". Second, there is the northern part of Willow Slough marsh immediately adjacent to the current refuge boundary. This area is a very high quality freshwater marsh which is hydrologically linked to the rest of Willow Slough within the existing McFaddin NWR boundary.

Expansion of Texas Point NWR Boundary – 1,400 Acres

	Acres	Percent of Expansion
Texas Point NWR Boundary Expansion	1,400	100%
Total Uplands	150	11%
Total Wetlands	1,250	89%
Declining Wetland Types	1,110	
Non-declining Wetland Types	140	

As in Refuge Boundary Expansion Alternative B, much of the expansion area consists of a number of small tracts immediately adjacent to the current refuge boundary. These tracts are coastal marsh, small coastal woodlots, or a combination of the two. Acquisition of these tracts would provide the refuge with a much more manageable boundary and provide

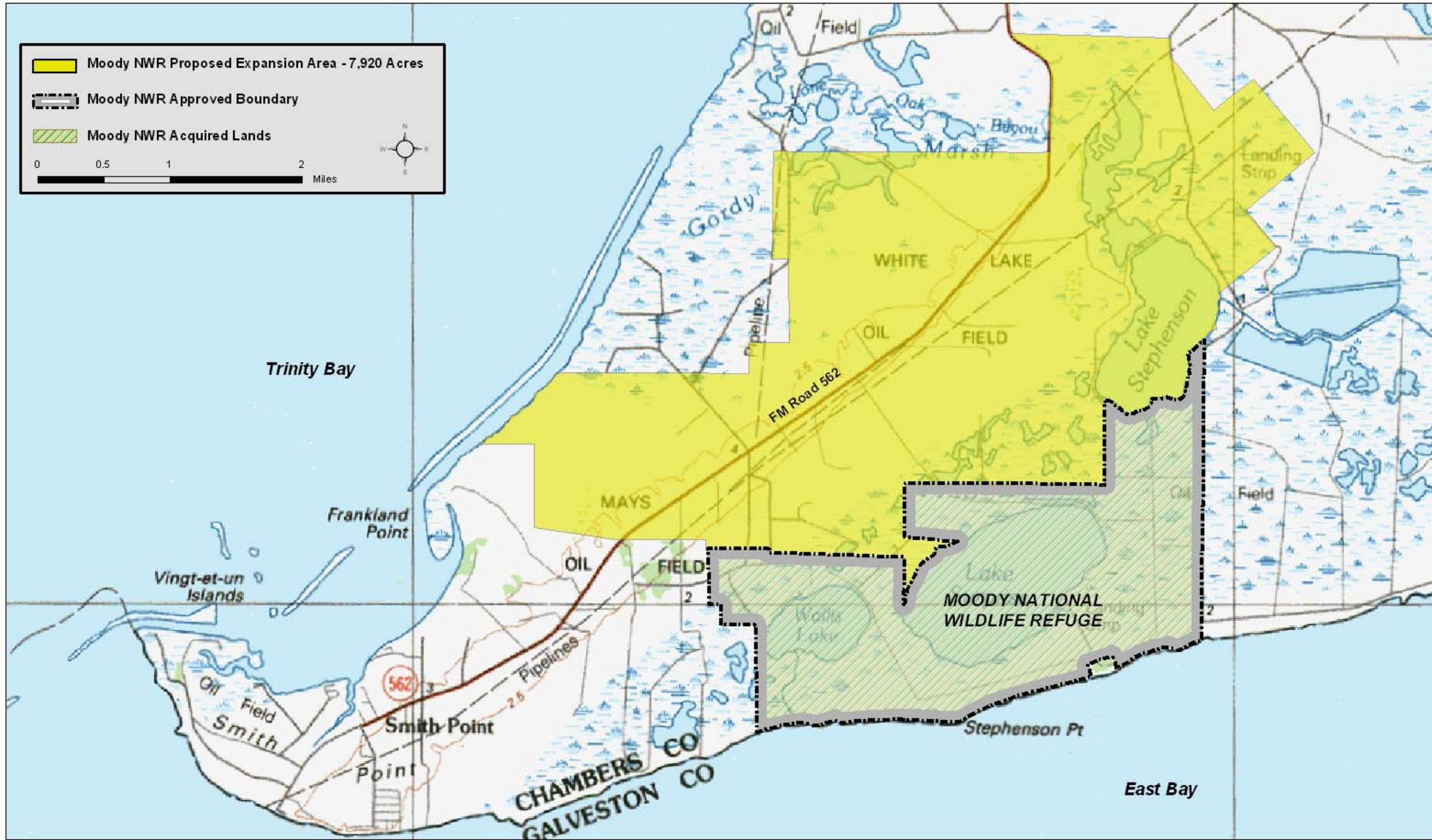
more much needed visitor access. In addition, this alternative includes all of the remaining marsh area south of State Hwy. 87 between the exiting refuge and Sea Rim State Park. All of this expansion area would fall within the Sea Rim Marsh which was identified in the "Category 8 Plan" as the #7 "Preservation Effort Priority."

Maps for Individual Boundary Expansions for Refuge Boundary Expansion Alternative C

Maps depicting the individual boundary expansions for Refuge Boundary Expansion Alternative C for Moody, Anahuac, McFaddin and Texas Point NWRs are on the following pages.

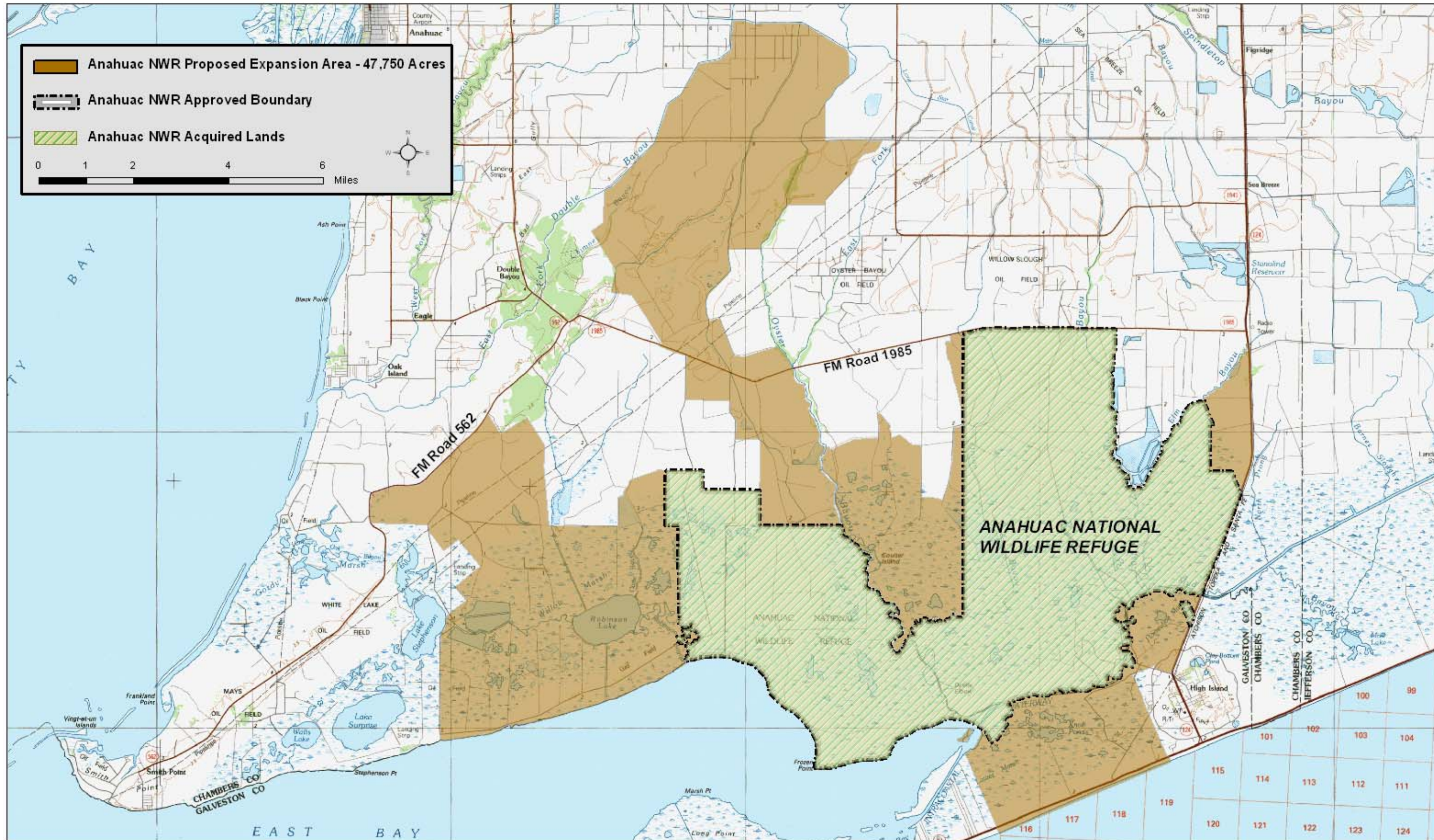


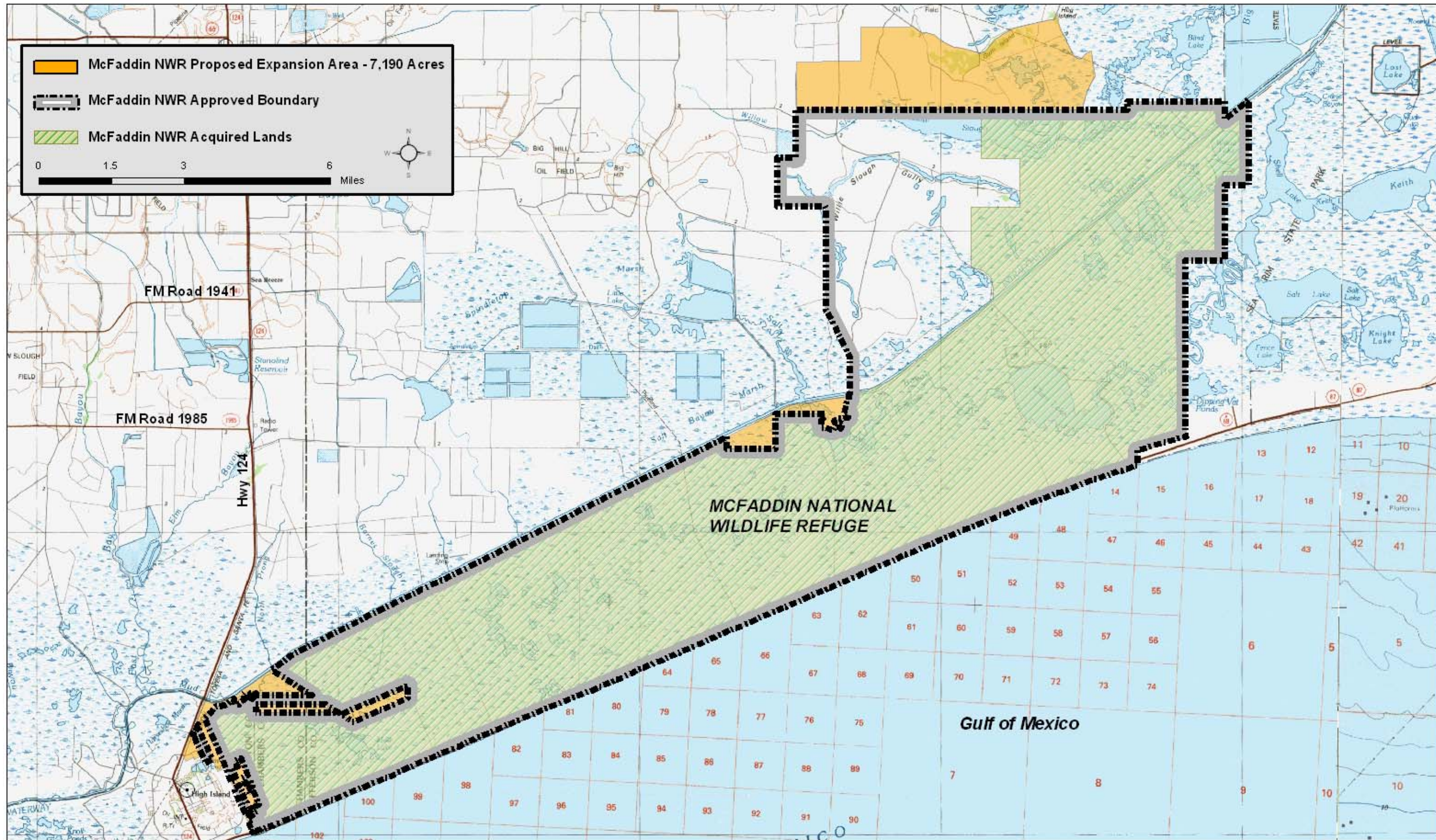
Moody National Wildlife Refuge Expansion - Alternative C - PREFERRED ALTERNATIVE





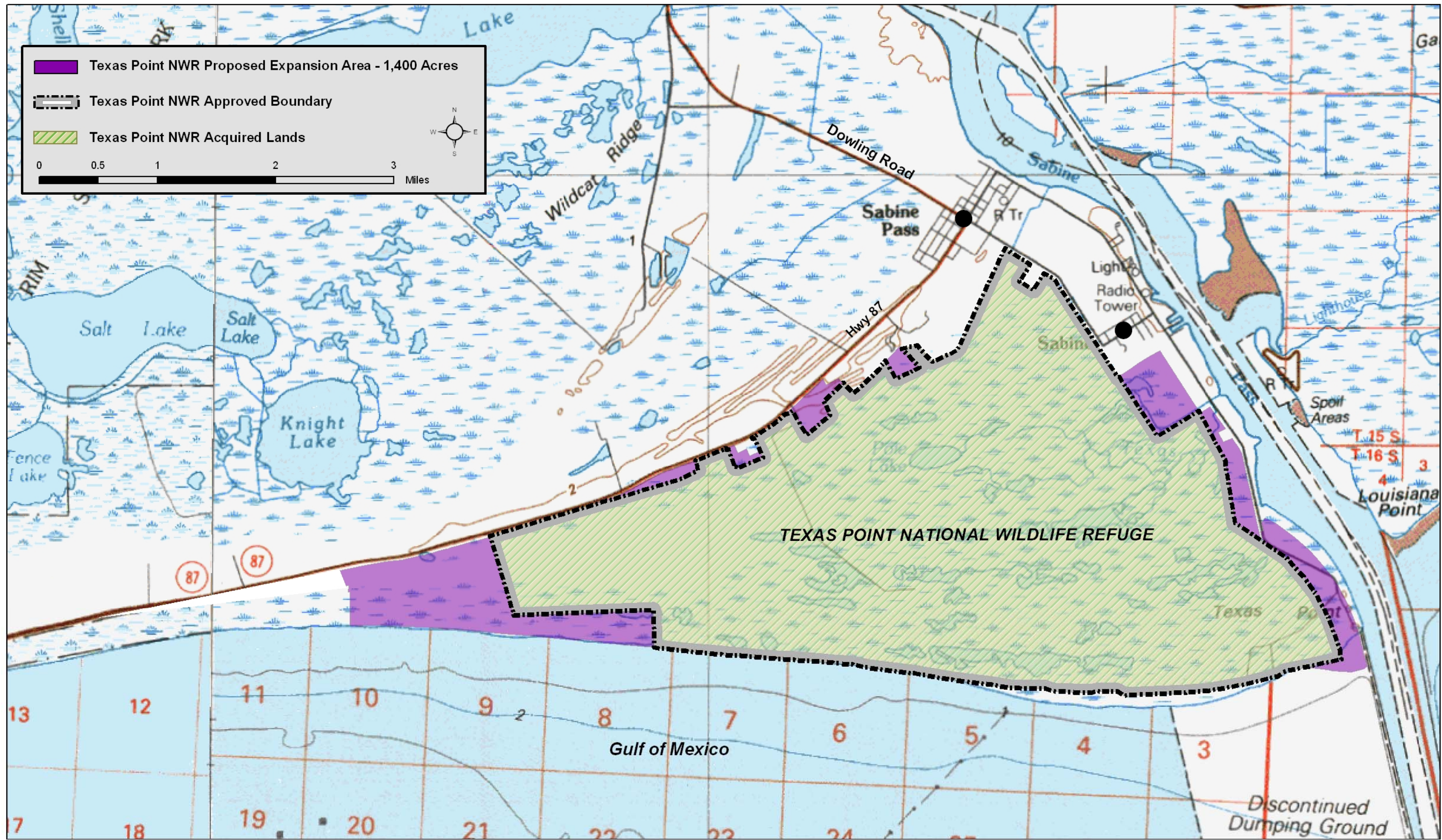
Anahuac National Wildlife Refuge Expansion - Alternative C







Texas Point National Wildlife Refuge Expansion - Alternative C



IV. REFUGE BOUNDARY EXPANSION ALTERNATIVE D – 104,120 ACRES

Alternative D Concept with Map

Alternative Focus

Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative C. Similar to Alternative C, this Alternative continues the four refuge’s historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetlands portions of this Alternative concentrate on high-value wintering waterfowl habitats near the coast which are contiguous to existing refuges. This focus supports the goal of the Gulf Coast Joint Venture: Chenier Plain Initiative which is stated as follows: “The goal of the Chenier Plain Initiative is to provide wintering and migration habitat for significant numbers of dabbling ducks, diving ducks, and geese (especially lesser snow and greater white-fronted), as well as year-round habitat for Mottled Ducks.” Priority is given to those wetland areas which have long been identified as high-priority areas for acquisition in USFWS documents such as the “Wetland Preservation Program, Category 8 – Texas Gulf Coast” and the “Emergency Wetlands Resources Act, Region 2 Wetlands, Regional Concept Plan”.

In addition to these primarily wetland areas, this Alternative includes two areas of important coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. The primary habitat type for these areas is non-saline prairie, of which a significant component is prairie/grassland which is a unique community type within the Texas Chenier Plain. One of these areas, “Middleton Prairie”, is likely the largest remnant native coastal tallgrass prairie remaining on the Upper Texas Coast.

This Alternative also includes an important near-coast bottomland hardwood area, which is an acquisition target new to this Refuge Complex. The primary habitat type in this area is forested wetlands which provide high quality wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species. Forested wetlands are considered a unique community type within the Texas Chenier Plain region. Also, this area has been identified as an important regional “fall-out” area for neotropical migratory songbirds making trans-Gulf migrations during spring. The remainder of the area consists of inland open water or converted coastal prairie, both of which have high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. Besides the above-described types of high biological value habitats, this Alternative contains those areas included in Refuge Boundary Expansion Alternative C which were identified by refuge management as necessary for the following reasons:

- lands that “fill in the gaps” in earlier single-ownership based expansions and complete logical biological/geographical boundaries,
- lands hydrologically linked to adjoining already-acquired refuge lands,
- lands whose acquisition would contribute to more effective management of the already acquired lands.

Expansion of the existing acquisition boundary is proposed for each of the four refuges in the Refuge Complex as follows:

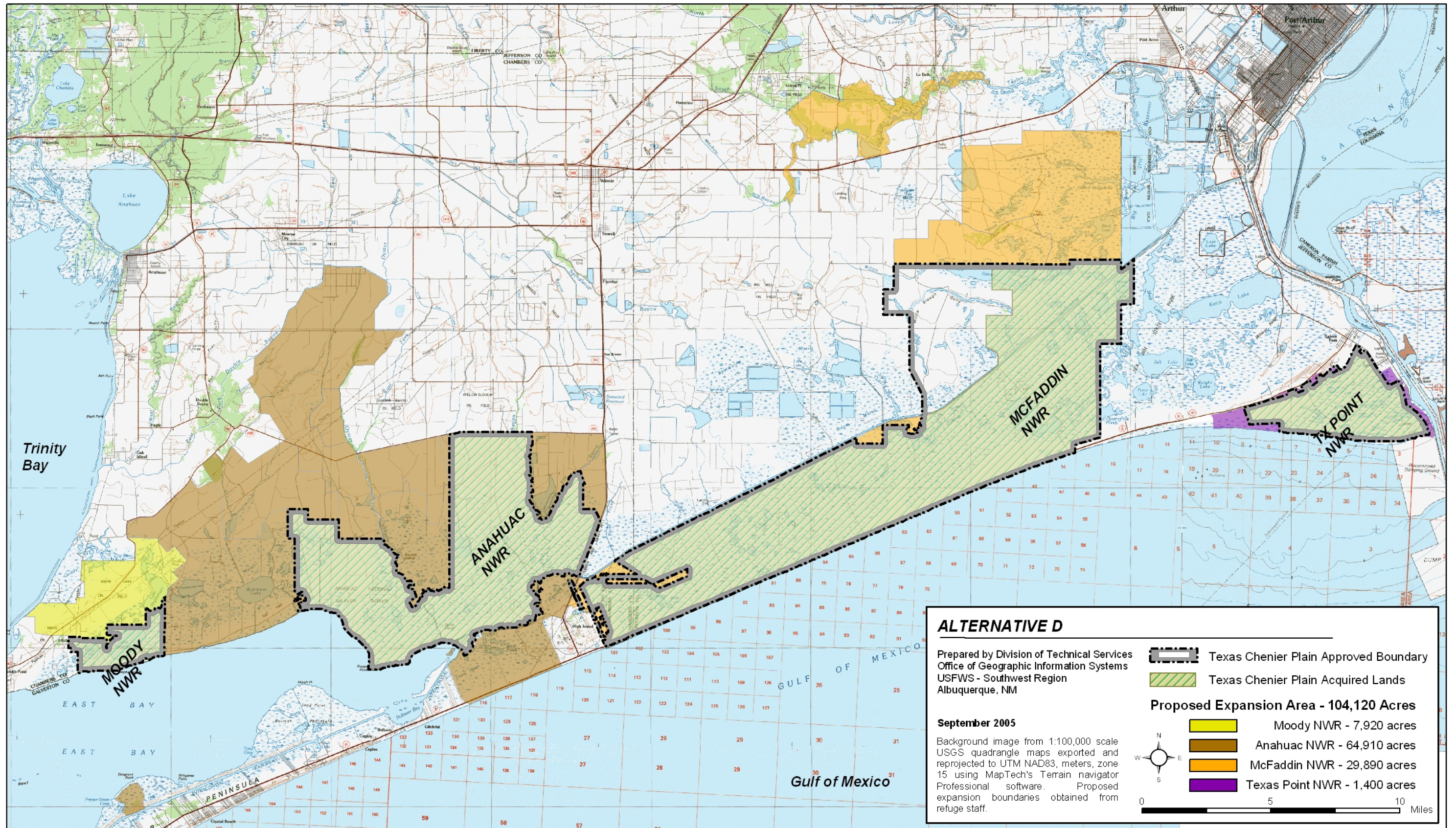
<u>Refuge</u>	<u>Size of Boundary Expansion</u>
Moody NWR	7,920 acres*
Anahuac NWR	64,910 acres*
McFaddin NWR	29,890 acres*
Texas Point NWR	1,400 acres*

** All acreage figures are approximate*

The 104,120 acre expansion proposal for the entire Refuge Complex is depicted the following page.



Texas Chenier Plain Refuge Complex & Proposed Expansion Areas



Rationale for Alternative

The coastal marshes, prairies and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. The Texas Gulf Coast is the primary site for ducks wintering in the Central Flyway, with an average of 1.3-4.5 million birds, or 30-71% of the total flyway population (Stutzenbaker and Weller 1989). This area also winters 90% of the snow, Canada, and greater white-fronted geese in the Central Flyway (Buller 1964). Additionally, the coastal marshes, prairies and prairie wetlands of the Chenier Plain region of the Texas Gulf Coast serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America, including three species identified by the USFWS as Gamebirds Below Desired Condition (Northern Pintail, Lesser Scaup and Ring-necked Duck). These wetland habitats also provide year-round habitat for Mottled Ducks, an important resident waterfowl species. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as Avian Species of Conservation Concern and species listed as priorities for conservation action under the U.S. Shorebird Conservation Plan and the North American Waterbird Conservation Plan. Hundreds of thousands shorebirds, wading birds, and other marsh and waterbirds also winter or migrate through the region, including several now identified by the USFWS as Avian Species of Conservation Concern. Coastal prairie and coastal woodlots support over 150 migratory and resident landbird species, including 9 species of grassland birds and 7 species utilizing woodland habitats listed as Rare and Declining within the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000). Overall, wetland, prairie and woodland habitats on the Refuge Complex provide habitat for 33 Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005).

The “Wetland Preservation Program, Category 8 – Texas Gulf Coast” was a joint effort between Federal, State, and Private participants to identify high-value wintering waterfowl habitat along the Texas coast that required little or no additional development. The USFWS had ranked the Texas Gulf coast as Number 8 out of 33 categories on a national priority scale based on its importance to the Nation’s waterfowl resource. Further, the USFWS had ranked the Texas Gulf coast Number 4 as a national “Important Resource Problem (IRP) area. In early 1977, a group of conservationists representing Ducks Unlimited, sportsmen, businessmen, Texas General Land Office, Texas Parks and Wildlife Department, and the USFWS delineated 25 key areas of habitat along the Texas Gulf coast having high value to the waterfowl resource. These 25 areas were ranked by a team of Texas Parks and Wildlife Department, Texas General Land Office, and USFWS personnel; and, acquisition of the private lands was recommended for the top 20 areas as being necessary for habitat preservation. This plan and report was “updated” in August of 1981. Within the Chenier Plain region of the upper Texas Gulf coast, the “Category 8 Plan” identified the following five high-value wintering waterfowl habitats: (#1) Oyster Bayou Marsh, (#4) Lake Surprise area, (#5) McFaddin Marsh, (#7) Sea Rim Marsh, and (#10) Robinson Bayou Marsh. (The numbers indicate that area’s “Preservation Effort Priority” ranking). All of these five high-value wintering waterfowl habitats are included in this expansion alternative.

The Emergency Wetlands Resources Act of 1986 (Public Law 99-645) was enacted by the United States Congress to: “Promote the conservation of migratory waterfowl and to offset or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitat, and for other purposes”. In compliance with this Act, the USFWS has prepared the National Wetlands Priority Conservation Plan. The National Plan provides the framework, criteria, and guidance for identifying wetlands warranting priority attention for Federal and State acquisition. Its primary purpose is to help decision-makers focus their acquisition efforts on the more important, scarce, and vulnerable wetlands in the Nation. The National Plan requires each of the seven USFWS Regions to prepare Regional Wetlands Concept Plans that address the wetlands of each State within each Region.

The USFWS’ Region 2 encompasses the States of Arizona, New Mexico, Oklahoma and Texas. In 1990, Region 2 published its Regional Wetlands Concept Plan addressing the wetland issues of each State separately. The Regional Wetlands Concept Plan steps down the National Plan to the local, site-specific level and discusses the wetland functions, values, threats and other issues on a state by state basis. The Regional Plan contains a list of priority wetlands sites that have been evaluated through the wetlands

assessment threshold criteria of the National Wetlands Priority Conservation Plan and qualify for acquisition under the Emergency Wetlands Resources Act. The wetlands in Texas were broadly grouped into six categories: 1) Gulf coast salt and freshwater marshes; 2) bottomland hardwood forests in the river valleys of East Texas; 3) playa lakes of the Panhandle region; 4) freshwater springs and their headwater streams of Central and Southwest Texas; 5) West Texas riparian areas; and 6) coastal pothole wetlands of South Texas. Each group is addressed in terms of the following three criteria used for prioritization: 1) Wetland Loss, 2) Wetland Threats, and 3) Wetland Functions and Values. Within the Chenier Plain region of the upper Texas Gulf coast, the Regional Plan identified the following four areas as “Texas Priority Wetlands for Acquisition Consideration”: 1) Middleton Marsh, 2) Horseshoe Marsh, 3) Lower Marsh, and 4) Robinson Bayou Marsh. Each of these four wetland sites meets all threshold criteria and qualifies for acquisition consideration under provisions of the National Wetlands Conservation Plan. All four of these wetlands sites are included in this expansion alternative.

This Alternative includes the Big Hill Bayou marsh west of J. D. Murphee State Wildlife Management Area. In combination with the Willow Slough Marsh to the east, this is the largest freshwater marsh remaining in Texas. This significant, high-quality palustrine wetland would provide an additional important freshwater marsh component and could be managed in connection with the adjacent Willow Slough Marsh on the North Unit of McFaddin NWR.

The USFWS defined the various wetland types in Classification of Wetlands and Deepwater Habitats of the United States (FWS/OBS-79/31, December, 1979). Further, the USFWS classified seven of these wetland types as “decreasing” in its Land Acquisition Priority System (LAPS). The “decreasing” wetland types are; 1) Palustrine Emergent, 2) Palustrine Forested, 3) Palustrine Scrub-Shrub, 4) Estuarine Intertidal Emergent, 5) Estuarine Intertidal Forested, 6) Estuarine Intertidal Scrub-Shrub, and 7) Marine Intertidal. Using National Wetlands Inventory data available at <http://nwi.fws.gov>, the USFWS’ Region 2 GIS Coordinator mapped the proposed acquisition areas identifying the wetland areas and the areas of aggregated decreasing wetland types (see Map # in Chapter 3, Affected Environment). Using the seven aggregated decreasing wetland types, he developed summary tables which compare decreasing wetland types to non-decreasing wetland types and wetlands to uplands. A summary table is presented for each Alternative as a whole and a summary table is presented for each refuge’s separate boundary expansion.

Over 9 million acres of native tallgrass prairie once occurred along the western Gulf Coast in Texas and Louisiana (Smeins *et al.* 1991). Based on remnant stands of native grasslands, prairies on the Upper

	Acres	Percentage of Boundary Expansion
Boundary Expansion		
Alternative D	104,120	100%
Habitat Type (Upland or Wetland) of Alternative B Expansion		
Uplands	29,690	29%
Wetlands	74,430	71%
Declining Wetland Types	67,640	
Non-declining Wetland Types	6,790	

Texas Coast were characterized by little bluestem, brownseed paspalum, and Indiangrass or eastern gammagrass and switchgrass associations, depending on hydrology (Diamond and Smeins 1984). It is now estimated that 99.8% and 99.6% of little bluestem prairies and eastern gamma

grass/switchgrass prairies, respectively, have been lost in Texas (McFarland 1995). The little bluestem-brownseed paspalum community has been identified as a “threatened natural community” and the eastern gammagrass-switchgrass community has been identified as an “endangered natural community” by the Texas Organization for Endangered Species (Diamond *et al.* 1992). The Texas Organization for Endangered Species (TOES) defines “threatened natural community” as any series-level natural community vulnerable to extirpation in Texas, with six to twenty occurrences in Texas and 100 or fewer occurrences globally. TOES defines “endangered natural community” as any series-level natural

community in immediate danger of extirpation in Texas, with five or fewer known occurrences in Texas and 100 or fewer occurrences globally. Both communities are assigned a Global conservation status rank of “Critically Imperiled” (G1) by The Nature Conservancy (2002).

Many animal species typical of northern prairies, such as Henslow’s Sparrows, Smooth Green Snakes, and Prairie Voles, were all found year-round in the Gulf coastal prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf coastal prairies as wintering and/or migratory habitat. Many of the birds that would benefit from protection and management of native coastal prairie habitats under this Alternative are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as “Avian Species of Conservation Concern” in the Gulf Prairies Bird Conservation Region (USFWS 2002). For example, Mottled Duck, White-tailed Hawk, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, and LeConte’s Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats.

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

Statewide in Texas, the coastal prairie has seen the greatest industrial development since World War II (Schmidly 2002). Most of the original coastal prairie has been lost because of direct conversion to other cover types, i.e. improved pasture, cultivated rice and other crops, and industrial, urban or suburban development. Additionally, remaining areas have been altered through a number of factors, primarily changes in fire, herbivory, and hydrology. Native prairies managed as pastures face such threats as homogenized burn regimes, overgrazing, and application of broadleaf herbicides. All these management practices are thought to reduce the floristic diversity that exemplifies coastal prairies (Allain and Johnson 1997). The introduction of non-native plant species has also impacted native coastal prairies on the Gulf Coast, and invasive exotic species such as Chinese tallow pose a significant threat to remnant prairies.

The USFWS’ proposed boundary expansions of the Moody and Anahuac NWRs under this Alternative contain important coastal prairie habitats. The Nature Conservancy’s Gulf Coast Marshes and Prairies Ecoregional Conservation Plan identified the “Middleton Prairie” and “Robinson-Oyster Bayou” areas in Chambers County as important conservation areas because they contain remnants of both “Critically Imperiled” prairie plant communities (The Nature Conservancy 2002). Both areas contain an historical topographic feature called “mima mounds”. These mounds provide the topographic and hydrological variability believed responsible for much of the floristic diversity found in high quality coastal prairies (Grace *et al.* 2000).

This Alternative also includes some additional lands north of the current Anahuac NWR north to FM Road 1985. These lands are former coastal prairie which has been converted to agricultural uses, mostly rice farming or improved pasture. Part of these croplands would be incorporated into the refuge cooperative rice farming program to provide supplemental food sources for migratory waterfowl and wetland habitat for other migratory birds, and other croplands would be managed as moist soil units. Virtually all of the improved pasture and the remainder of the cropland would be targeted for future restoration to native coastal prairie. The native coastal prairie restoration would include restoration of small emergent wetlands which, in conjunction with the prairie components, would provide much important nesting and brood-rearing habitat for Mottled Ducks.

This Alternative includes the Taylors Bayou area in Jefferson County, which is similar to the other important bottomland hardwood forests in East Texas river valleys. The primary habitat type is forested wetlands which provide high quality wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species. It is estimated that Texas had lost 63% of its original bottomland hardwood forests by 1980 (Frye 1987) and future declines in bottomland hardwoods are expected from continued land use changes. Studies of songbird migration using radar indicate that the Taylors Bayou bottomlands area is a regionally important annual “fall out” area for neotropical migratory songbirds making trans-Gulf migrations during spring (Dr. Sidney Gauthreaux, personal communication). The palustrine forested wetlands are a nationally-recognized declining wetland type and are considered a unique community type within the Texas Chenier Plain.

INDIVIDUAL REFUGE BOUNDARY EXPANSIONS FOR REFUGE BOUNDARY EXPANSION ALTERNATIVE D

Expansion of Moody NWR Boundary – 7,920 Acres

	Acres	Percent of Expansion
Moody NWR Boundary Expansion	7,920	100%
Total Uplands	3,260	41%
Total Wetlands	4,660	59%
Declining Wetland Types	3,810	
Non-declining Wetland Types	850	

The expansion for Moody NWR is the same as proposed in Refuge Boundary Expansion Alternative C. The expansion area includes the areas immediately north of the current refuge boundary up to FM Road 562. The Lake Surprise area was identified in the “Category 8 Plan” as the #4 “Preservation Effort Priority”. The area is predominately marsh, being

largely freshwater and intermediate marsh, and includes several lakes with Lake Stephenson being the largest. FM Road 562 runs along a low ridge between the 5 and 10 foot contours and separates the drainage between Trinity Bay and East Bay. The low ridge consists of coastal prairie with many pothole wetlands and “mima” mounds. Mima mounds are a historic topographic feature in the region’s coastal prairies which provide the topographic and hydrological variability believed responsible for much of the floristic diversity found in high quality coastal prairies (Grace *et al.* 2000). This Alternative also includes an area to the west of FM Road 562 which drains into Trinity Bay. This area contains some coastal marsh but is largely coastal prairie with many pothole wetlands and “mima” mounds.

Expansion of Anahuac NWR Boundary – 64,910 Acres

	Acres	Percent of Expansion
Anahuac NWR Boundary Expansion	64,910	100%
Total Uplands	22,020	34%
Total Wetlands	42,890	66%
Declining Wetland Types	39,340	
Non-declining Wetland Types	3,550	

The wetlands portion of the expansion area consists primarily of five coastal marsh areas: Robinson Bayou Marsh, Oyster Bayou Marsh, Middleton Marsh, Horseshoe Marsh, and Lower Marsh. All five of these marsh areas are high-value wintering waterfowl habitats and have been identified as high-priority acquisition areas in USFWS documents: The “Category 8

Plan” ranked Oyster Bayou Marsh as #1 and Robinson Bayou Marsh as #10 in “Preservation Effort Priority”. The Regional Wetlands Concept Plan identified Middleton Marsh, Robinson Bayou Marsh, Horseshoe Marsh, and Lower Marsh as “Texas Priority Wetlands for Acquisition Consideration”. All five of these marshes are high-value, largely intermediate marshes having some freshwater marsh components. The Robinson Bayou Marsh area, which is the largest wetland area in the expansion, extends from the current western boundary of Anahuac NWR all the way along East Bay to the boundary of Moody NWR. This is the largest remaining coastal marsh along East Bay. The Oyster Bayou Marsh area consists of both the upper and lower marshes east of Oyster Bayou which is surrounded virtually on three sides by

the current Anahuac NWR. The Middleton Marsh area consists of the rest of the upper marsh between Elm Bayou and State Hwy. 124. Horseshoe Marsh is on Bolivar Peninsula immediately north of High Island and west of State Hwy. 124. Lower Marsh is also on Bolivar Peninsula and is the large undeveloped marsh to the west of High Island. These two tidal influenced marshes are hydrologically separated by the GIWW from the existing Anahuac NWR. In addition to these five major marshes, this Alternative includes the marsh area known as Elmgrove Point north of the GIWW on Bolivar Peninsular. This is a tidal influenced marsh with a unique, large coastal woodlot.

Another portion of the expansion is in the area west of Oyster Bayou from FM Road 1985 south to the existing refuge boundary. This area includes the main entrance road to Anahuac NWR used by both visitors and staff. This area consists of primarily of coastal prairie, much of which has been converted to agricultural uses, and includes some fresh marsh and riparian woodlands. Acquisition of this area would facilitate improved management of the main refuge entrance and provide opportunities to improve and expand recreational uses including hunting, wildlife observation and photography.

The last portion of the expansion consists of two major coastal prairie components. The largest area is the "Middleton Prairie" which contains a large contiguous block of native tallgrass prairie and some converted agricultural lands between Oyster Bayou and the East Fork of Double Bayou north of FM Road 1985. The other area is the coastal prairie to the northeast of the Robinson Bayou Marsh lying on the east side of FM Road 562. Both of these prairie areas contain small freshwater marshes and a large number of natural prairie "pothole" wetlands.

Expansion of McFaddin NWR Boundary – 29,890 Acres

	Acres	Percent of Expansion
McFaddin NWR Boundary Expansion	29,890	100%
Total Uplands	4,260	14%
Total Wetlands	25,630	86%
Declining Wetland Types	23,380	
Non-declining Wetland Types	2,250	

The coastal wetlands portion of this expansion consists of several coastal marshes included under different rationales. First, there are two areas which are gaps in the refuge boundary from earlier single-ownership based expansions. One area consists of a number of separated tracts in the marsh just to the east of High Island. The other area is two separate marsh

tracts on the south side of the GIWW in the vicinity of Star Lake. Both areas would be considered part of McFaddin Marsh which was identified in the "Category 8 Plan" as the #5 "Preservation Effort Priority". Second, there is the northern part of Willow Slough Marsh immediately adjacent to the current refuge boundary. This area is a very high quality freshwater marsh which is hydrologically linked to the rest of Willow Slough within the existing McFaddin NWR boundary. Third, there is the large Big Hill Bayou marsh west of J. D. Murphee State Wildlife Management Area. In combination with the Willow Slough Marsh, this is the largest freshwater marsh remaining in Texas.

The other portion of this expansion is the bottomland hardwoods along and between the two forks of Taylors Bayou downstream from the Fannet Oilfield. This area is primarily forested wetlands with some converted agricultural lands between the two forks. This is a regionally important "fall out" area for neotropical migratory songbirds making trans-Gulf migrations during spring. Current agricultural areas would be restored to forested wetlands.

Expansion of Texas Point NWR Boundary – 1,400 Acres

	Acres	Percent of Expansion
Texas Point NWR Boundary Expansion	1,400	100%
Total Uplands	150	11%
Total Wetlands	1,250	89%
Declining Wetland Types	1,110	
Non-declining Wetland Types	140	

The expansion for Texas Point NWR is the same as proposed in Refuge Boundary Expansion Alternative C. Much of the expansion area consists of a number of small tracts immediately adjacent to the current refuge boundary. These tracts are coastal marsh, small coastal woodlots, or a combination of the two.

Acquisition of these tracts would

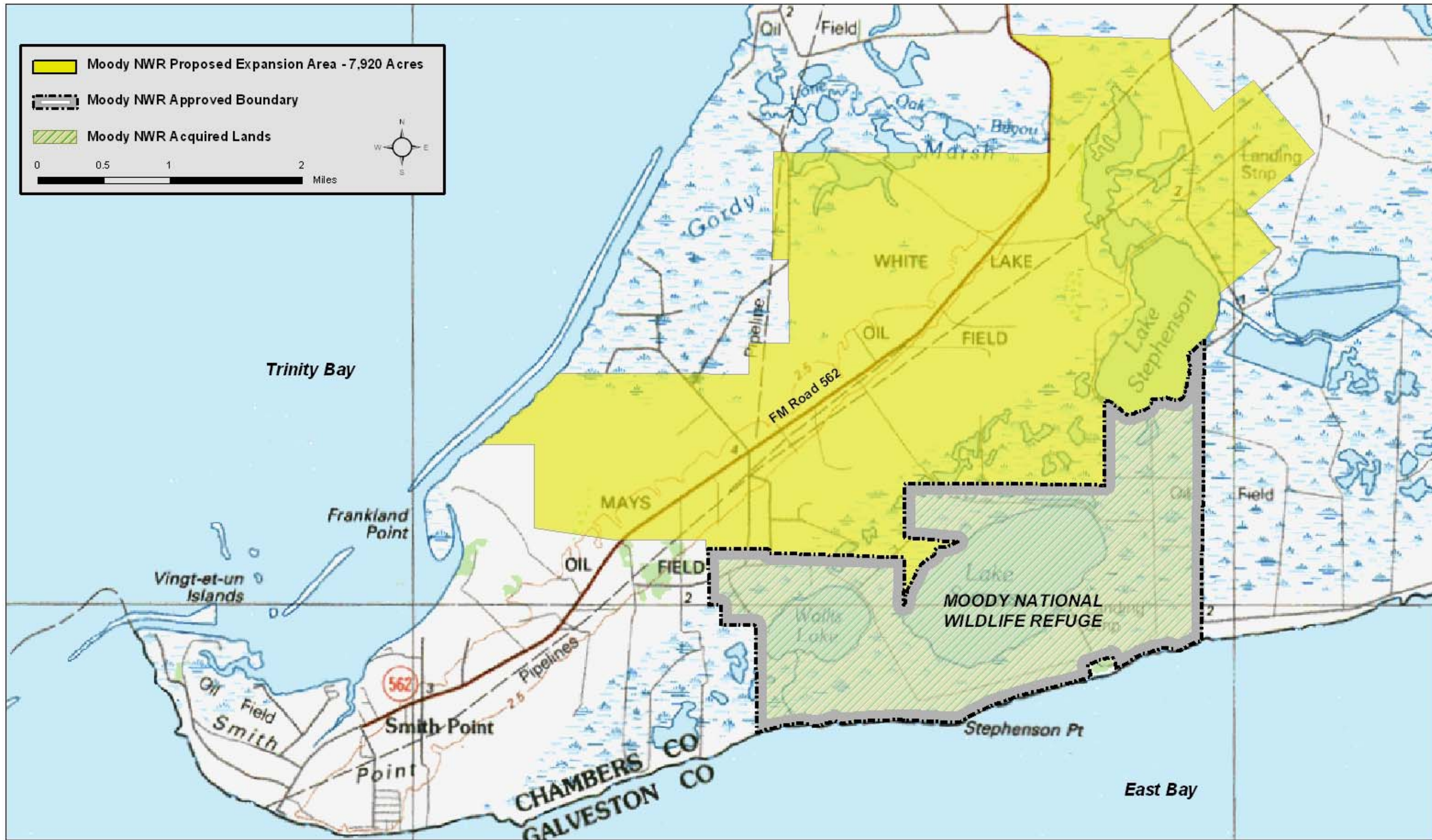
provide the refuge with a much more manageable boundary and provide more much needed visitor access. In addition, this Alternative includes all of the remaining marsh area south of State Highway 87 between the exiting refuge and Sea Rim State Park. All of this expansion area would fall within the Sea Rim Marsh which was identified in the “Category 8 Plan” as the #7 “Preservation Effort Priority”.

Maps for Individual Boundary Expansions for Refuge Boundary Expansion Alternative D

Maps depicting the individual boundary expansions for Refuge Boundary Expansion Alternative D for Moody, Anahuac, McFaddin and Texas Point NWRs are on the following pages.

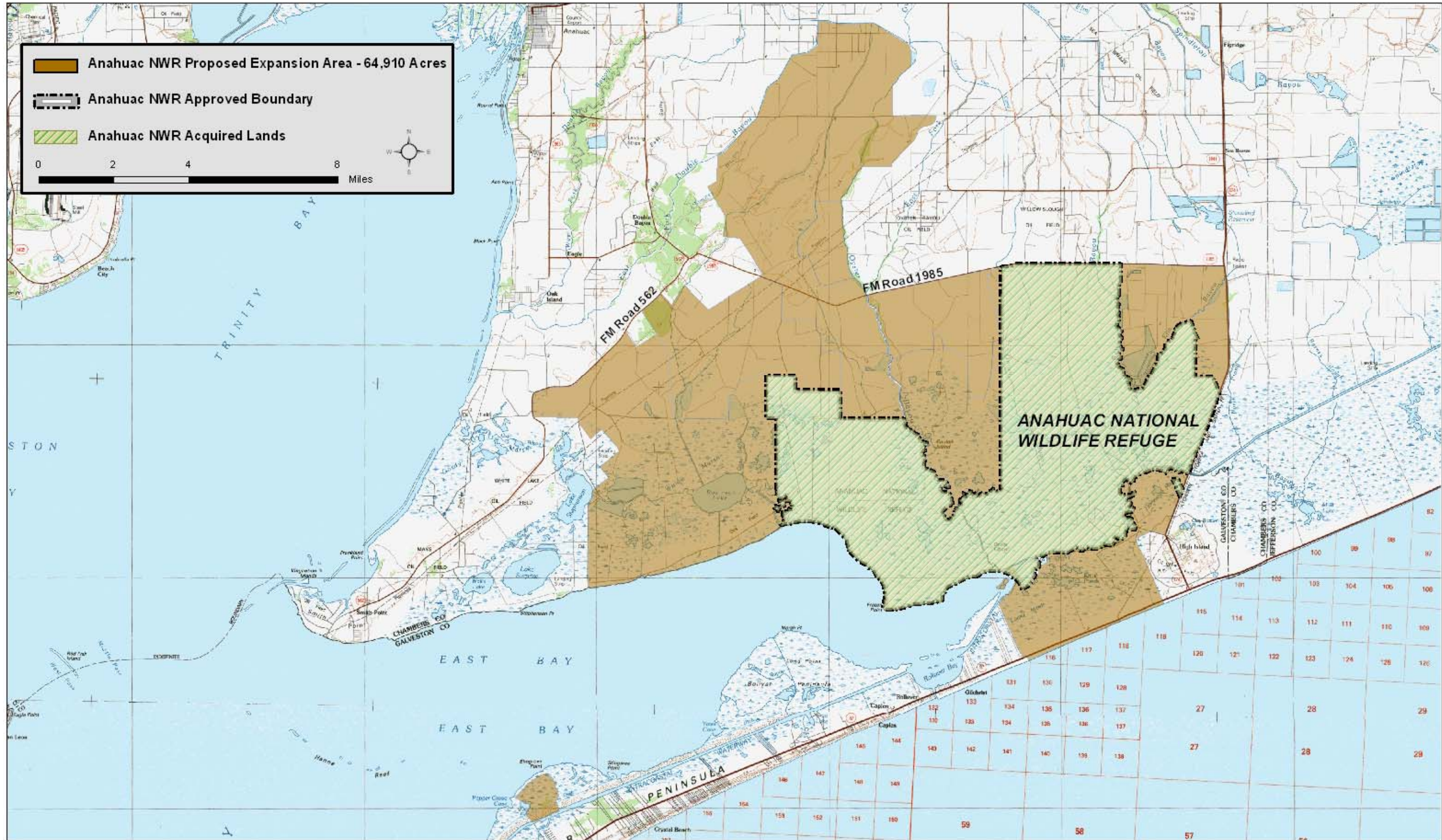


Moody National Wildlife Refuge Expansion - Alternative D



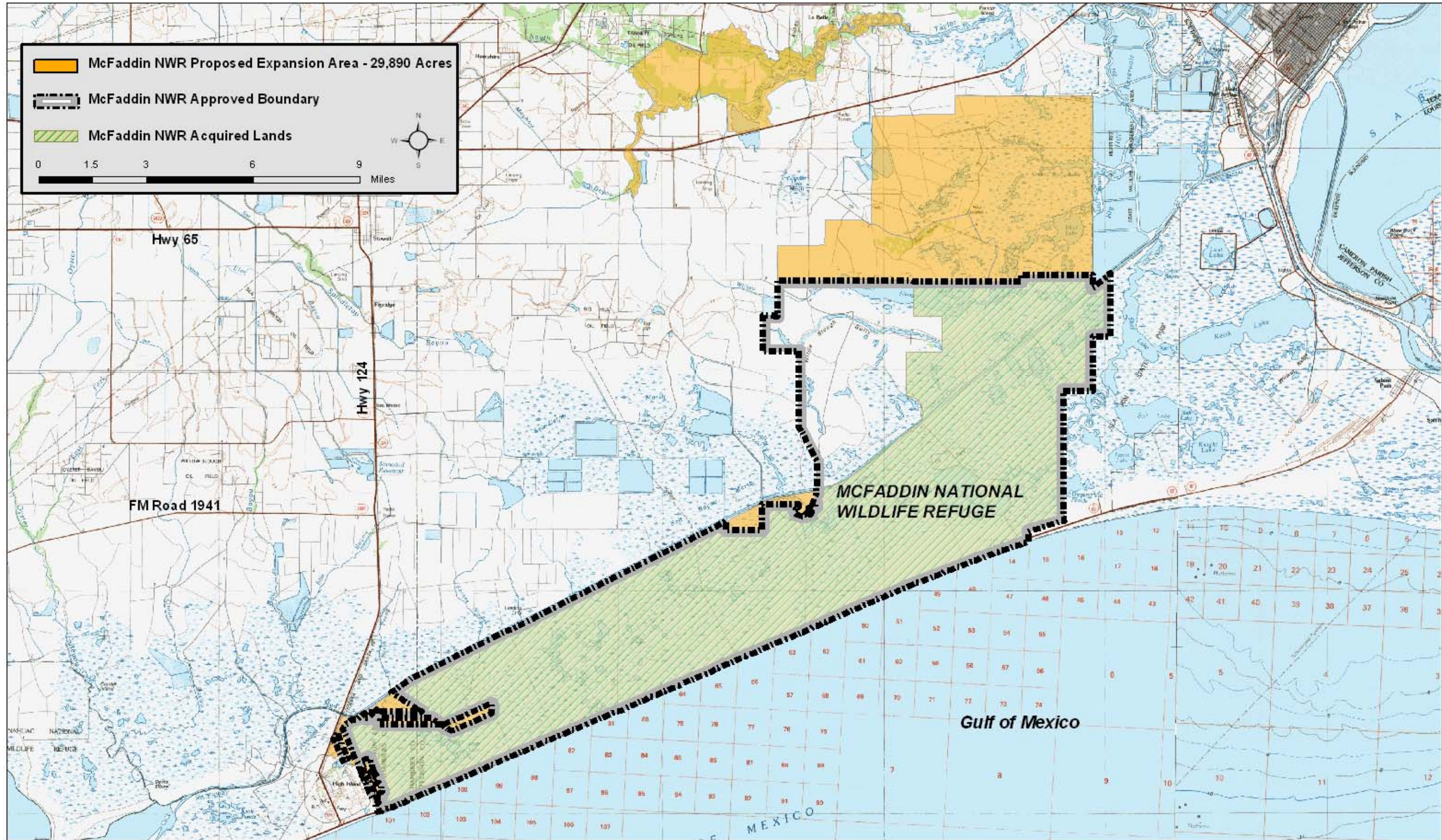


Anahuac National Wildlife Refuge Expansion - Alternative D



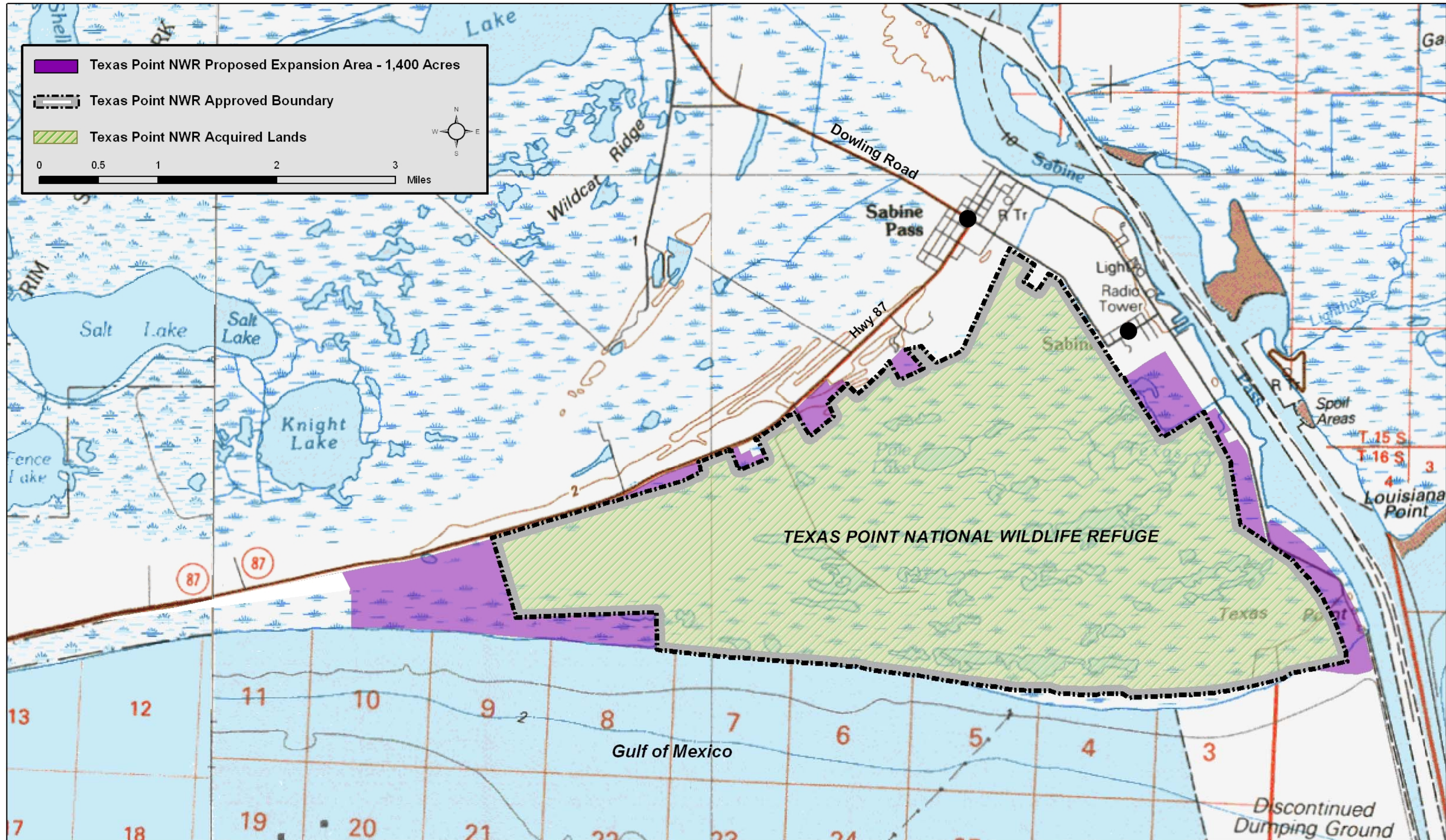


McFaddin National Wildlife Refuge Expansion - Alternative D

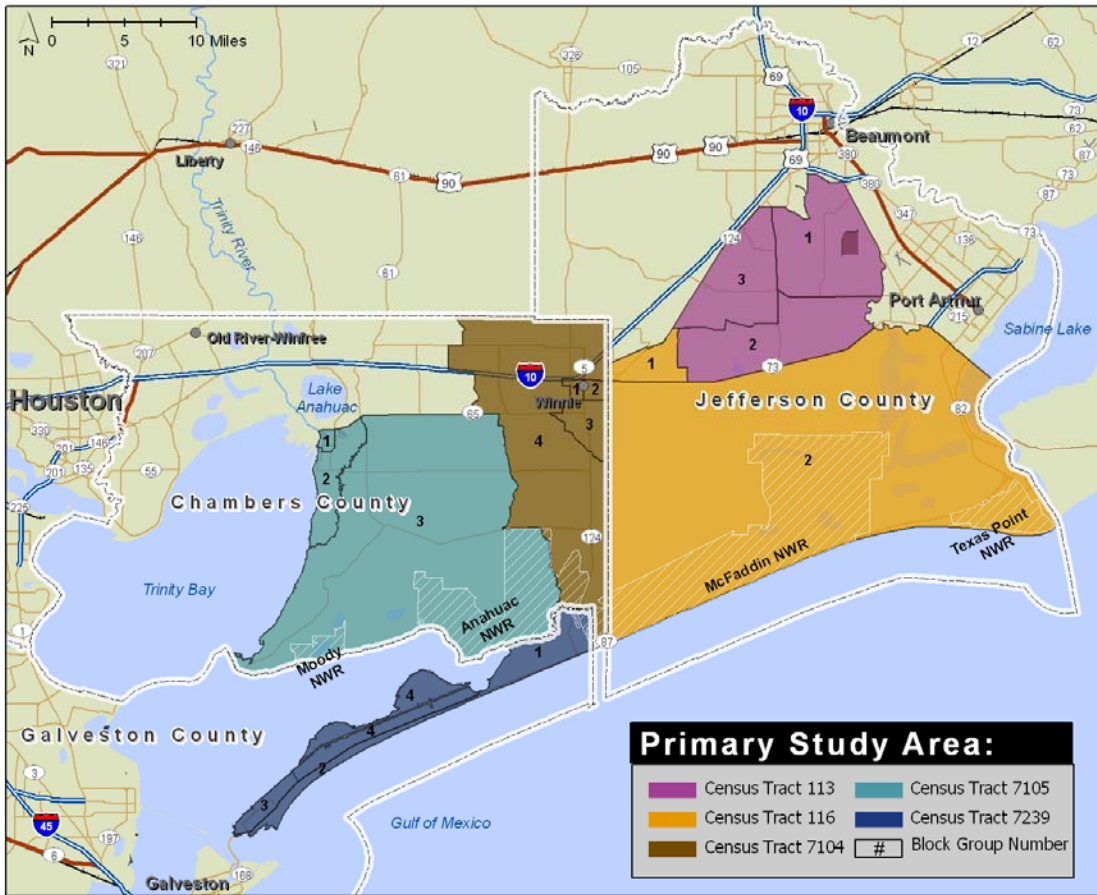




Texas Point National Wildlife Refuge Expansion - Alternative D



CHAPTER 3: AFFECTED ENVIRONMENT



Introduction

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

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

General Setting

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

Table 3-1

National Wildlife Refuges within the Texas Chenier Plain Refuge Complex

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

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

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

- Moody NWR is located in along East Galveston Bay in south central Chambers County. The town of Smith Point is approximately 5 miles west of this Refuge. The USFWS holds a perpetual non-development conservation easement on the Moody NWR, which is otherwise entirely privately-owned and managed.
- Anahuac NWR is located on the north shore of East Galveston Bay. Almost all of the Refuge lies within Chambers County, with a small portion lying south of the GIWW in Galveston County. The Refuge is bounded by Robinson Bayou on the west, State Highway 124 on the east, several private farms and ranches and F.M. Road 1985 on the north, and East Bay and the GIWW on the south. Anahuac NWR staff are now officed on the Refuge, with Refuge Complex staff headquartered in the city of Anahuac, located 18 miles northwest of the Refuge.
- McFaddin and Texas Point NWRs are located on the southeastern tip of the Upper Texas Coast, adjacent to the Gulf of Mexico. All of Texas Point NWR and most of McFaddin NWR are located in Jefferson County. Texas Point and McFaddin NWRs are bounded on the south by the Gulf of Mexico, and the refuges contain approximately 6 and 17 miles of Gulf of Mexico shoreline, respectively. The GIWW dissects McFaddin NWR and divides once contiguous watersheds into two distinct units. Texas Point NWR is adjacent to the town of Sabine Pass, and McFaddin NWR lies 12 miles further west. The town of High Island is located along the Gulf near the McFaddin NWR's western boundary, which lies within Galveston County. Office facilities for the staffs of the McFaddin and Texas Point NWRs and some Refuge Complex staff (Fire Management) are located on the McFaddin NWR.

Ecosystem Setting

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

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

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

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

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



Chenier Plain Region

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

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

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

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

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

I. PHYSICAL ENVIRONMENT

A. Climate and Air Quality

1. Climate

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

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

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

2. Air Quality

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

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

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

B. Geology and Soils

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

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

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

1. Geomorphology

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

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

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

2. Chenier Ridges

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

3. Soils

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

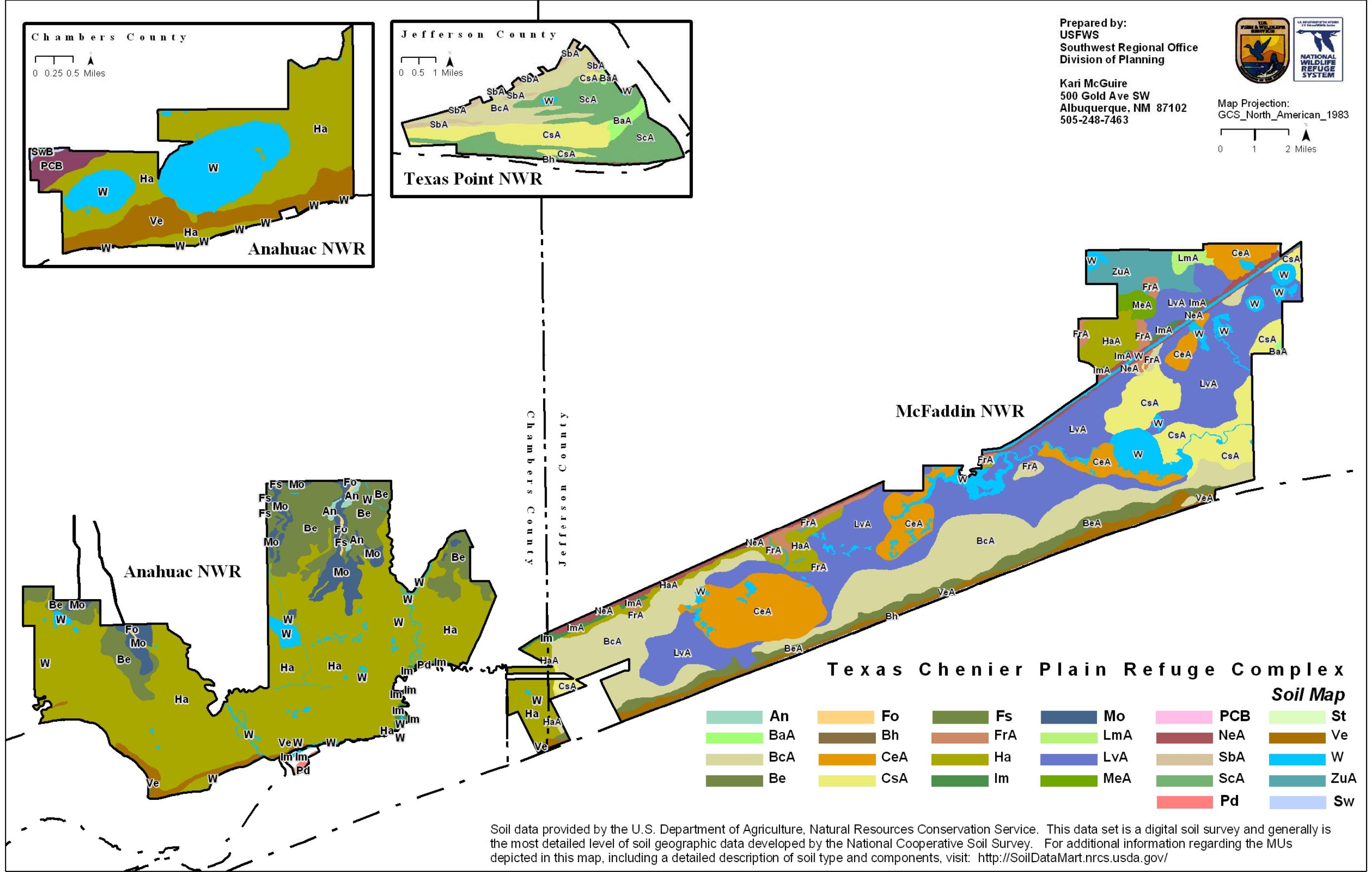
Three principal soil associations are found on the Refuge Complex and include: Morey-Crowley-Hockley Association consisting of silty soils of the coastal prairie; Harris-Made Land Association comprised of clay soils of the coastal marsh and spoil from dredging and similar operations; and the Sabine-Coastal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

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

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

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

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



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Map Projection:
GCS_North_American_1983
0 1 2 Miles

4. Relative Sea Level Rise

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

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

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

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

A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has also accelerated rates of shoreline retreat and coastal land loss along the Gulf shoreline. This reduced sand supply has contributed to the loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion and retreat by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges. Shoreline erosion and retreat along the Gulf of Mexico in the project area is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. The historic barrier beach/dune system has been almost entirely 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 the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water. (On McFaddin NWR, coastal erosion and damage from storm tidal surges have also destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

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

C. Hydrology

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

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

- Saltwater now reaches farther inland into historically freshwater marshes altering the plant species composition and plant productivity. Overall, biological diversity decreased through the conversion of fresh and intermediate marshes to more brackish regimes and salt-tolerant plant and animal communities. Saltwater intrusion also introduced sulphates to these freshwater marshes, which under conditions of high water temperatures during summer are reduced to hydrogen sulphide. Sulphide toxicity can cause plant die-offs and has been implicated in a as a contributing factor in the conversion of vegetated emergent marsh to open water.
- New channels and modifications of natural waterways introduced tidal energies into historically non-tidal or micro-tidal marshes, resulting in decreased plant productivity, plant mortality, peat collapse and erosive loss of organic marsh soils. All have contributed to the conversion of the vegetated emergent marsh to open water. Introduction of tidal influence also altered marsh hydroperiods or wetting and drying cycles. Non-tidal and microtidal marshes whose soil surfaces were exposed only seasonally or during periods of drought became subject to daily tidal fluctuations.
- Increased saltwater intrusion reduces plant productivity in plant communities adapted to fresher hydrological regimes. Plant productivity, especially below-ground biomass in root systems, is an important component of soil formation in the Chenier Plain region's fresher coastal marshes. Reduced plant productivity may reduce soil formation and limit marsh surface elevation gain.
- Alterations to the natural drainage systems in the region have resulted in a rapid transport of freshwater and sediments from inland areas directly to the GIWW, bays and the Gulf, and have

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

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

1. Drainage Basins

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

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



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

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

2. Flooding

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

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

3. Water Quality

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

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

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

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

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

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

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

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

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

4. Water Rights

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

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

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

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

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

D. Mineral Resources

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

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

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

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

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

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

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

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

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

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

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

II. BIOLOGICAL RESOURCES

A. Vegetation and Habitats

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

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

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

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

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

1. Wetland and Aquatic Habitats

a. Estuarine and Palustrine Emergent Wetlands

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

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

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

Table 3-2. Common Plants of Wetland and Aquatic Habitats	
Marsh Type	Associated Plant Species (Common and <i>Scientific</i> Name)
Saline	smooth cordgrass <i>Spartina alterniflora</i> glassworts <i>Salicornia spp.</i> marshhay cordgrass <i>Spartina patens</i> maritime saltwort <i>Batis maritima</i> seashore saltgrass <i>Distichlis spicata</i> blackrush <i>Juncus roemerianus</i> saline marsh aster <i>Aster tenuifolius</i> Carolina wolfberry <i>Lycium carolinianum</i> bushy sea-oxeye <i>Borrchia frutescens</i>
Brackish	saltmarsh bulrush <i>Bulbuschoesus robustus</i> widgeon grass <i>Ruppia maritima</i> dwarf spikerush <i>Eleocharis parvula</i> marsh pea <i>Vigna luteola</i> water hemp <i>Amaranthus australis</i> marshhay cordgrass <i>Spartina patens</i> seashore saltgrass <i>Distichlis spicata</i>
Intermediate	Olney bulrush <i>Bulbuschoesus olneyi</i> coastal water-hyssop <i>Bacopa monnieri</i> California bulrush <i>Scirpus californicus</i> banana waterlily <i>Nymphaea mexicana</i> Colorado river hemp <i>Sesbania macrocarpa</i> marshhay cordgrass <i>Spartina patens</i> seahore paspalum <i>Paspalum vaginatum</i> baby pondweed <i>Potamogeton pusillus</i> sand spikesege <i>Eleocharis montividentis</i> narrow leaf cattail <i>Typha angustifolia</i> common reedgrass <i>Phragmites australis</i> spikerushes <i>Eleocharis spp.</i> sago pondweed <i>Potamogeton pectinatus</i> coast cockspur <i>Echinochloa walteri</i> sprangletop <i>Leptochloa spp.</i>

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

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

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

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

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

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

b. Palustrine Forested Wetlands

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

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

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

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

c. Aquatic Habitats

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

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

2. Upland Habitats

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

a. Native Coastal Prairie and Prairie Grasslands

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

b. Upland Forests and Coastal Woodlots

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

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

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

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

c. Agricultural Lands

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

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

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

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

3. Refuge Complex Habitat Characterization

a. Moody NWR

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

b. Anahuac NWR

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

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

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

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

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

Table 3-6. Habitat Types of the McFaddin NWR, Texas.		
Habitat Type	Approximate Acreage	Percent of Refuge
Fresh Marsh	5,356	9.6
Intermediate Marsh	37,468	67.0
Brackish Marsh	3,294	5.9
Salty Prairie	3,817	6.8
Non-Saline Prairie	1,320	2.4
Inland Open Water – Bayous, GIWW	646	1.2
Leveed Impoundment	95	0.2
Dredge Material	988	1.8
Containment Compartment		
Natural Lake - Intermediate	712	1.3
Natural Lake - Brackish	1,479	2.6
TOTAL ACRES*	55,918	---

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

c. McFaddin NWR

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

The GIWW bisects the Refuge and divides historically contiguous watersheds. The South Unit of the Refuge lies south of the GIWW and is predominately an intermediate marsh consisting of emergent marsh and several interconnected ponds and shallow lakes. The GIWW effectively cut off freshwater inflows via natural waterways and surface sheet flows from the marshes and prairies north of the GIWW to the marshes of the South Unit. Freshwater supply to the South Unit is now limited to local precipitation. Salt Bayou drains the eastern two-thirds of the South Unit eastward to the GIWW and the Sabine River (Sabine-Neches

Ship Channel,) and Mud Bayou drains the western third of the South Unit to the GIWW and East Galveston Bay. Star Lake, Clam Lake, Willow Lake and Barnett Lake are natural lakes occurring within the Salt Bayou watershed on the South Unit. Brackish marshes occur primarily in the western and eastern portions of the South Unit, where tidal influence through Mud and Salt bayous is greatest. Intermediate and brackish marshes comprise approximately 37,468 acres and 3,294 acres of the Refuge, respectively.

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

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

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

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

d. Texas Point NWR

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

Table 3-7. Habitat Types of the Texas Point NWR, Texas.		
Habitat Type	Approximate Acreage	Percent of Refuge
Intermediate Marsh	1,362	15.2
Brackish Marsh	2,300	25.6
Saline Marsh	4,865	54.2
Salty Prairie	209	2.3
Non-saline prairie	232	2.6
TOTAL ACRES*	8,968	---

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

4. Habitat Characterization for Refuge Boundary Expansion Areas

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

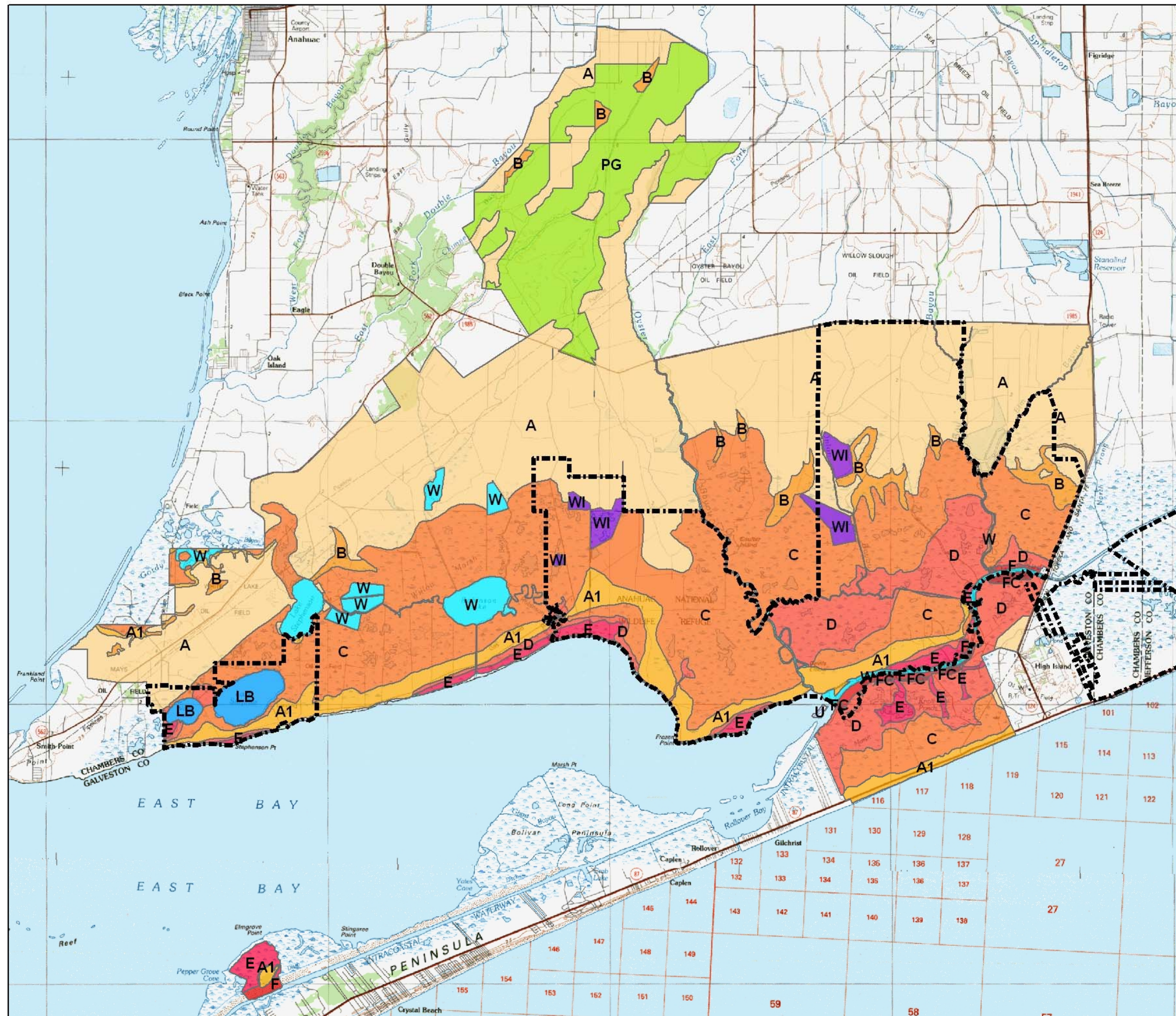
- **East of High Island** – Intermediate and brackish marsh. Contains two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent. High quality wintering and migrational habitat for waterfowl and other wetland-dependent migratory bird species. Intertidal areas are utilized by a variety of commercial and recreational activities important to marine organisms. There are no known unique community types in this area.
- **Middleton Prairie** – Non-saline prairies of which a significant component is prairie/grassland. Contains one of the largest remnant native coastal tallgrass prairie tracts on the Texas Upper Coast. This area also has one nationally recognized declining wetland type - the palustrine emergent. High habitat value for waterfowl, particularly for the resident Mottled Duck and for many species of grassland-dependent migratory birds. Unique community type within the Texas Chenier Plain region is the prairie/grassland habitat type.
- **Willow Slough Marsh** – Fresh marsh and non-saline prairie (prairie/agriculture). Contains the last large and relatively intact marsh in the Texas Chenier Plain which provides high quality habitat for waterfowl, other migratory birds, and for a great variety of plant and wildlife species dependent on this wetland type. Two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent. Contains two large coastal woodlots, a unique community type in the Texas Chenier Plain region.
- **Oyster Bayou Marsh** – Non-saline prairie (prairie/agriculture) with intermediate marsh. Contains two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent. High quality wintering and migrational habitats for waterfowl and other wetland-

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

- **Robinson Bayou** – Non-saline prairie (prairie/agriculture) and intermediate marsh (over 80% of the area). Contains two nationally recognized declining wetland types - estuarine intertidal emergent and palustrine emergent wetland types. High quality wintering and migrational habitats for waterfowl and other wetland-dependent migratory bird species. This area has several coastal woodlots, a unique community type in the Texas Chenier Plain. Contains prairie/grasslands, a unique community type within the Texas Chenier Plain region.
- **Taylor's Bayou** – Over 60% of this area contains forested wetlands which provide a high quality habitat for migrating neotropical migratory birds and wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species. Forested wetland is one of the nationally recognized declining wetland types. It is also considered a unique community type within the Texas Chenier Plain region.
- **Elm Bayou** – Non-saline prairie (prairie/agriculture). Contains one nationally recognized declining wetland type - Palustrine emergent wetland type. Rice croplands are currently managed such that they provide high quality wintering and migrational habitats for waterfowl and other wetland-dependent migratory bird species. A small but important riparian area is located along Elm Bayou. No unique community types.
- **Lower Marsh** – Brackish marsh with one nationally recognized declining wetland type - estuarine intertidal emergent wetlands. Moderate habitat value to waterfowl and other migratory birds. Intertidal areas are utilized by a variety of commercial and recreational activities. These areas are important to marine organisms. Has an established beach dune system which may reduce coastal erosion rates. No known unique community types.

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

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



Vegetation Types on the Moody and Anahuac NWRs

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

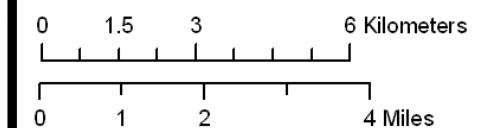
This map is meant for use in viewing relative positions and sizes of the habitats at small scales.

Legend

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

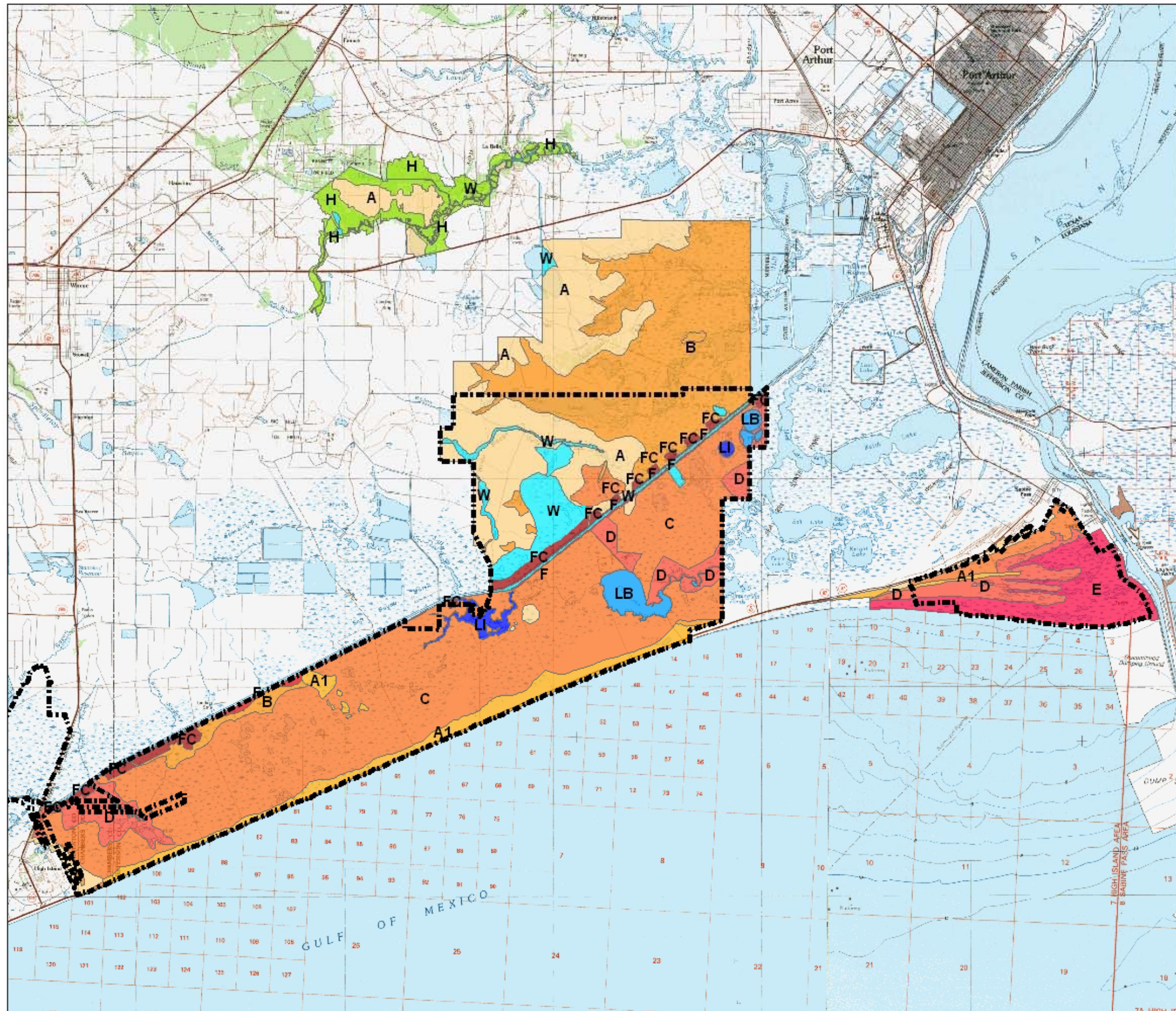
Refer to Table 3-2 *Common Plants of Wetland and Aquatic Habitats*, in Chapter 3, for a list of indicator species commonly associated with the marsh types.

Scale = 1:135,996



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Vegetation Types on the McFaddin and Texas Point NWRs

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

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

Legend

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

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

Scale = 1:183,182



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B. Fish and Wildlife Resources

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

1. Avian Species

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

a. Waterfowl

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

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

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

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

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

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

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

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

Table 3-11.

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

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

* Survey not conducted in February 2002 and 2003.

Table 3-12.

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

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

* Survey not conducted in February 2002 and 2003.

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

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

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

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

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

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

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

b. Resident Waterfowl - Mottled Ducks

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

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

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

c. Shorebirds, Wading Birds, Marsh, and Waterbirds

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

Shorebird counts were conducted along the Texas Coast between March 22 through May 17 during two-week intervals in the spring of 1993 (Lee Elliot, USFWS biologist personal communication, February 2000). Peak numbers of shorebirds were recorded between March 22 and April 12 at three sites in or near the project area (Bolivar Peninsula, Anahuac NWR, and Harris/Waller counties). The Bolivar Peninsula, site of the Houston Audubon Society’s Bolivar Flats Shorebird Preserve, had the greatest shorebird concentrations with over 17,000 birds observed. The most abundant species observed during the surveys were American avocet, western sandpiper, long-billed and short-billed dowitchers, semi-palmated sandpiper, pectoral sandpiper, black-bellied plover, dunlin, sanderling, willet, semi-palmated plover, least sandpiper, and snowy plover. All of these species occur on the Refuge Complex. Common nesting shorebirds species on the Refuge Complex include killdeer, black-necked stilt, and willet. Other shorebird and related species commonly observed on the Refuge Complex include long-billed curlew, Wilson’s snipe, ring-billed gull, laughing gull, herring gull, least tern (a nesting species), royal terns, and Caspian terns (USFWS 1997a).

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

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

d. Migratory and Resident Landbirds

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

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

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

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

e. Avian Species of Conservation Concern

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 3-19.

Waterbird species classified into risk categories as “High” or at “Moderate” under the North American Waterbird Conservation Plan which occur on the Texas Chenier Plain Refuge Complex.

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

2. Fisheries Resources

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

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

and Management Act (MSFCMA) (P.L. 104 - 297).

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

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

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

3. Threatened and Endangered Species

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

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

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

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

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

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

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

** Not listed

***Proposed delisting

a. Federally-Listed Threatened and Endangered Species

Sea Turtles

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

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

Bald Eagle

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

Brown Pelican

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

Piping Plover

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

American Alligator

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

b. State of Texas-Listed Threatened and Endangered Species

Arctic Peregrine Falcon

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

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

Bachman's Sparrow

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

Reddish Egret

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

Wood Stork

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

White-faced Ibis

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

Least Tern

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

American Swallow-tailed Kite

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

Alligator Snapping Turtle, Smooth Green Snake, Texas Horned Lizard

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

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

4. Mammals, Reptiles, Amphibians, and Invertebrates

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

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

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

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

Alligators received protection under the Endangered Species Act in 1974, when they were listed as Endangered. Following population increases, the listing status was changed to Threatened due to similarity of appearance with the Endangered American crocodile. Harvest of alligators in Texas was reinitiated in 1980. Alligators are harvested on the Refuge Complex, and this program is managed as a compatible refuge economic use. Harvest quotas for the refuges are set by the Texas Parks and Wildlife Department. Annual harvests on the Refuge Complex from 1998 to 2004 ranged from 211-649 alligators and averaged 382 alligators (USFWS unpublished data).

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

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

III. CULTURAL RESOURCES

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

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

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

The following cultural resource discussion is a compilation of information gathered from the Handbook of Texas Online (<http://www.tsha.utexas.edu/>), data forms obtained from TARL from surveys conducted for sponsor-initiated projects on the Refuge Complex, and published information on the archeological and ethnohistoric resources of the project area, for which the primary sources are Aten (1979), Fox (1983), and Story *et al.* (1990).

Prehistory Period

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Historical Period

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

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

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

Sabine Pass, at the natural opening between Sabine Lake and the Gulf of Mexico, served as important seaport connection that fostered the growth of Port Arthur. A civil war battle occurred at Sabine Pass in 1863. The United States Navy barricaded the Texas coast beginning in the summer of 1861, while Confederates defended the major ports. Lt. Richard W. Dowling led the Confederates during the Battle of Sabine Pass to turn back one of several Union attempts to invade and occupy part of Texas during the Civil War. Federal efforts to improve navigation across the bar that once blocked the entrance of deepwater vessels to the Sabine River began during the 1870s. The Sabine-Neches, or Port Arthur Ship Canal, was dug during 1897 and 1898 from Sabine Pass to Port Arthur.

The Spindletop oilfield was discovered on a salt dome formation south of Beaumont in eastern Jefferson County in 1901. The discovery marked the birth of the modern petroleum industry. The Texas Company (now Texaco), Gulf Oil Corporation (now Chevron), Sun Oil Company, Magnolia Petroleum Company (now Mobil), and Humble (now Exxon) were a few of the major corporations. The discovery of oil and the development of the Spindletop oilfield provided a major impetus for further canal development. The Rivers and Harbors Act authorized a second major survey of inland waterways in 1905. By 1920, the Gulf Intracoastal Waterway (GIWW) had crossed the southern part of the Jefferson County. By 1940,

major industries included oil refining, shipbuilding, rice milling, food processing, and the manufacture of machinery, chemicals, garments, and crates.

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

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

IV. REFUGE COMPLEX MANAGEMENT PROGRAMS

A. Habitat Management and Restoration

1. Wetland Specific Management and Restoration

a. Water Management in Coastal Marshes

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

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

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

Managed marsh units within the Refuge Complex are under varying degrees of structural control, and may best be described as marsh semi-impoundments. A small number of units lie almost entirely behind man-made levees and water control structures, which allows for relatively intensive management of water levels and salinities through manipulation of the water control structures. Conversely, hydrologic regimes in less-intensively managed marsh units are influenced primarily by daily and seasonal tidal fluctuations, precipitation and natural topography.

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

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

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

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

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

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

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

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

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

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

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

b. Marsh Restoration

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

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

Shoreline stabilization (see below) methodologies have included restoration of intertidal marshes, primarily in the intertidal zone between existing shorelines and constructed offshore wavebreaks. Smooth cordgrass rootstock is planted by hand in these areas and rapidly colonizes, creating habitat important to marine organisms and which also are heavily used by many wading bird species. Approximately 30 acres of estuarine intertidal emergent marsh have been restored on the Refuge Complex for this purpose, along the Galveston Bay shoreline on Anahuac NWR and along the GIWW shoreline on McFaddin NWR.

c. Cooperative Rice Farming Program

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

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

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

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

Pest management problems associated with rice production at Anahuac NWR are infestations of red rice, annual grasses, sheath spot or blight (*Rhizoctonia oryzae-sativae*) and army worms. Flooding fields is a valuable technique used to limit insect damage to rice. Therefore, insecticides are seldom required. Crop diseases can occur, but no fungicides have been approved for use on the Refuge because they are incompatible with the grazing program. Cropland management involves techniques to reduce the infestations of the native red rice, which is a non-marketable form of rice. Since fallow fields provide ideal

conditions for red rice growth, most fields are drained until the field is cultivated prior to planting. Fields lay fallow for one to two years before being planted again to prevent insects or red rice problems. Red rice can be removed by foraging waterfowl (Baldwin 1981). Ordram is the primary chemical herbicide used to control red rice in the project area, but is rarely used on the Refuge and only in circumstances when infestations reach the point requiring its use. Most applications of herbicides and fertilizer in rice farming operations in southeast Texas are done by air. Fields in crop rotations are disced every three years to prevent exotic species like Chinese tallow and deep-rooted sedge from establishing.

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

d. Moist Soil Management

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

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

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

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

The diversity of native plants and invertebrates produced utilizing moist soil management provides habitat for more species of waterfowl and other wetland wildlife than do commercial row crops. The efficiency of modern harvesting equipment leaves less waist grain for waterfowl. The total energy of moist soil foods is often as high as or higher than corn, milo and soybeans (Frederickson and Taylor 1982). Waterfowl foods produced by moist soil management are not as affected by weather events, fungus or disease that can reduce production or cause entire cultivated crops to fail. Natural wetlands also provide greater numbers of invertebrates than do cereal grain crops. Moist soil management practices that favor perennial plants like smartweed or submerged aquatics which have more finely dissected leaf structures produce more invertebrates. Invertebrates are also important to waterfowl during the wintering period. Several species of wintering waterfowl molt during the winter, and invertebrates provide important sources of protein required to complete these winter molts.

2. Upland Specific Management and Restoration

a. Native Prairie Restoration

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

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

Approximately 4,420 acres of mixed grassland non-saline uplands occur on the Anahuac NWR. Of this total, approximately 2,914 acres are permanently fallowed agricultural fields which have revegetated over time by native and non-native grasses, forbs and woody vegetation. Restoration activities including transplanting or sprigging of native grasses and forbs and seeding have occurred on some of these mixed grassland units in an effort to increase abundance and diversity of native plants in these habitats. Once a prairie grassland stand is successfully established, prescribed fire and rotational grazing are used to maintain the habitat.

The highest quality native prairie on Anahuac NWR occurs in relatively small, fragmented areas which were never cultivated or were cultivated for a relatively short time. These remnant prairie areas total approximately 1,065 acres. Approximately 1,152 acres of non-saline prairie grasslands occur on McFaddin NWR, almost all of which are found on the North Unit. A total of 172 acres of non-saline prairie grasslands occur on the northern portion of Texas Point NWR. Grassland habitats on these refuges have not been cultivated, but have been reduced in quality by a variety of factors including invasion by exotic Chinese tallow and McCartney rose.

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

region. To date, approximately 441 acres of permanently fallowed cropland have been intensively restored to native prairie using these techniques on Anahuac NWR's East Unit.

b. Coastal Woodlot Restoration and Protection

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

There are approximately 57 acres of coastal woodlots and riparian woodlands on Anahuac NWR, 60 acres of woodlots on the chenier ridges on Texas Point NWR, and 10 acres of woodlots on McFaddin NWR's North Unit. Coastal woodlot restoration and protection activities on the Refuge Complex include: 1) native tree and shrub plantings; 2) exotic/invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

3. General Habitat Management and Restoration Activities

a. Fire Management

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

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

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

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

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

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

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

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

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

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

the flashy fuels present on the Refuge Complex and the fact that a common suppression strategy involves burning out from established fuel breaks.

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

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

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

b. Controlled Livestock Grazing

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

The grazing program on the Refuge Complex involves cow-calf operations with some bulls introduced for breeding. The cow bloodline is a mixed breed of Zebu ancestry, with Brahma, Angus or Charolais bulls used for breeding. Using a graze-rest strategy, permittees typically graze coastal marshes during the cool season, generally October through April. Some warm-season grazing on non-saline upland grasslands currently occurs on Anahuac NWR. Between 1998 and 2005, an average of 11,501 (range 8,884 – 14,451) animal unit months (AUMs) occurred annually on Anahuac NWR, an average of 10,489

(range 4,778 – 14,275) AUMs occurred annually on McFaddin NWR, and an average of 761 (range 0 – 1,140) animal unit months (AUMs) occurred annually on Texas Point NWR. Grazing strategies include variations in stocking rates, timing (cool vs. warm season) and duration. Stocking rates and rotations are determined annually according to management objectives for the various grazing units and the quantity and condition of forage in those units, and are often influenced by the availability of freshwater. Grazing does not take place uniformly across units, particularly in coastal marshes. Cattle tend to concentrate grazing pressure adjacent to upland areas with decreased grazing pressure with increasing distance from high ground. Acres grazed and grazing pressure varies from year to year.

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

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

c. Shoreline Restoration and Stabilization

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

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

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

Shoreline restoration/stabilization efforts on Anahuac NWR have been ongoing for the last 25 years. The north shore of East Galveston Bay has experienced steady erosion over time. Some areas have been eroding at 1.2 meters annually (Carrol 1974, USFWS 1992). Continuous erosion threatens approximately 6,000 acres of inland brackish and intermediate marshes from excessive saltwater intrusion and roads with destructive wave action. Several shoreline stabilization studies were conducted on the Anahuac NWR to develop effective shoreline protection techniques which involved locating the most suitable native plant species capable of establishment for stabilizing the shoreline and determining an effective material to serve as a wave stalling device (Webb 1974, Webb and Dodd 1976, 1978). Breakwaters enhance marine habitat in the bay as they function as an artificial reef and provide excellent opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. The smooth cordgrass provides habitat for snails, shrimp, crabs, insects, and numerous benthic organisms. Breakwater structures also enhance recreational fishing opportunities along the bay shoreline. Numerous efforts to stabilize the eroding shoreline on Anahuac NWR have involved the placement of barriers of shell and stone on the eroding shoreline, restoring vegetation along Galveston Bay, and the construction of offshore wave breaks and sprigging smooth cordgrass transplants immediately behind it. The latter methodology has been the most effective.

d. Invasive Species Management

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

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

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

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

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

Chinese Tallow (*Sapium sebiferum*)

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

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

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

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

Water hyacinth (*Eichhornia crassipes*)

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

Water lettuce (*Pistia stratiotes*)

Water lettuce is an exotic floating aquatic plant found in fresh water habitats. It is found in stable fresh water habitat protected from wind and current. The plant can form dense mats which can cover open water and shade out beneficial native plants. It spreads from seeds and plant fragments. Water lettuce is found in several reservoirs on the refuge complex. Water lettuce also clogs navigation channels, water delivery canals and water control structures. Water lettuce is likely introduced from whole plants attached

to boats, boat trailers or any equipment which moves through established stands. Once the plant becomes established it is very difficult to eradicate. Water lettuce is controlled using water level draw downs which expose plants to extreme frosts, water with salinities greater than 10 ppt, mechanical removal and spot herbicide treatments. Entry points to water delivery locations and pumps must be screened off to prevent plant from clogging infrastructure or infesting new areas.

Alligatorweed (*Alternanthera philoxeroides*)

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

Deeprooted Sedge (*Cyperus entrerianus*)

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

Johnson grass (*Sorghum halepense*)

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

Vasey grass (*Paspalum urvillei*)

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

Common Salvinia (*Salvinia minima*)

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

Giant Salvinia (*Salvinia molesta*)

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

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

Cattail (*Typha spp.*)

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

Common reed or Phragmites (*Phragmites australis*)

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

Eastern baccharis (*Baccharis halimifolia*) and big-leafed sumpweed (*Iva frutescens*)

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

Sesbania, coffee bean-rattle box, bag-pod (*Sesbania spp.*)

There are several species of Sesbania which occur on the Texas Gulf Coast. All of the Sesbania species can form dense colonies which can preclude use by many marsh wildlife species. Dense colonies cover valuable refuge open water habitat, reservoirs, rice fields and moist soil impoundments precluding use by shorebirds, wading birds and migratory waterfowl. *Sesbania macrocarpa* seeds do have some wildlife value while *Sesbania vesicaria* and *Sesbania drummondii* provide few wildlife values. *Sesbania vesicaria* and *S. drummondii* are found in fresh water habitats while *S. macrocarpa* can be found in salinities as

high as 10 ppt (Stutzenbaker 1999). When these plants form dense stands they can shade out beneficial food plants used by migratory waterfowl. All plants have abundant seeds sources and typically germinate in summer when soils are exposed or during droughts. Roller chopping can be use to control *S. vesicaris* and *S. macrocarpa*, however when possible a summer draw-down and mowing and/or discing is necessary to remove dense stands of *S. drummondii*. *S. drummondii* is a perennial and plants can reach 4-5 inches in diameter at the base making control difficult. Herbicides labeled for aquatic use can be used to treat on small stands.

Japanese honeysuckle (*Lonicera japonica*)

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

Feral Animals

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

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

Nutria

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

Red Imported Fire Ants

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

B. Biological Program – Surveys, Monitoring, and Research

The primary mission of the biological program on the Refuge Complex is to collect sound and accurate data for use in guiding refuge management and making management decisions. This program collects data that are applicable at various scales. Some work relates to flyway or continental level populations, while other projects are only applicable to Refuge or unit level. Regardless of the scale of the project,

inventory, monitoring and research is generally designed to provide feedback in the adaptive management cycle. Well designed data collection and analyses provide the basis for good resource management decisions.

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

1. Habitats and Vegetation

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

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

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

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

2. Waterfowl – Wintering and Migrating

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

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

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

Continued banding of snow geese on Anahuac NWR will provide insight to spring migration corridors and the impacts of the Light Goose Conservation Order.

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

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

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

3. Waterfowl – Resident (Mottled Ducks)

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

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

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

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

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

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

In addition, periodic spring and fall shorebirds surveys are conducted in various wetland habitats. Recent periodic shorebird surveys have accumulated sufficient data to qualify Anahuac NWR as a Site of International Importance under the Western Hemisphere Shorebird Reserve Network. Annual surveys are done for colonial nesting waterbirds on Gulf shoreline of Texas Point NWR and McFaddin NWR.

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

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

6. Fisheries

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

7. Threatened and Endangered Species, Species of Conservation Concern

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

8. Mammals

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

9. Reptiles and Amphibians

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

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

10. Invertebrates

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

C. Public Use Program

Guidance for authorizing public uses on National Wildlife Refuges (NWRs) is provided in the National Wildlife Refuge System Improvement Act (the Act) of 1997 (P.L. 105-57). The Act states, "Compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System . . . through

which the American public can develop an appreciation for fish and wildlife.” The Act recognizes that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation, when determined to be compatible, are legitimate and appropriate public uses of the Refuge System that should receive priority consideration in refuge planning and management.

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

Combined, the Refuge Complex received over 172,000 visitors during Fiscal Year 2002. Highest visitation in FY02 occurred on McFaddin NWR, which received 94,600 visitors, with the primary use being

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

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

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

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

1. Hunting and Fishing

a. Hunting

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

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

(1). Anahuac NWR

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

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

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

(2). McFaddin NWR

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

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

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

(3). Texas Point NWR

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

b. Fishing

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

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

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

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

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

a. Wildlife Observation and Photography

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

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

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

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

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

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

b. Environmental Education and Interpretation

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

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

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

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

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

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

c. Beach Uses

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

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

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

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

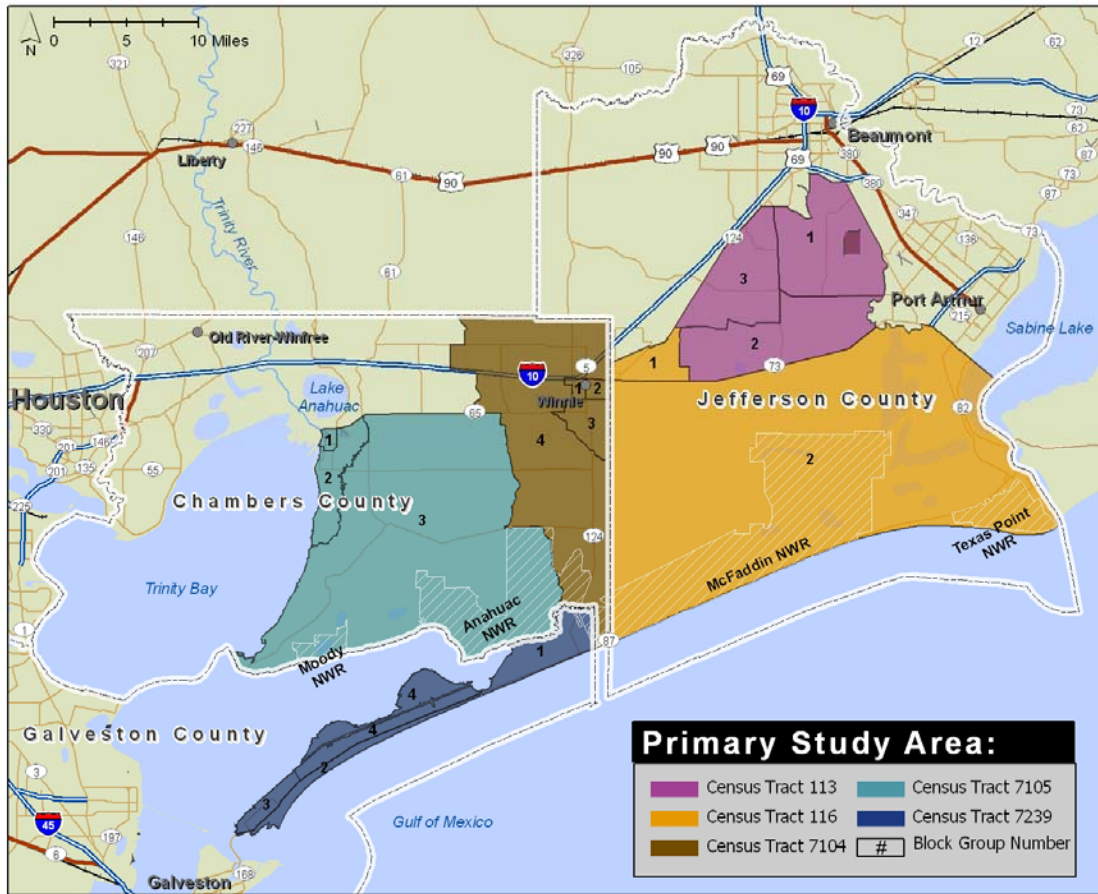
d. Other Public Uses

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

D. Community Outreach and Partnerships

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

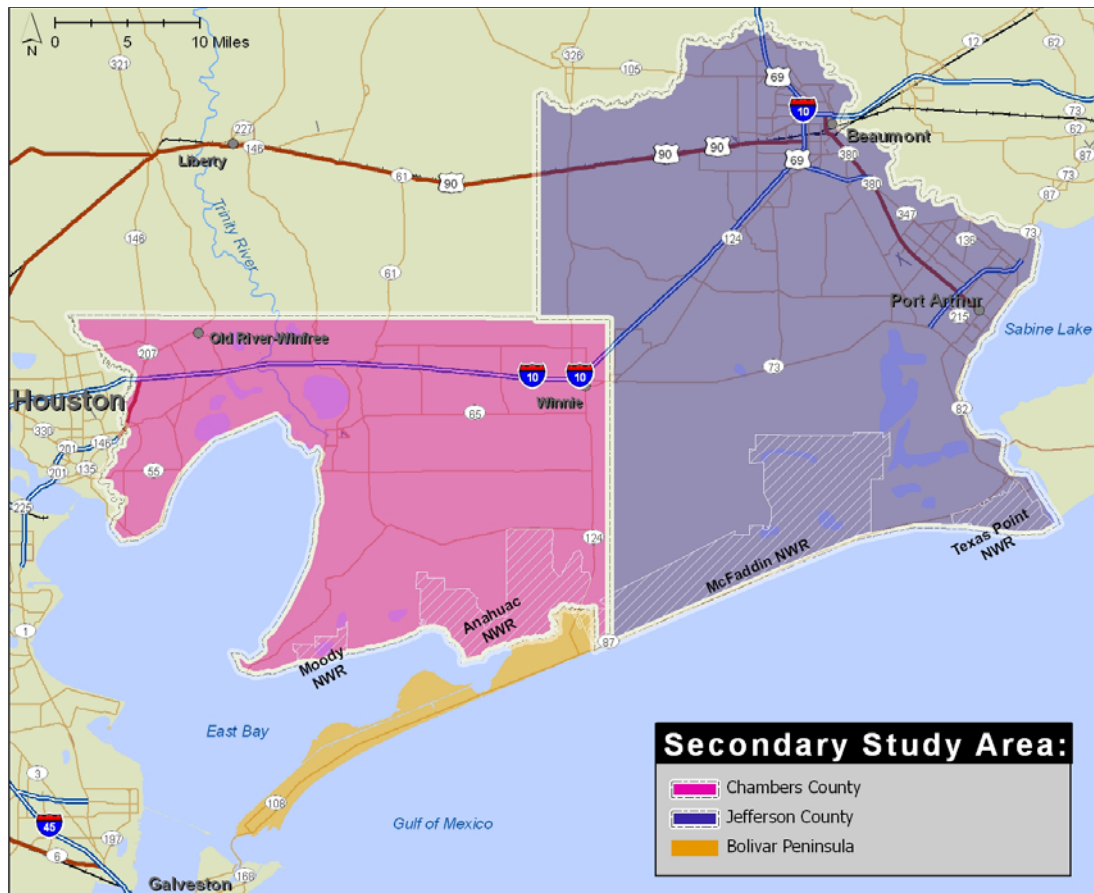
The Refuge Complex has also established partnerships with several private landowners in the area to restore and enhance wetland and upland habitats on private lands. Refuge Complex staff provide technical assistance on habitat restoration and management activities and facilitate development of partnerships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



V. SOCIOECONOMIC ENVIRONMENT

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

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



A. Land Use

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

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

1. Land Use Overview

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

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

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

Most of the active cropland and farming activities in both counties can be found in areas inland of direct marine influence along the Gulf. This land is higher in elevation and less susceptible to tidal flooding and salt influence. Rice farming requires freshwater supplies and non-saline soils. Grazing occurs throughout both counties.

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

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

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

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

2. Land Conservation and Wildlife and Habitat Protection

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

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

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

3. Agricultural Use

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

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

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

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

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

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

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

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

Rice as a major agricultural product in the area depends on cultivation to maximize production. This crop is primarily used for human consumption, but it also provides food for

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

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

Pastureland in the area consists of improved and unimproved pasture. Improved pasture contains low successional native grasses and forbs characteristic of native prairie, but may also contain forage crops

for cattle. These areas primarily support cattle production through cow-calf operations, but they also support a variety of wildlife including several species of reptiles, a number of amphibian species, and several species of resident mammals. These lands also provide habitat for a number of migratory birds.

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

4. Recreation Resource Use

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

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

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

Between fiscal years 2001 and 2002, visitation to Sea Rim State Park decreased by 4 percent from 62,676 to 60,122 visitors. In the same period, visitation to the Sabine Pass Battleground State Park & Historic Site increased by nearly 2 percent from 50,357 to 51,348 visitors. Sea Rim State Park is currently closed due to damage suffered during Hurricane Rita in September 2005.

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

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

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

5. Oil and Natural Gas Development Use

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

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

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

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

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

6. Developmental Use

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

However, from a developmental support perspective, there may be indirect conflicts between existing land uses involving Refuge Complex land ownership and management. Some land that could be acquired by the USFWS and added to Refuge Complex land holdings would be developable for residential and industrial purposes, or may be desired by State agencies or local special purpose

agencies for use either within State Parks or as part of drainage and flood control districts. Some of these scenarios would result in competing and mutually exclusive land use decisions. Furthermore, some of these uses, such as flood control, could promote economic development of other local areas.

7. Additional Land Ownership Considerations

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

B. Economic Characteristics

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

1. Employment

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

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

2. Personal Income

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

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

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

Labor income consistently accounts for the greatest percentage of personal income for these two counties and the State of Texas. In 2000 labor income accounted for 72 percent of personal income in Chambers County, 63 percent in Jefferson County and 74 percent statewide. Income derived from non-labor sources has remained relatively constant in Jefferson and Chambers Counties averaging 36 percent and 25 percent respectively.

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

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

3. Per Capita Income

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

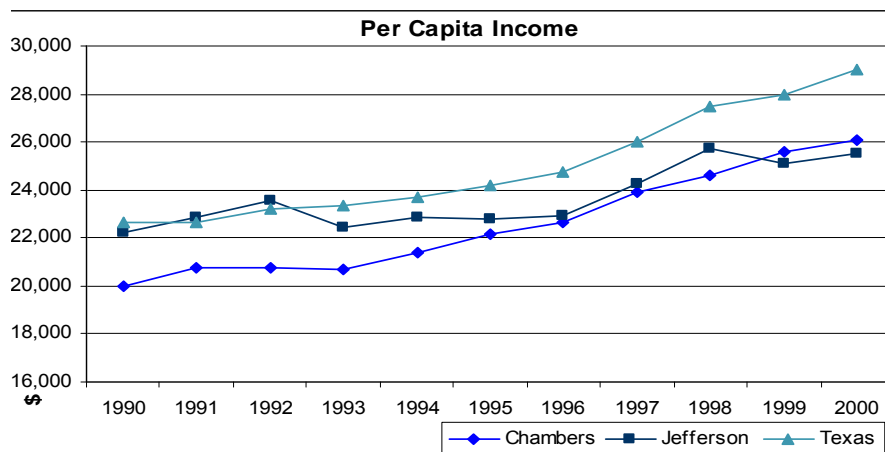


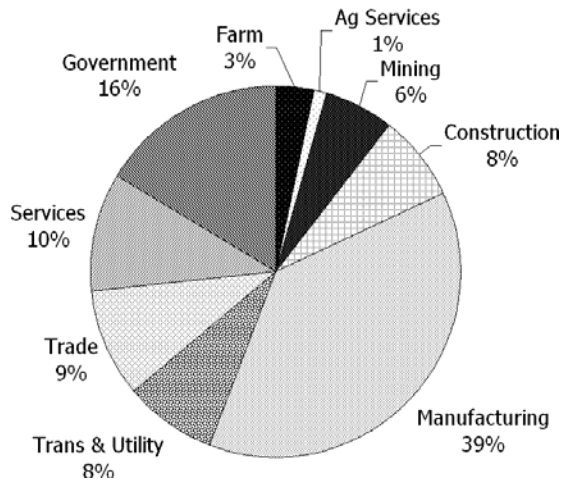
Figure 3.1 Per Capita Income for the Study Area and State of Texas 1990-2000.

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

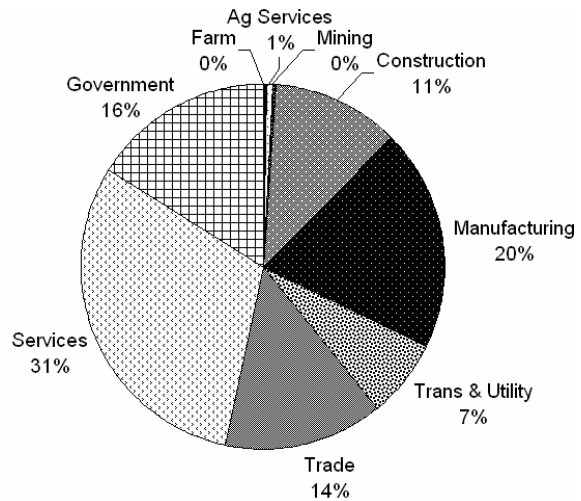
Total earnings by industry for Texas and the counties in the study area for 1990 through 2000 were also

obtained from BEA. Figures 3.2 and 3.3 provide a summary of earnings share by industry for the study area.

Earnings from the services sector comprise the majority of the earnings statewide in Texas accounting for over 25 percent of earnings. The same result also appears in Jefferson County where the service industry accounts for 31 percent of the earnings in 2000. The situation in Chambers County differs substantially from Jefferson County and the statewide condition. Manufacturing is the largest component of earnings



3.2 Chambers County Earnings by Industry



3.3 Jefferson County Earnings by Industry

with a share of 39 percent. The service sector, which accounted for 10 percent of total earnings in 2000, ranks third in the county behind manufacturing and government sectors.

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

4. Average Earnings by Industry

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

5. Unemployment

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

Location	Change in Civilian Labor Force (1992-2000)	Change in Civilian Labor Force (1992-2000)
Texas	1,225,744	15%
Chambers County	1,923	19%
Jefferson County	-5,516	-5%

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

6. Economic Base Industries/Location Quotients

An area's economic base is composed of industries that are primarily responsible for bringing outside income into the local economy. These industries typically export their goods and services outside the

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

Table 3-25
Location Quotients for Chambers County

location quotient was calculated for both employment and income and compares each industry's share of total local employment or income to the industry's state or national share. This

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

Table 3-26
Location Quotients for Jefferson County

sector. When compared to the national economy, farming and agricultural services show an even greater industry concentration, while mining becomes less concentrated. In Jefferson County the quotients indicate a stronger reliance on construction and manufacturing compared to the state. The farming and mining sectors show the most significant difference by being much less concentrated. In comparison to the national economy there is a higher employment concentration in the several industries in terms of employment while income concentration is similar to that of the rest of the country.

C. Major Industries in the Study Area

1. Agriculture

The importance of agriculture varies within the study area. For instance, farm and farm services comprised less than one percent of total earnings and less than 2 percent of total employment for Jefferson County in 2000. However, in Chambers County farm and agricultural services are more

region and in turn support ancillary industries such as retail trade, housing construction and personal services. The location of important industries in certain areas has traditionally been tied to such factors as natural resource base, cost factors (transportation and labor) and existing transportation infrastructure. However, technology has affected these location factors.

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

Table 3-25 and 3-26 indicate the two county study area is similar to the state's economy as a whole. Industries that do show a stronger concentration in Chambers County compared to the state's economy include farming, agricultural services and manufacturing. One industry that is weak in this area compared with the state is the services

Table 3-27

Acreage, Yield and Production for Rice, 2000 and 2001*

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

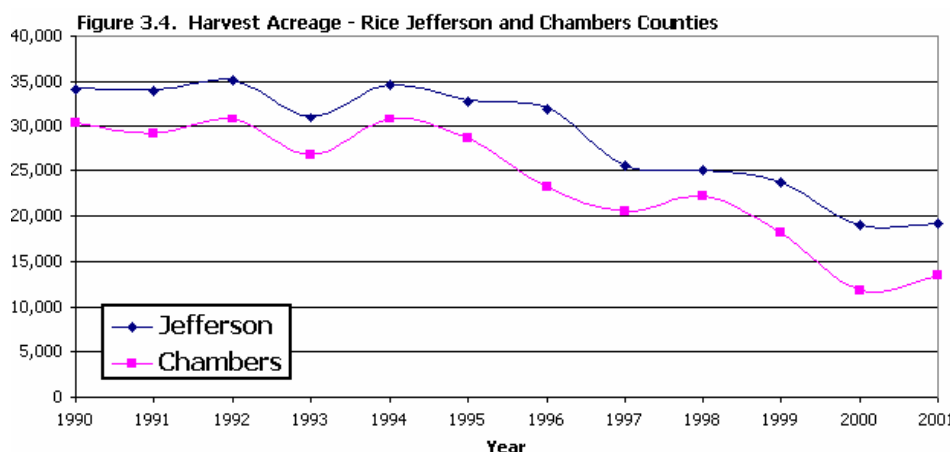
*Source: Texas Agricultural Statistical Service, "2001 Texas Agricultural Statistics", Austin Texas.

important to the local economy accounting for 10 percent of total employment and 4 percent of total gross earnings. The importance of this industry by county is also apparent in the location quotients discussed in the last section. A larger percentage of employment and income is concentrated in farm and farm services in Chambers County relative to the State of Texas and the U.S. However, Jefferson County does not exhibit as strong a relationship to agriculture though it is more important in this county than other areas of the country.

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

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

Acreage used for rice production has been declining in both Chambers and Jefferson counties throughout



the last decade as summarized in Figure 3.4. In 1990 harvest acreage for rice in both counties exceeded 30,000 acres but steadily declined to current levels shown in Table 3-27. Much of this decline follows trends throughout Texas. Rice production² has declined in Texas due to increased production cost, decreased profits,

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

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

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

and landlord tenant issues created from direct payment changes in the 1996 Farm Bill. Texas is the highest cost area for production in the U.S due to the three-year rice rotation schedule.

Rice crops planted on this schedule require two-thirds of the acreage to be left fallow for two years without the ability to plant other crops in the rotation. The soils and climate in this area are not suitable for planting other crops, and rice is prone to weed invasion thus increasing the costs of production. The depressed market for rice has also impacted this area. Falling prices have resulted in reduced profits as well as a reduction in acreage. Throughout the area, more land has been lost west of Houston than east of Houston, however, acreage east of Houston produces lower yields. Land area used for rice production was declining before 1996, but this trend accelerated after 1996.

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

Other significant crops produced in Chambers and Jefferson counties include soybeans, sorghum, wheat

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

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

* Less than 1,000 acres planted

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

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

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

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

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

2. Livestock

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

3. Agricultural Production in the Primary Study Area

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

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

4. Oil and Gas Production and Refineries

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

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

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

Source: Railroad Commission of Texas, February, 2003.

* Inactive well with valid 14 (B)(2) extension.

Chambers and Jefferson counties are no exception to the Texas Coast reliance on petroleum and natural gas exploration and production and petroleum based refining. This began with the discovery of the Spindle Top Gushers in Jefferson County and continues today. Of the 100,000 individuals employed in private industry in Jefferson County, ten percent are employed in the petroleum or petrochemical industry with an annual payroll that represents 20 percent of the total private sector payroll in 2000.³ The petroleum and chemical manufacturing industries in Chambers County accounted for thirty-seven percent of total private industry employment and 60 percent of total private industry annual payroll.

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

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

Source: Railroad Commission of Texas, February, 2003.

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

5. Oil and Gas Activities on the Refuge Complex

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

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

Currently one operator holds lease in the Clam Lake Oil and Gas Field within the McFaddin NWR. The lease covers several small producing wells in addition to shut-ins wells operated under 14(B) exemptions. Facilities include separators and tank batteries, flowlines, office and storage buildings, roads, etc. Oil is

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

removed from refuge primarily by off-loading from tank battery to barges in Gulf Intracoastal Waterway. Natural gas is piped off-site.

There are also several pipelines that cross the Refuge Complex and support oil and gas activities offshore and onshore. Most of these pipelines were preexisting to the establishment of the wildlife refuges. This includes two pipelines that cross the Anahuac NWR from offshore and support gas production. A tributary line, which also crosses Anahuac, supports gas production on neighboring private property. Three permitted and active pipelines that support production offshore currently cross the McFaddin NWR. An additional pipeline that crosses this refuge is used by U.S. Department of Energy for the transport of brine from the Big Hill Strategic Petroleum Reserve facility for disposal in the Gulf of Mexico. Several other pipelines that cross McFaddin have been abandoned in recent years. Texas Point NWR has two permitted and active pipelines that cross within its boundaries.

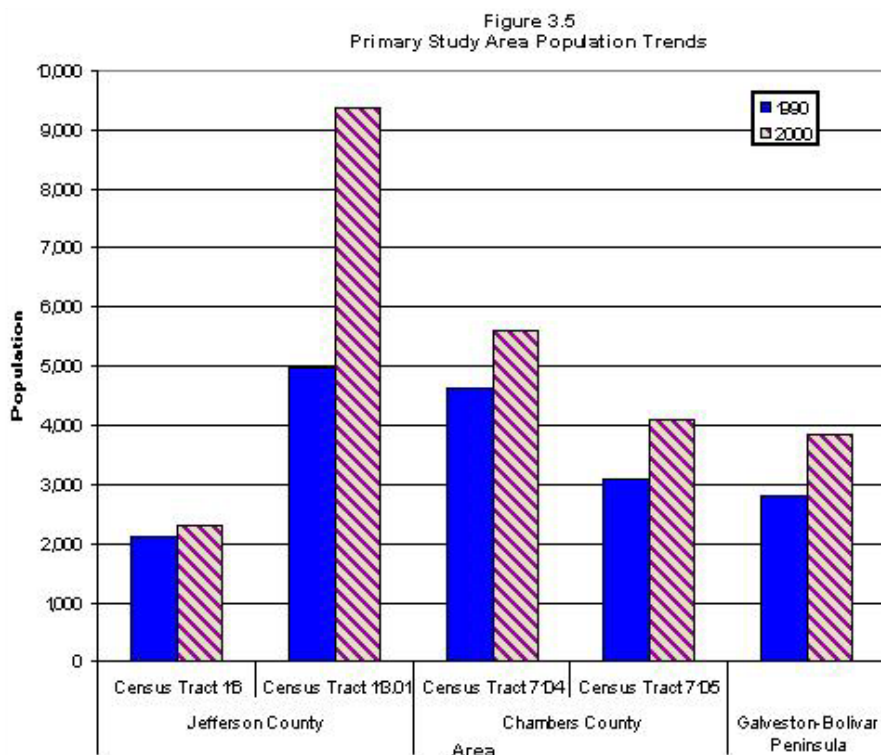
6. Recreation

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

7. Refuge Complex Operations

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

and purchase of equipment and supplies.



D. Demographics

1. Population Trends

a. Secondary Study Area

Overall, population increased by 4.1 percent in the secondary study area over the last two decades with an annual average population increase of 0.2 percent. During the 1980s, the area experienced a population decline of 2.9 percent with an annual average population decrease of 0.3 percent. During the 1990s, however, the population rose by 7.2 percent with a 0.7 percent annual average increase.

The largest annual increase in the secondary study area population was experienced more recently at 4.8 percent in 2000 (4.4 percent in Jefferson County and 8.5 percent in Chambers County).

b. Primary Study Area

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

2. Migration Patterns

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

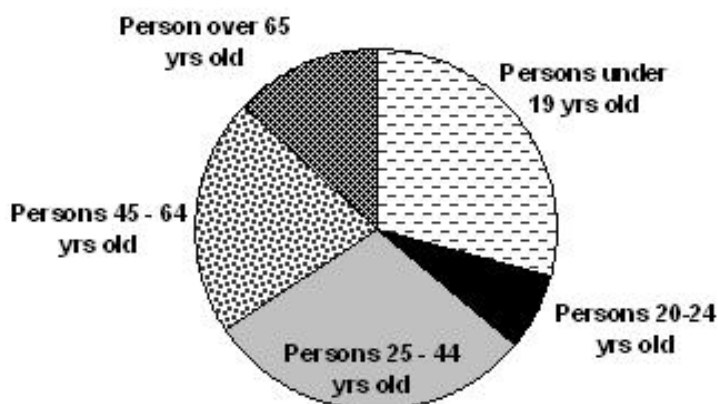
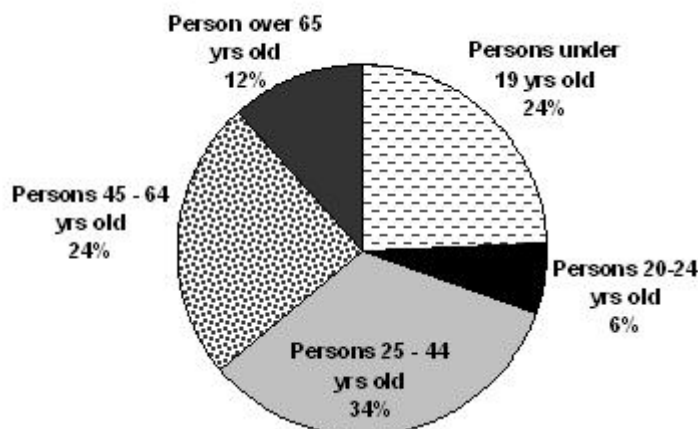


Figure 3.6
Age Distribution Within the Secondary Study Area (2000)
Source: US Census Bureau

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



3. Population Characteristics

a. Age

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

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

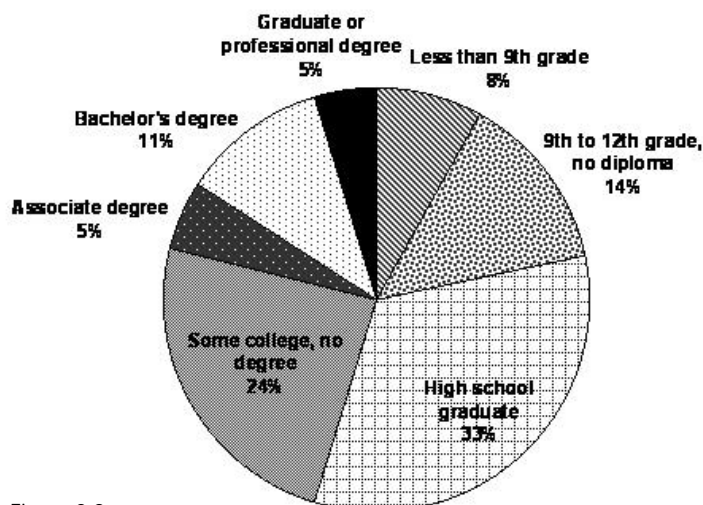


Figure 3.8
Educational Attainment Within the Secondary Study Area (2000)
Source: US Census Bureau

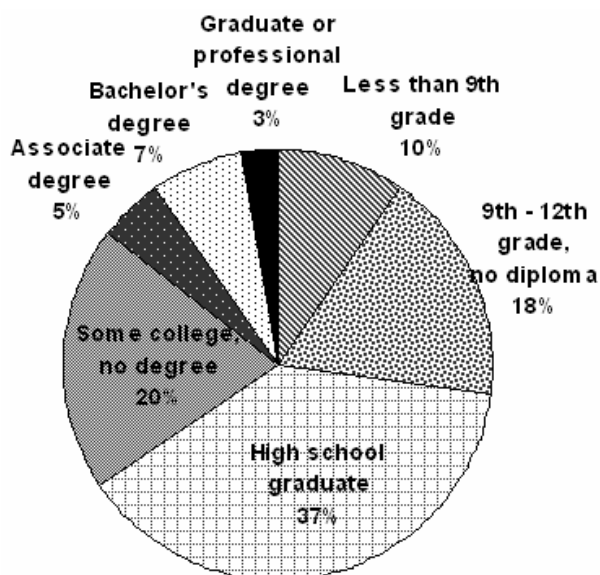


Figure 3.9
Educational Attainment Within the Primary Study Area (2000)

b. Education

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

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

4. Environmental Justice

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

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

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

Low-income populations are defined as those below the federal poverty thresholds. Low-income populations are identified using statistical poverty thresholds from the Bureau of Census of \$17,463 for a family of four (the 1990 poverty guideline was \$13,254). While rigid guidance is provided to determine the composition of a minority population for an analysis, best judgment is the only recommended tool for low-income populations. EPA identifies a low-income community as an area with a significantly greater population of low-income families than a statistical reference area.⁴ A good statistical reference area for this project is the secondary study area, which has a 14.2 percent poverty rate; poverty rates ten percentage points above the secondary study area would be significantly higher. For the purposes of this analysis, low-income populations will be defined as an area where the low-income population exceeds 25 percent poverty or if isolated pockets of large low-income populations are present.

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

a. Minority Populations

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

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

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

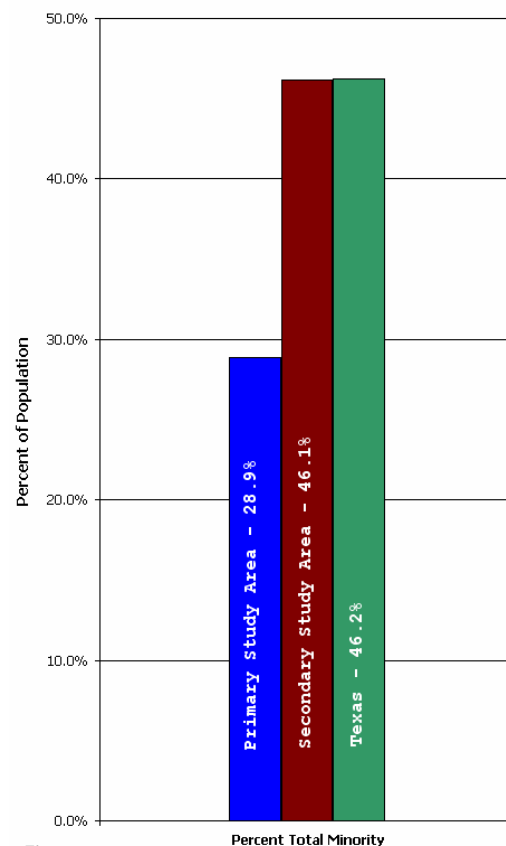


Figure 3.10
Ethnicity for the Economic Study Area (2000)
Source: US Census Bureau

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

minority, which includes 28 percent Black or African American, 9.4 percent Hispanic or Latino, and 7.1 percent in Some Other Race.

Table 3-33

Poverty and Ethnicity Composition of the Economic Study Area (2000)

Source: US Census Bureau

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

b. Household Income Levels

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

(1). Low-income Populations

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

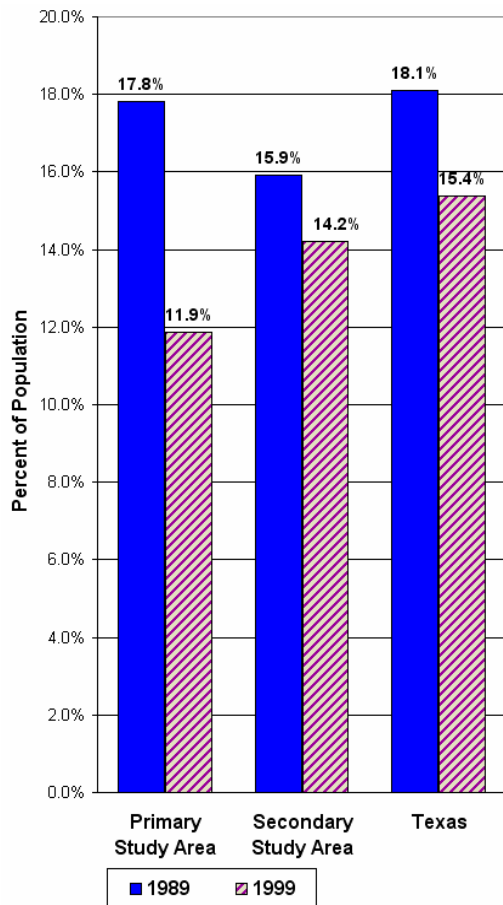


Figure 3.11
Poverty for the Economic Study Area (1999 vs. 1989) Source: US Census Bureau

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

Two block groups are just below 20 percent with poverty rates both at 18.8 percent, Census Tract 7104 Block Groups 1 and 3 in Chambers County. Census Tract 7104 Block Group 1 encompasses the western part of Winnie, of which 64.8 percent are minority, and encompasses the Anahuac and Moody National Wildlife Refuges. Census Tract 7104 Block Group 3 encompasses the Stowell area and has a population of 1,572 people.

Two block groups are just below 20 percent with poverty rates both at 18.8 percent, Census Tract 7104 Block Groups 1 and 3 in Chambers County. Census Tract 7104 Block Group 1 encompasses the western part of Winnie, of which 64.8 percent are minority, and encompasses the Anahuac and Moody National Wildlife Refuges. Census Tract 7104 Block Group 3 encompasses the Stowell area and has a population of 1,572 people.

(2). Housing

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

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

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

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

E. Governmental Infrastructure and Services

1. Chambers County

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

a. Utilities

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

b. Transportation

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

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

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

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

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

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

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

c. School Districts

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

Table 3-34 Chambers County School Districts			
School District	Location	Students	Teachers
Anahuac Independent School District	Anahuac, TX	1,427	101
Barbers Hill Independent School District	Mont Belvieu, TX	2,703	183
East Chambers Independent School District	Winnie, TX	1,128	82

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

d. Emergency Services

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

e. City of Anahuac

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

(1). Utilities

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

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

(2). Transportation

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

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

(3). School District

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

(4). Emergency Services

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

f. Winnie

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

(1). Utilities

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

(2). Transportation

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

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

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

(3). School District

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

(4). Emergency Services

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

g. Smith Point

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

(1). Utilities

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

(2). Transportation

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

(3). School District

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

(4). Emergency Services

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

2. Jefferson County

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

⁶ <http://winnietexas.com/>

⁷ The Texas State Historical Association, The Handbook of Texas Online, www.tsha.utexas.edu/handbook/online.

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

a. Utilities

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

b. Transportation

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

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

c. School Districts

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

Table 3-35 Jefferson County School Districts				
School District	Elementary Schools	Middle Schools	High Schools	Alternative Education
Beaumont ISD	21	5	3	3
Nederland ISD	4	2	1	1
Port Arthur ISD	9	3	1	2
Port Neches-Groves ISD	6	2	1	2
Sabine Pass ISD (1 all level school)	1	1	1	1
Hamshire- Fannett	2	1	1	1

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

d. Emergency Services

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

e. Sabine Pass

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

(1). Utilities

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

(2). Transportation

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

(3). School District

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

(4). Emergency Services

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

3. Galveston County

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

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

a. High Island

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

(1). Utilities

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

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

(2). Transportation

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

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

(3). School District

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

(4). Emergency Services

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

F. Fiscal Conditions of Local Governments

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

1. Taxing Districts in Jefferson County

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2. Jefferson County

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

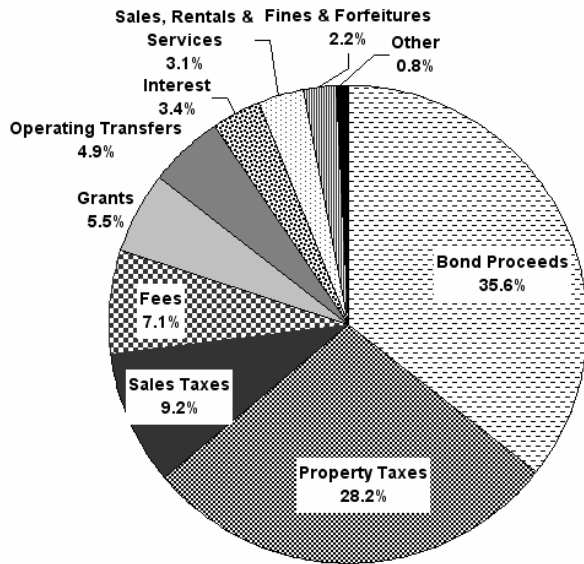


Figure 3.12
Jefferson County Revenues by Source (FY 2000)*

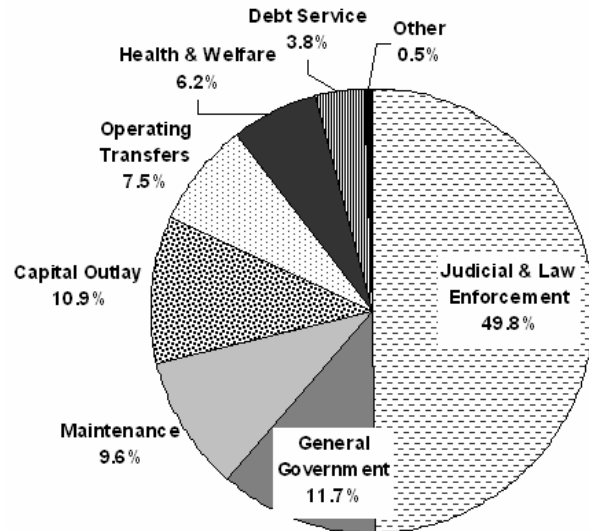


Figure 3.13
Jefferson County Expenditures by Function (FY 2000)*

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

a. Hampshire-Fannett ISD

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

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

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

b. Sabine Pass ISD

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

Table 3-47 Financial Overview - Sabine Pass ISD, Sabine Pass, Texas					
	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Revenues					
Property Taxes	\$3,150,012	\$4,383,203	\$7,707,582	\$8,651,960	\$7,239,197
"Robin Hood" - Redistribution	-\$1,102,006	-\$1,818,069	-\$4,333,005	-\$3,435,570	-\$4,620,966
Other Sources	\$0	\$0	\$0	\$0	\$318,431
Total Revenue	\$2,048,006	\$2,565,134	\$3,374,577	\$5,216,390	\$2,936,662
Expenditures					
Instruction	\$1,230,460	\$1,262,695	\$1,296,401	\$1,166,479	\$1,243,481
Operations & Other	\$711,593	\$729,586	\$904,601	\$875,227	\$1,340,947
Total Expenditures	\$1,942,053	\$1,992,281	\$2,201,002	\$2,041,706	\$2,584,428
Balance	\$105,953	\$572,853	\$1,173,575	\$3,174,684	\$352,234

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

2. Taxing Districts in Chambers County

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

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

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

Source: Chambers County Appraisal District

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

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

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

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

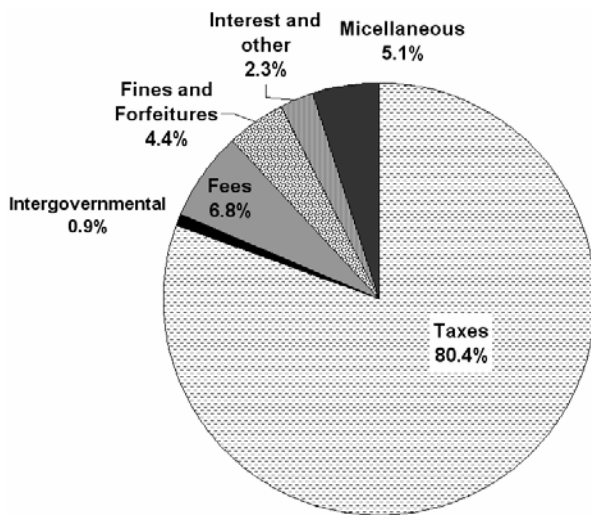


Figure 3.14
Chambers County Revenues by Source (FY 2001)
Source: Chambers County, Texas Comprehensive Annual Financial Report, 2001.

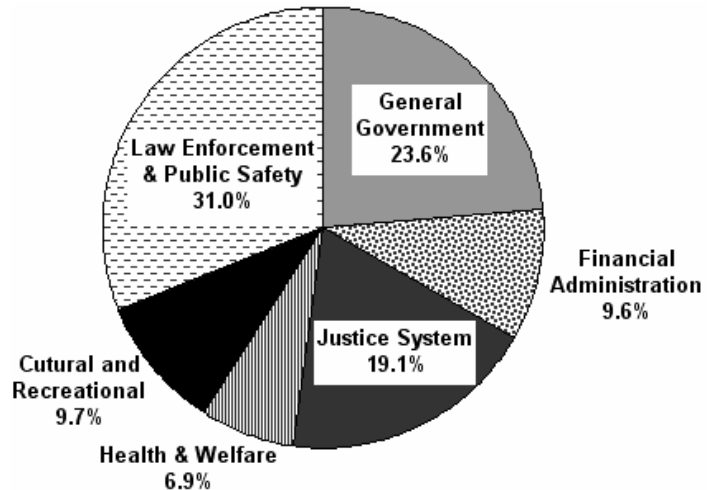


Figure 3.15
Chambers County Expenditures by Function (FY 2001)
Source: Chambers County, Texas Comprehensive Annual Financial Report, 2001.

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

a. Anahuac ISD

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

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

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

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

b. East Chambers ISD, Winnie, Texas

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

Table 3-51

Financial Overview - East Chambers ISD - Winnie, Texas

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

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

3. Taxing Districts in Galveston County

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

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

Table 3-52

2002 Tax Rates for Potential Impact Districts in Galveston County

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

Source: Galveston County

4. Refuge Revenue Sharing Payments

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

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

revenue was generated from the refuge lands the county received no payment. The Refuge Revenue Sharing Act

was amended in 1964 to allow a payment of either 1) 25% of the net receipts, 2) $\frac{3}{4}$ of 1% of the adjusted purchase price of refuge land, or 3) 75 cents per acre, whichever was greater, on acquired lands. Payments still had to be made out of refuge receipts in the National Wildlife Refuge Fund. Beginning in Fiscal Year 1976, the refuge receipts were not sufficient to make the county payments and the payments were reduced accordingly. Partly because of this, the Refuge Revenue Sharing Act was again amended in 1978. This amendment allowed Congress to appropriate funds to make up any shortfall in the revenue sharing fund. It also approved use of the payments for any governmental purpose; whereas, before, the payments could only be used for roads and schools.

Because refuge receipts have not kept up with the general increase in property values, the $\frac{3}{4}$ of 1% of market value of refuge lands has effectively become the largest amount of refuge revenue sharing payment allowable under the Act since 1976. Initially, Congress appropriated the additional funds necessary to make the largest payment, but only through Fiscal Year 1980. Since that time, Congress has not appropriated sufficient additional funds to make the largest payment allowed by law. If the amount Congress appropriates is not enough to match the largest payment allowable, the units of local government receive a pro-rata share. Even without the full supplemental appropriations, the dollar amount of Refuge Revenue Sharing payments is substantial and significantly offsets the local tax losses. In some instances, largely for lands subject to the agricultural exemption, the Refuge Revenue Sharing payments have been equal to or even greater than the amount paid in taxes while in private ownership. The USFWS supports full Congressional appropriations to achieve the maximum Refuge Revenue Sharing payments.

Table 3-53 Annual Refuge Revenue Sharing Payments to Chambers, Jefferson and Galveston Counties, Texas			
	Refuge (County)	Acreage	Payment
1995	Anahuac (Cham.)	30,515 acres	\$44,966
	McFaddin (Jeff.)	46,642 acres	\$50,837
	Texas Point (Jeff.)	8,952 acres	\$9,488
1996	Anahuac (Cham.)	31,796 acres	\$51,786
	McFaddin (Jeff.)	47,145 acres	\$56,919
	Texas Point (Jeff.)	8,952 acres	\$10,462
1997	Anahuac (Cham.)	31,796 acres	\$47,276
	McFaddin (Jeff.)	47,145 acres	\$51,963
	Texas Point (Jeff.)	8,952 acres	\$9,551
1998	Anahuac (Cham.)	31,796 acres	\$44,492
	McFaddin (Jeff.)	47,145 acres	\$48,902
	Texas Point (Jeff.)	8,952 acres	\$8,988
1999	Anahuac (Cham.)	34,066 acres	\$48,235
	Anahuac (Galv.)	167 acres	\$236
	McFaddin (Cham.)	1,281 acres	\$557
	McFaddin (Jeff.)	47,150 acres	\$49,199
	Texas Point (Jeff.)	8,952 acres	\$9,346
2000	Anahuac (Cham.)	34,066 acres	\$42,313
	Anahuac (Galv.)	167 acres	\$207
	McFaddin (Cham.)	1,281 acres	\$1,546
	McFaddin (Jeff.)	47,150 acres	\$43,159
	Texas Point (Jeff.)	8,952 acres	\$8,199
2001	Anahuac (Cham.)	34,066 acres	\$43,188
	Anahuac (Galv.)	167 acres	\$211
	McFaddin (Cham.)	1,281 acres	\$1,578
	McFaddin (Jeff.)	47,150 acres	\$44,052
	Texas Point (Jeff.)	8,952 acres	\$8,369
2002	Anahuac (Cham.)	34,066 acres	\$35,922
	Anahuac (Galv.)	167 acres	\$176
	McFaddin (Cham.)	1,281 acres	\$932
	McFaddin (Jeff.)	47,150 acres	\$34,289
	Texas Point (Jeff.)	8,952 acres	\$7,323
2003	Anahuac (Cham.)	34,066 acres	\$34,526
	Anahuac (Galv.)	167 acres	\$169
	McFaddin (Cham.)	1,281 acres	\$895
	McFaddin (Jeff.)	47,150 acres	\$32,957
	Texas Point (Jeff.)	8,952 acres	\$7,039
2004	Anahuac (Cham.)	34,066 acres	\$30,538
	Anahuac (Galv.)	167 acres	\$150
	McFaddin (Cham.)	1,281 acres	\$792
	McFaddin (Jeff.)	47,150 acres	\$29,150
	Texas Point (Jeff.)	8,952 acres	\$6,226

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

calendar year. By law the USFWS make the payments to the unit of local government that levies and collects general purpose real property taxes, which in Texas, is the county government.

G. Social Conditions

1. Social Conditions and Structures

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

- Geography
- Economic activity
- Population density
- Lifestyles

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

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

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

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

2. Stakeholder Categories

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

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

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

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

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

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

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

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

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

CHAPTER 4: ENVIRONMENTAL IMPACT ANALYSIS

Introduction

This Chapter analyzes the environmental impacts from the actions proposed in the alternatives presented in Chapter 2 of this document. This Chapter is organized in the same way as Chapter 2 with a separate section addressing the impacts relating to each of the two separate, but related, sets of alternatives for

1) Refuge Management and 2) Refuge Boundary Expansion. The terms impacts, consequences, and affecting/effects all mean the same thing in the context of this chapter. An action affects the physical environment if it changes the physical environment; and, effects on the human environment from changes in the physical environment are addressed as the socio-economic effects.

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

This Chapter has three (3) parts:

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

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

PART A: IMPACT ANALYSIS FOR THE FIVE REFUGE MANAGEMENT ALTERNATIVES

Summary of Refuge Management Alternatives

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

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

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

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

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

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

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

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

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

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

Refuge Management Alternative E: Emphasis on a Passive Management Approach

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

USFWS Habitat Management and Restoration

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

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

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

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

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

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

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

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

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

Impacts to Cultural Resources

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

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

Overview

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

A. Natural Resources Section

1. Impacts to Air Quality

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

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

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

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

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

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

2. Impacts to Geology and Soils

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

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

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

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

The historic barrier beach/dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (2004) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline is eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of habitat, loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

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

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

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

In addition to ongoing impacts, relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

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

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

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

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

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

3. Impacts to Hydrology and Water Quality

a. Hydrology

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

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

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

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

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

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

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

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

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

b. Water Quality

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

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

4. Impacts to Vegetation and Habitats

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

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

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

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

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

(1). Wetland Specific Management and Restoration

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

(a). Water Management in Coastal Marshes

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

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

- Approximately 12,000 acres of marsh habitats on the Anahuac NWR would continue to be managed via large water control structures on Oyster Bayou, Onion Bayou, East Bay Bayou, Jackson Ditch, and Oil Field Ditch and their associated levees and canal/ditch systems. Such water management infrastructure includes more than 100 small water control structures, and numerous smaller levee and canal/ditch systems. There are also four marsh impoundments on Anahuac NWR. These leveed units are generally managed as deeper permanent freshwater habitats, although periodic drawdowns and mechanical manipulations of soil surfaces are needed to manage vegetation and maintain a desired mosaic of open water and emergent marsh habitats. These include the 250-acre Shoveler Pond on the northwest portion of the refuge, and Rail Reservoir (150 acres) and the two East Unit reservoirs (98 and 162 acres) located on the west side of the East Unit. The East Unit reservoir extends onto private land so its management must be coordinated with that landowner.
- Approximately 18,000 acres of the McFaddin NWR's structurally managed marshes would continue to be managed via large water control structures on Willow Slough, Wild Cow Bayou, 5-Mile Cut and the GIWW, and their associated levees and canal/ditch systems.
- Water management on Texas Point NWR would continue to be conducted in a passive manner. The refuge is drained from west to east through several branches of Texas Bayou and interconnected tidal cuts and streams. Three rock weirs, located in constructed ditches, were installed in 2001 and 2002 to protect and restore emergent marshes in the eastern portion of the refuge. These structures are reducing saltwater intrusion and dampening tidal energies, which were causing emergent marsh loss (conversion to open water), while allowing ingress and egress of marine organisms. A north south levee, historically built as an access road to an oil and gas well, traverses the central portion of the refuge and is maintained with culverted water crossings.

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

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

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

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

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

(b). Marsh Restoration

Under the Refuge Management Alternative A, the level and scope of wetlands restoration activities, as well as their benefits to the Refuge Complex, would generally continue. For example, in the year 2000, approximately 50 acres of emergent marsh were restored and created on and adjacent to Texas Point NWR through a U.S. Army Corps of Engineers, Galveston District project implemented under Section 206 of the Water Resources Development Act. This COE Continuing Authorities Program is entitled Ecosystem Restoration through the beneficial use of dredged material. This project was conducted in partnership with the Texas General Land Office, which provided non-Federal matching funding through the Texas Coastal Erosion and Response Act program. Approximately 850,000 cubic yards of dredged material from the Sabine-Neches Ship Channel were used to increase elevation in a subsided marsh which had been converted to open water allowing reestablishment of emergent vegetation, and restored additional emergent marsh which had eroded into the Gulf.

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

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

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

(c). Moist Soil Management

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

Under Refuge Management Alternative A, 500 acres of moist soil units would continue to be managed annually on Anahuac NWR to provide and enhance shallow freshwater wetland habitat for migratory birds and other wetland-dependent wildlife. Water management (drawdowns and flooding) in moist soil units is accomplished with water control structures, levees, and water delivery systems including pumps and canal systems. Conventional farm machinery with discs and roller choppers are used to manipulate soils and vegetation.

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

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

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

(d). Cooperative Rice Farming Program

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

The USFWS has agreements with three local farmers who farm rice on approximately 500 to 700 acres annually on a three-year rotation, leaving approximately 1,000 to 1,200 acres of the Refuge farm as “maintenance” acreage. The farmers are required to disc, spray, or mow noxious weeds on all maintenance acres each year according to the USDA farm program. Cooperators are allowed to take the first rice crop and are required to maintain levees and flood fields after harvest. Generally rice is harvested in September or October. Several farmers have produced organically grown rice on the Refuge during the past ten years. Today almost 80% of the rice produced on the refuge is organically grown. Organically produced rice reduces the overall input of herbicides on the Refuge.

Rice production has declined during the last decade in counties surrounding the Refuge Complex, reducing this type of agricultural wetland habitat for waterfowl, shorebirds and other wetland-dependent species. Other changes in rice cultivation practices may also have deleterious effects on waterbird populations. Abandoned rice fields and pasturelands are susceptible to invasion by Chinese tallow, Eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality and will require extensive restoration efforts.

Continuation of the cooperative rice farming program on Anahuac NWR under Refuge Management Alternative A would provide shallow freshwater wetland habitat and serve several management outcomes for migratory bird management on the Refuge Complex: creating forage for migrating and wintering waterfowl, habitat for migrating shorebirds, and fresh water habitat for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also left for wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest rice fields that were cultivated and at least partially flooded (Czech and Parsons 2002). Managed rice fields on the Refuge Complex provide wintering and migrational habitat for Blue-winged Teal, Northern Pintail, Green-winged Teal and Snow geese, several shorebirds species including Long-billed Dowitchers and Semi-palmated, Western, Least, White-rumped, Baird’s, Pectoral, Stilt and Buff-breasted sandpipers, and for several wading bird species. Mottled Ducks also heavily use habitats adjacent to rice fields for nesting (Stutzenbaker 1988). Rice farming also helps to offset waterfowl consumption of crops on adjacent privately-owned croplands.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

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

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

permanently fallowed former agricultural fields which have naturally revegetated over time and currently contain native and non-native grasses, forbs and woody vegetation. Sites within these habitats have been enhanced by transplanting, sprigging and seeding of native grasses and forbs. On the East Unit, approximately 441 acres of permanently fallowed cropland has been restored to native prairie through an intensive restoration process. This involves control of exotic and native woody vegetation, restoring natural contours and hydrology by removing rice field levees and ditches, working the soil and planting with native prairie plant seed mixtures. The highest quality native prairie on Anahuac NWR occurs in relatively small, fragmented areas which were never cultivated or were cultivated for a relatively short time. These “remnant” prairie areas total approximately 1,065 acres.

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

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

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

Seed viability in prairie plants is believed to be reduced in highly fragmented prairie landscapes due to loss of genetic variability as remnant stands become smaller and more isolated. Conservation of existing coastal prairie remnants in the project area is critical because they represent reservoirs of genetic material, and are extremely valuable sources of viable local seed and plant materials. Prairie plants on the upper Texas Coast evolved under relatively unique climatic conditions of high annual rainfall and hydric soils, and future restoration of native prairie in the region depends on the protection of existing viable local seed and plant material sources. Native prairie conservation efforts on the Refuge Complex under Refuge Management Alternative A would help maintain a small but potentially important source of native prairie seed.

(b). Woodlot Restoration and Protection

Although comprising less than 1 percent (approximately 127 acres) of the Refuge Complex acreage, woodlots help support a diverse avian community, which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in the Refuge Complex’s coastal woodlots. Migratory birds also depend on coastal woodlots for

cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier 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 Refuge Management Alternative A, the following USFWS management actions would continue to have beneficial impacts on the existing 127 acres of coastal woodlots: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

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

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

(3). General Habitat Management Activities

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

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

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

Under Refuge Management Alternative A, the current fire management program would continue to be implemented on the Refuge Complex. Suppression of unplanned wildland fires and prescribed burning would continue as under current conditions. Approximately 12,000 to 15,000 acres per year would be

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

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

Fire has long had a role in the ecology of the Texas Chenier Plain marshes. Pre-European settlement, fire frequency for these marshes is estimated to be 1-3 years (Frost 1995). Lightning caused wildfires were common in coastal marshes (Hoffpauer 1968, Frost 1995). Additionally, Native Americans used fire to facilitate hunting and travel (O'Neil 1949, Givens 1962). In the past, fires in the Gulf coast prairies and marshes probably varied greatly in spatial extent. Natural firebreaks existed in many forms. Bayous, tidal creeks, fault lines, animal trails, and areas previously disturbed by fire or animal herbivory all may limit the spread of wildfires. Weather, fuel conditions, and water levels influence the effectiveness of the natural firebreaks and ultimately the size of the fire. Anecdotal data suggest that prior to the settlement and the major changes in hydrological regimes which followed, much of the vegetation that dominated these fresher marshes (i.e. Sawgrass (*Cladium mariscus* subsp. *jamaicense*), maidencain (*Panicum hemitomon*), giant cutgrass (*Zizaniopsis miliacea*), and bullwhip (*Schoenoplectus californicus*)) was less pyrogenic than common vegetation found today, such as marshhay cordgrass. This may have reduced the frequency and size of historical fires in the region's marshes compared to current vegetative conditions. Conversely, natural fire starts in the region have undoubtedly been significantly reduced because of the landscape-level conversion of upland prairie habitats to agricultural uses. Navigation canals, ditches, levees and roads constructed throughout upland and wetland habitats effectively serve as firebreaks and have greatly affected fire spread and the ultimate size of present-day natural fires.

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

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

Marshes recover quickly after winter cover burns. Soil moisture or surface water protects the subterranean plant parts from damage. Gabrey and Afton (2001) found in the Chenier Plain of Louisiana, that the total above ground biomass was reduced for two years while dead above ground biomass was reduced for three years post fire compared to unburned control plots. In addition, they found that plant

species composition in burned plots was the same as unburned plots, with a slight increase in richness during the first growing season post-fire.

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

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

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

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

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

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

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

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

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

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

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

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

(b). Controlled Livestock Grazing

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

Under Refuge Management Alternative A, grazing intensity, duration, location, and timing of use would continue unchanged, as would overall impacts to vegetation and habitats on approximately 41,000 acres on the Refuge Complex. Grazing strategies currently include variations in stocking rates, timing (cool vs. warm season) and, duration. Stocking rates and rotations are determined annually according to management objectives for the various grazing units and the quantity and condition of forage in those units, and are often influenced by the availability of freshwater. Anahuac NWR implements cool season and summer cattle grazing on various marsh and upland units. Permittees graze only during the cool season, generally from November 1 through May 1 on the McFaddin and Texas Point NWRs.

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

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

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

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

conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

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

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

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

Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1995). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing intensity, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and cattle can spread seed of undesirable plant species by physically carrying them or ingesting them.

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

(c). Invasive Species Management

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

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

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

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

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

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

Under Refuge Management Alternative A, the USFWS would also continue to control exotic animal species on the Refuge Complex to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral pigs are the primary species currently impacting habitats on the Refuge Complex. Rooting and wallowing by feral pigs cause significant habitat and infrastructure damage. These soil disturbances in marsh and upland sites allow invasive plants to establish and reduce the value of the habitats to wildlife. Feral pigs are particularly damaging to water management infrastructure. They wallow and root extensively on levees and within rice fields and moist soil units effecting the management of thousands of acres of habitat. Feral hogs are prolific and are able to exploit wetland and upland habitats. Under Alternative A, the USFWS would continue to control feral hog activities on the Refuge Complex by using State animal damage control agency personnel to capture and remove hogs or kill them on-site. In addition, Refuge Complex law enforcement personnel would continue to conduct periodic lethal control activities. Although nutria have not reached population levels capable of damaging habitats in recent years on the Refuge Complex, this exotic animal has been highly destructive in coastal wetlands in neighboring Louisiana and other coastal states. Control activities for nutria which could be implemented under Refuge Management Alternative A include trapping and removal by State animal damage control agents, Refuge staff or qualified individuals under Special Use Permit for nuisance animal control.

(d). Shoreline Protection and Restoration

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

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

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

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

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

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

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

(e). Mowing and Haying

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

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

b. Impacts from Public Use Programs

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

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

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

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

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

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

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

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

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

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

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative A, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.

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

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative A would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

5. Impacts to Fish and Wildlife Resources

Under Refuge Management Alternative A, habitat management and restoration and biological program activities on the Refuge Complex are focused on conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS also administers the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

The USFWS manages of oil and gas exploration and development activities on the Refuge Complex so as to ensure maximum protection of habitats and fish and wildlife resources.

USFWS community outreach and partnership programs support natural resource conservation initiatives on the Refuge Complex and throughout the project area, and contribute greatly to achieving fish and wildlife conservation objectives.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on a landscape scale has increased the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.⁹ Many wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Declines in habitat quality caused by regular tidal overwash are adversely affecting migratory waterfowl use, especially on McFaddin and Texas Point NWRs. As beach ridges and the banks of the GIWW erode they are less effective barriers to tidal inundation and salt water intrusion during storm and other high tidal events. Overwash events create sudden and drastic spikes in salinities, often killing submerged aquatic vegetation and seed producing annual plants. Inundation of the marshes with sea water provides the sulphates which are reduced to hydrogen sulfide under conditions of high water temperatures. Hydrogen

⁹ During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

sulfide toxicity and low dissolved oxygen cause large scale die-offs of plants and animals, including many invertebrates which provide an important food source for waterfowl and other migratory birds. Survey data indicate that waterfowl numbers have dropped to below five birds per thousand acres in affected areas following overwash events, and below one bird per thousand acres after severe events (USFWS unpublished data). Areas impacted by overwash events now encompass nearly 15,000 acres on McFaddin NWR and 1,500 acres on Texas Point NWR.

Under the Refuge Management Alternative A, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations on the Refuge Complex:

(a). Wetlands Management and Restoration

Under Refuge Management Alternative A, approximately 30,000 acres of marsh habitats would be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. For example, structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

On Anahuac NWR, 500 acres of moist soil units would continue to be managed to provide habitat for wintering and migrating waterfowl. Moist soil management provides optimal conditions for germination and growth of preferred waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia.

On Anahuac NWR, the cooperative rice farming program would continue to provide food resources for wintering and migrating waterfowl on 500-700 acres annually. Management of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Marsh and wetland restoration activities would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

(b). General Habitat Management and Restoration Activities

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex promotes optimum habitat conditions for wintering waterfowl and many additional migratory bird species. Prescribed burning and grazing promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Waterfowl habitat on the Refuge Complex is also enhanced through the control of undesirable invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* must also be controlled to restore and maintain open water

habitats. Maintaining an interspersed of open water and vegetated emergent wetlands provides the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats increases the production of submerged and floating aquatic plants, an important food source. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields also enhances waterfowl habitat.

Overall, continuing current wetland management and restoration on the Refuge Complex under Refuge Management Alternative A can be expected to maintain wintering and migrating waterfowl populations at levels similar to those documented over the past 20 years. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

Continuation of shoreline protection and restoration activities under Refuge Management Alternative A would enhance waterfowl habitat on the Refuge Complex by decreasing saltwater intrusion into inland marshes and addressing threats of additional saltwater intrusion. However, the scope and extent of these activities under Refuge Management Alternative A will likely not counteract the ongoing and future impacts of relative sea level rise, loss of coarse sediment supply, and altered hydrological regimes, especially on McFaddin and Texas Point NWRs. Declines in habitat quality caused by regular tidal overwash are adversely affecting migratory waterfowl use on these refuges. As beach ridges and the banks of the GIWW erode they are less effective barriers to tidal inundation and salt water intrusion during storm and other high tidal events. Overwash events create sudden and drastic spikes in salinities, often killing submerged aquatic vegetation and seed producing annual plants. Inundation of the marshes with sea water provides the sulphates which are reduced to hydrogen sulfide under conditions of high water temperatures. Hydrogen sulfide toxicity and low dissolved oxygen cause large scale die-offs of plants and animals, including many invertebrates which provide an important food source for waterfowl and other migratory birds. Survey data indicate that waterfowl numbers have dropped to below five birds per thousand acres in affected areas following overwash events, and below one bird per thousand acres after severe events (USFWS, unpublished data). Areas that can be heavily impacted by overwash events now encompass nearly 15,000 acres on McFaddin NWR and near 1,500 acres on Texas Point NWR.

Increased saltwater intrusion from frequent tidal overwash from the Gulf into inland marshes on these refuges will continue to negatively impact habitat quality for waterfowl, other migratory birds, and other native fish and wildlife species. Declining habitat conditions due to increased saltwater inundation could result in further significant declines in wintering waterfowl use on McFaddin and Texas Point NWRs.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Mottled ducks are year-round residents of the Chenier Plain region. This species prefers fresh to slightly brackish marshes (Gosselink *et al.* 1979), although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled Ducks on the Refuge Complex are part of the western Gulf Coast (WGC) population of Mottled Ducks. Banding studies have indicated that WGC Mottled Ducks do move between Mexico, Texas, Louisiana and Mississippi and Alabama, but no interchange occurs between this population and the Florida population of Mottled Ducks.

Mottled Duck numbers on the Refuge Complex (and other national wildlife refuges on the Texas Coast) have declined precipitously during the last 20 years, as indexed by annual breeding pair surveys and monthly aerial counts conducted September through March (USFWS, Division of Migratory Birds, unpublished reports). Stutzenbaker (1988) reported that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include conversion of native habitats for agricultural and urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988, Morton and Paine 1990), as well as increased pollutants (Cain

1988). Saltwater intrusion into wetlands that range from fresh to moderately brackish probably affects growth and survival of ducklings (Moorman *et al.* 1991). Encroachment of Chinese tallow into nesting habitat probably leads to abandonment of nesting areas (Stutzenbaker 1988). Other potential factors influencing Mottled Duck populations include declines in rice agriculture, extended periods of drought, mortality from predation due to increasing populations of alligators and possible increases in mammalian predators, a continued high incidence of lead pellet ingestion, and harvest (USFWS Division of Migratory Birds, unpublished reports).

Under Refuge Management Alternative A, the following habitat management and restoration activities would continue to be the primary management activities impacting Mottled Ducks on the Refuge Complex. All would be expected to have positive impacts on this species, although the landscape level issues described above are likely to control population dynamics of the Western Gulf Coast Mottled Duck population.

(a). Wetlands Management and Restoration

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative A would provide and enhance habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Managing water levels and salinities in managed coastal marsh units would maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. Marsh management also would enhance diversity and productivity of submerged aquatic vegetation which provides important year-round food sources for Mottled Ducks. Moist soil management and the cooperative rice farming program on Anahuac NWR would continue to provide critical shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. Approximately 100-150 acres of moist soil units would continue to be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

(b). Uplands Management and Restoration

Native prairie restoration and management activities under Refuge Management Alternative A would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The integrated application of prescribed burning, controlled livestock grazing, herbicide application and mowing/haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies (and on levees and along fence lines) would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as "sennabean ponds," as valuable brood rearing habitat. Protecting extant coastal prairie and restoring adjacent prairie and wetland habitats under Refuge Management Alternative A on the Refuge Complex will increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

(c). General Habitat Management Activities

Current levels of prescribed burning, grazing, and invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative A. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex which promotes optimum habitat conditions for wintering and migrating waterfowl also enhances wetland and upland habitats used by Mottled Ducks during all life history phases: pair formation, breeding, nesting, brood-rearing, molting and

wintering. Invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex. These cordgrass ridges are dominated by gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania* spp.) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks.

Improper application of these habitat management practices has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988).

Marsh habitats being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck production and brood rearing habitat. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. If erosion problems persist and result in increased frequency of events and water volumes entering marshes, Mottled Duck production can be expected to further decrease on the Refuge Complex.

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally-listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least Sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-round residents, such as Brown Pelican (Federally-listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migratory, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat

types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Refuge Management Alternative A would continue to positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative A, actively managing water levels and salinities (e.g., by utilizing water control structures, levees, water delivery systems) would allow for continued protection of managed marsh units, which includes a wide variety of vegetation and habitat types used by many avian species in this group. In general, shorebirds and wading birds would continue to benefit from moist soil management and rice farming activities that result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields would influence the type of and intensity of use by such birds (Huner *et al.* 2002).

Under Refuge Management Alternative A, the cooperative rice farming program on Anahuac NWR would continue to provide from 500-700 acres of shallow freshwater wetland habitat, benefiting many avian species in this group. In addition, approximately 100-150 acres of the Anahuac NWR's moist soil units would continue to be managed specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species include Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. An additional 250-300 acres of moist soil units would provide wetland habitat for shorebirds, wading birds, and other marsh and waterbirds over the winter months. Wading and marsh bird species using moist soil habitats on the Refuge Complex include American Bittern, Great Blue Heron, Great Egret, Snowy Egret, Little Blue Heron, Tri-colored Heron, Black-crowned and Yellow-crowned Night Herons, White Ibis, White-faced Ibis, and Roseate Spoonbill.

(b). Uplands Management and Restoration

Under Refuge Management Alternative A, restoration and enhancement of native prairie habitats on the Refuge Complex would benefit some avian species in this category primarily by providing improved habitat for migrating and wintering birds. Three Avian Species of Conservation Concern (USFWS 2002) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

Current prescribed burning, grazing, and invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative A. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex which promotes optimum habitat conditions for wintering and migrating waterfowl also enhances wetland and upland habitats used by many shorebird, wading bird and marsh bird species. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species. Prescribed burning and controlled livestock grazing help create optimal physical structure of vegetation for shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds. Invasive plant and animal control activities would also enhance wetland and upland habitats for these species. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species

that utilize open water habitats. Shoreline restoration activities including dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative A, the USFWS would also maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*), (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS uses these techniques in prescribed burning operations on the Refuge Complex.

Some management activities under Refuge Management Alternative A could negatively impact some species of shorebirds, wading birds, and marsh and waterbirds. For example, some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. Other habitat management activities could negatively impact some species of shorebirds, wading birds, marsh and waterbirds, especially if improperly implemented or timed. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979).

Most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. Under Refuge Management Alternative A, the USFWS strategy of management to maintain a mosaic of available habitats on the Refuge Complex should provide an adequate range of habitats for this group of avian species.

(4). Impacts to Landbirds

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.*

1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative A would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative A, the following wetland management and restoration activities would continue to have positive impacts on several landbird species including managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and cooperative rice farming program. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow, Nelson's Sharp-tailed Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

(b). Uplands Management and Restoration

Prairie Restoration and Management

Together, the native prairie management and restoration activities undertaken under Refuge Management Alternative A would continue to protect and enhance the 5,744 acres of non-saline grassland habitats (fallowed croplands, prairie remnants, and previously restored sites) on the Refuge Complex. Under this Alternative, 245 acres of former cropland would be restored to native prairie on Anahuac NWR, and other existing grassland habitats would be enhanced by seeding and sprigging of native plants.

Many animal species typical of northern prairies, such as Henslow's Sparrows, Smooth Green Snakes, and Prairie Voles, were all found year-round in the Gulf coastal prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf coastal prairies as wintering and/or migratory habitat. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative A are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as "Avian Species of Conservation Concern" in the Gulf Prairies Bird Conservation Region (USFWS 2005). For example, White-tailed Hawk, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats on the Refuge Complex.

Native prairie remnants and other upland grassland habitats on the Refuge Complex provide wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow, and nesting habitat for species including Dickcissel and Eastern Meadowlark. These are also important nesting habitats for Mottled Ducks. Several species of raptors commonly observed on the Refuge Complex include Red-tailed Hawk, Red-shouldered Hawk, Turkey Vulture, American Kestrel, White-tailed Kite, Northern Harrier, and Short-eared Owl (USFWS 1997a). Many other raptor species are observed during spring and fall migrations. Landbirds listed as Avian Species of Conservation Concern utilizing prairie grassland habitats and which would benefit from native prairie restoration and management activities on the Refuge Complex under Refuge Management Alternative A include LeConte's Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk.

Woodlot Restoration and Management

Under Refuge Management Alternative A, the following USFWS management actions would continue to have beneficial impacts on coastal woodlots: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

Although comprising less than 1 percent (approximately 127 acres) of the Refuge Complex acreage, woodlots help support a diverse avian community, which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in the Refuge Complex' coastal woodlots. Migratory birds also depend on coastal woodlots for cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier Plains prior to or immediately after crossing the Gulf of Mexico (Barrow *et al.* 2000). Trans-gulf or circum-gulf migratory songbirds use Texas Coastal woodlots as stopover habitat (Mueller 1981), which is critical at a time when the birds are depleted of water and energy reserves (Leberg *et al.* 1996).

A primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially *Lepidopteron* larvae. Chinese tallow woodlots may thus be an "ecological trap" that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001). In addition, activities by feral hogs can also damage understory vegetation and soils, as a result of their rooting habits, and may also cause a shift in plant succession. Such activities can also create disturbed areas that enable easier establishment of some invasive species. Feral hogs may also directly compete with several species of native wildlife for certain foods.

Overall, implementation of the USFWS management actions under Refuge Management Alternative A would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler. Since woodlot acreage is small relative to its importance to migrating neotropical migratory birds and other bird species that require trees and/or understory for cover, such positive impacts for each acre protected are proportionately significant.

(c). General Habitat Management Activities

Current prescribed burning, grazing, and invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative A. The integrated combination of water level and salinity management, fire management and controlled livestock grazing on the Refuge Complex which promotes optimum habitat conditions for wetland-dependent migratory birds also enhances wetland and upland habitats used by many land bird species. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is

possible that second year post-fire habitat offers the greatest interspersion of nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (1995) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post-fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife.

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Under Refuge Management Alternative A, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, exotic plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands and help maintain wetland habitat diversity and productivity important to a variety of fish and shellfish species.

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Structural marsh management is employed on portions of the Refuge Complex to enhance wetland habitats for migratory birds, to reduce impacts of saltwater intrusion and subsequent marsh loss and to maintain the historic salinity gradient that characterized coastal marshes of the Chenier Plain. Managing water levels and salinities using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Target salinity ranges typical of structurally managed marshes on the Refuge Complex range from fresh to the low end of brackish, being primarily intermediate (0.5-5.0ppt). While these salinity ranges are used by estuarine species, a study of fisheries use along a salinity gradient in Galveston Bay (Zimmerman *et al.* 1990) found estuarine fisheries were not greatly attracted to intermediate (oligohaline) marshes of the Trinity River delta. This study concluded that the oligohaline environment was not favorable for development of preferred foods, primarily epiphytic algae and peracarid crustaceans. Further, while transient species such as juvenile shrimp, crabs, and fishes had ready access to oligohaline marshes in this area, they did not use them extensively. These data indicate that while water control structures may limit ingress/egress of estuarine organisms, the habitat within may not be optimum for these organisms compared to brackish and saline marshes available on the Refuge Complex.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). Ingress/egress slots allow more marine organism passage than fixed crest weirs, with larger openings allowing greater fisheries access (Herke *et al.* 1992). These slots provide a means of allowing movement of estuarine organisms in and out of structurally managed marshes, but assist in maintaining the fresher end of the coastal marsh continuum that so many of the Refuge Complex's priority species depend on.

Periods of peak ingress and egress movements are associated with water level fluctuations and tidal cycles. Highest peak fisheries resource movements are often related to periods of combined lunar cycles and major tidal movements. Manipulating water control structures during the full moon and new moon of the lunar cycle allows opportunity for the maximum ingress potential of fisheries resources. Holding slight levels of excess water for several days prior to these cycles and releasing during peak ingress periods greatly increases access to the unit from fisheries species dependent on coastal estuaries. Many species will move towards fresher water during incoming tides (Guillory 1996). The USFWS uses these techniques on the Refuge Complex to enhance fisheries utilization of managed marsh units. In addition, the continuum of fresh to saline aquatic environments on the Refuge Complex supports highly diverse aquatic vertebrate and invertebrate communities. Disruption of salinity gradients would likely cause adverse impacts on blue crabs (Guillory 1996). Many of the refuge marshes would exceed these thresholds without some type of hydrologic management.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Knieb and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are experiencing rapid subsidence, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, activities which maintain and restore productive wetland habitats and help reduce rates of marsh loss would also benefit fisheries resources in the long-term.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican. Under Refuge Management Alternative A, protection, restoration and management of coastal wetland habitats on the Refuge Complex would continue to benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative A would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative A which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative A which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Habitat conditions which increase the abundance of insects, crustaceans, and other small prey benefit most species of amphibians and reptiles during at least a portion of their lifecycle. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Under Refuge Management Alternative A, some management activities would continue to have negative impacts on some wildlife species. Control of invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying “Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize.” Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

b. Impacts from Public Use Programs

The following analysis of impacts of public use programs on fish and wildlife resources focuses on the six wildlife-dependent uses which are the priority public uses of the National Wildlife Refuge System: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Impacts of beach recreational uses on McFaddin NWR are discussed under the specific wildlife species or groups of species affected by this use.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually under the USFWS national migratory bird hunting regulation frameworks, and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Alternative A will not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting intensity on the number of birds utilizing an area (Reichhoff, 1976, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton *et al.* 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required an additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Afton and Sayler in Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and/or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary areas of adequate size, encompassing and/or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998).

Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

Overall, it is expected that the maintenance of sanctuary areas on the Refuge Complex mitigates for disturbance impacts from hunting activities. In years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances, however, it is possible that hunting activities would result in reduced abundance of wintering waterfowl on the Refuge Complex. Maintenance of traditional sanctuary areas would continue under Refuge Management Alternative A.

Maintaining current Refuge-specific hunting regulations under Refuge Management Alternative A would also help mitigate the impacts of hunting activity-related disturbance to waterfowl. Waterfowl hunting in hunt areas is allowed three days per week (with the exception of the 1,500-acre Pace Tract on Anahuac NWR which is open for hunting seven days per week), and all hunting activity is curtailed each day at noon. The non-hunted days and afternoon and evening closures provide undisturbed periods within the hunt areas, facilitating waterfowl utilization of hunt area habitats for foraging and resting. Boat use on the Refuge Complex occurs primarily in bayous, canals and ditches, limiting disturbance impacts to these narrow corridors (exceptions are Star Lake and Clam Lake on McFaddin NWR and Pole Lake on Texas Point NWR). The majority of the hunt areas therefore are not impacted by boating activity, being accessible primarily by foot. In addition, a variety of regulations govern means of access to hunt areas, including boat motor and horsepower restrictions, prohibition of airboat and all-terrain vehicle use, and establishment of areas in which only non-motorized boat access is allowed. While these regulations are in place primarily to protect habitats and public safety, they also reduce overall disturbance impacts to waterfowl and other migratory birds.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation

Primary means of access to areas on the Refuge Complex use for fishing and wildlife observation and photography include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors use bicycles on public roads and levee trails on all three refuges. An even smaller number ride horses on roads at Anahuac NWR and on the Gulf beach at McFaddin NWR. Motorized vehicles and walking are used to access areas used for environmental education and interpretation on Anahuac NWR.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

Under Refuge Management Alternative A, most of these visitor facilities on the Refuge Complex would continue to be found on the Anahuac NWR, and the primary impacts of these activities on waterfowl would occur on this Refuge.

(2). Impacts to other Migratory Birds, Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds

(a). Waterfowl Hunting

Although the impacts of waterfowl hunting under Refuge Management Alternative A on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole, 1995), as will non-motorized boats, vehicles and walking through the marsh.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

Primary means of access to areas on the Refuge Complex for fishing, wildlife observation and photography include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors use bicycles on public roads and levee trails on all three refuges. An even smaller number ride horses on roads at Anahuac and McFaddin NWRs. Motorized vehicles and walking are used to access areas used for environmental education and interpretation on Anahuac NWR.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

On Anahuac NWR, visitors are allowed to access a 10-acre area within the Yellow Rail Prairie Management Unit to attempt to flush and view Yellow Rails. This is accomplished by walking slowly through the area, and is most successful when groups of people slowly walk parallel to each other dragging a rope in between participants. This activity occurs primarily during the months of March and April, and includes several guided “Yellow Rail Walks” led by refuge staff or trained volunteers. Disturbance of rails flushed during this activity undoubtedly occurs and likely leads to reduced utilization of this area by rails. Suitable undisturbed habitats exist adjacent to this site, and is unlikely that this disturbance results in long-term negative impacts to individual rails or rail populations.

Heaviest use and vehicular traffic of beaches on and adjacent to McFaddin NWR occurs from April through September. Numerous studies have documented impacts of beach recreation on shorebirds. Beach use affects beach-nesting birds directly and indirectly. Beach use may cause direct mortality of

birds through nest and chick destruction, displacement, or reduced reproductive success (Burger 1995). Burger (1984) found that human disturbance accounted for over half of the reproductive failures of Least Tern colonies in New Jersey. Most of this loss was due to off-road vehicles and people walking through the colonies. The presence of people on the beach decreases foraging time and increases vigilance of Piping Plovers, potentially having a negative effect on chick survival and adult maintenance (Burger 1991). Flemming *et al.* (1988) suggest that population decline of piping plovers could be caused by human disturbance altering chick behavior, thereby increasing their susceptibility to inclement weather and predators, and consequently increasing mortality. Beach-nesting birds respond to recreationalists based on species' characteristics, habituation to disturbance, exposure, seasonality, and nesting dispersion (Burger and Gochfeld as cited by Knight and Gutzwiller 1995). Beach use may also cause indirect impacts to birds by increasing predators or habitat loss (Burger 1995).

Long-term declines in the abundance of some migratory shorebird species may be associated with increased human disturbance factors on beaches (Pfister *et al.* 1992). This study found that vehicles, pedestrians, and pets displace shorebirds from traditional resting areas, thereby reducing the utility of impacted areas to migrating shorebird populations. Burger and Gochfeld (1991) found that human disturbance from beach use (walking, sunbathing, swimming, and jogging) impacted the time devoted to foraging by wintering sanderlings. An increase in the number of people on the beach was associated with sanderlings spending more time directly running or flying due to disturbance.

Recreational beach uses and associated vehicular traffic have had impacts on shorebirds and other waterbirds on Gulf of Mexico beaches on and adjacent to McFaddin NWR. Species known to nest on the beach, dunes and/or overwash terrace on the Refuge include Least Tern, Wilson's Plover, Black Skimmer, Killdeer, and Common Nighthawk. Mortality of least tern chicks, and the loss of least tern, killdeer, and common nighthawk nests and eggs has been documented on the Refuge due to illegal motorized vehicle activity on the dunes and overwash terrace inland of the beach. Illegal travel on these habitats occurs primarily when high water or erosion precludes travel on the beach. Beach walkers and unleashed pets have also caused disturbance to least tern colonies located on the overwash terrace. Under Refuge Management Alternative A, the USFWS would continue routine law enforcement patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

(3). Impacts to Fisheries

(a). Fishing

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term. Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative A should not have any measurable effect on overall populations and the long-term viability of these species' populations.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative A.

(4). Impacts to Threatened and Endangered Species

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

It is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats are subject to the some level of disturbance by public use activities on the Refuge Complex, but these impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative A.

(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

It is likely that mammals and amphibians and reptiles are subject to some level of disturbance from public use activities occurring on the Refuge Complex, but these impacts are expected to be negligible. Vehicles do occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

(b). Commercial Alligator Harvest

Under Refuge Management Alternative A, an adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Refuge Management Alternative A should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

(c). Control of Muskrat Populations

Under Refuge Management Alternative A, muskrat populations would be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

Surveys, monitoring and research activities for waterfowl to continue under Refuge Management Alternative A include the following: 1) monthly aerial surveys of waterfowl (September through March); 2)

annual Mottled Duck breeding pair surveys; 3) national, regional and local banding studies of waterfowl, including ongoing banding studies of Mottled Ducks and snow geese; 4) data collection from harvested waterfowl at check stations including body condition indices and lead shot ingestion rates; 5) participation in the annual Audubon Society Christmas Bird Count; and 6) coordination of research studies on Mottled Ducks and other priority waterfowl species through partnerships with the USFWS Division of Migratory Birds, universities and the U.S. Geological Survey Biological Resources Division.

Surveys, monitoring and research for shorebirds, wading birds and other marsh and waterbirds to continue under Refuge Management Alternative A include the following: 1) an annual nesting survey for colonial nesting waterbirds on Gulf shoreline of Texas Point NWR; 2) periodic spring and fall shorebird surveys in various representative wetland habitats; 3) participation in the annual Audubon Society Christmas Bird Count; and 4) research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Surveys, monitoring, and research activities for resident and migratory landbirds to continue under Refuge Management Alternative A include the following: 1) periodic surveys of selected landbirds in marsh, prairie and woodland habitats; 2) participation in the annual Audubon Society Christmas Bird Count; and 3) coordination of research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Surveys and monitoring activities for fisheries resources to continue under Refuge Management Alternative A include the following: 1) coordination with the USFWS Fisheries Program for periodic fisheries monitoring in representative wetland habitats; and 2) coordination with USFWS Division of Ecological Services and other State and Federal agencies to conduct periodic monitoring and studies of contaminant impacts to fisheries.

Surveys and monitoring activities indirectly benefiting T&E species to continue under Refuge Management Alternative A include the following: 1) participation in the annual coast-wide wintering Piping Plover survey; and 2) coordination of research studies on sensitive and/or declining species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Under Refuge Management Alternative A, annual aerial basking surveys and nighttime spotlight surveys to monitor alligator population trends would continue. Data collection from harvested alligators would continue, including data collection on previously marked and released alligators. Coordination and information sharing with the Texas Parks and Wildlife Department on alligator harvest management, population monitoring, and research would continue.

Collection of information on species composition and relative abundance of invertebrates on the Refuge Complex would continue under Refuge Management Alternative A. These data are typically collected through "BioBlitz" events and other surveys conducted in partnership with universities, the U.S. Geological Survey Biological Resources Division, and volunteer naturalists. The North American Butterfly Association's Fourth of July Butterfly Counts would also continue on the Refuge Complex. These monitoring activities are providing baseline information, previously not available, on this important resource. Many species of invertebrates provide a critically important prey base for migratory birds and other native fish and wildlife.

Surveys and monitoring and research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information facilitates implementation of an adaptive management approach which allows continual refinement and improvement of management activities. In some cases, monitoring activities are providing baseline information, previously not available, on this important resource.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative A, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits.

Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex is a reduced impact on fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative A, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative A would result in benefits to fish and wildlife resources as important habitats are restored and enhanced. Projects on private lands such as those implanted to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat. Ongoing partnerships with the Refuge Friends groups, agencies and conservation organizations and volunteers would support a variety of habitat restoration and biological program activities on the Refuge Complex, contributing directly to conservation of fish and wildlife resources.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements:

- 1) Direct expenditures made by USFWS to manage operations at the Refuge Complex,
- 2) Value of production from agricultural programs on the Refuge Complex, and
- 3) Expenditures made by recreational visitors to the Refuge Complex.

Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of each management alternative, including the No Action Alternative, were estimated using the data and methods discussed below.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

a. Direct Economic Impacts

(1). Value of Refuge Operations (Direct Expenditures)¹⁰

Data on current local USFWS operational expenditures at the Refuge Complex was gathered and is summarized in Table 4-1. Expenditures that support operations from sources outside the region were not

Salaries	\$1,736,727
Utilities	\$35,000
Supplies	\$28,000
Travel	\$39,123
Heavy Equip. Rental	\$50,000
Equipment Replacement	\$27,000
Annual Maintenance (Facilities and Equipment)	\$231,000
Deferred Maintenance	\$533,333
Special Programs	\$15,000
Total	\$2,695,184

considered. This is due to the fact that these expenditures do not have a local economic impact and are thus not a focus of this analysis. The average annual expenditure estimates were based on budgets for the Refuge Complex for Fiscal Years 2001, 2002 and 2003. The largest expenditure associated with the Refuge Complex is for staff salaries, which comprises approximately 65 percent of total budgeted costs. Deferred maintenance projects are the second largest local expenditure and comprise approximately 20 percent of the annual budget. These projects cover the costs of continuing habitat management and restoration at the Refuge Complex. The third highest cost is for annual maintenance of facilities and equipment.

To support these activities, the USFWS purchases a variety of inputs from the local economy. This includes such things as labor (FWS jobs or contract), materials (e.g. equipment, construction materials, office supplies, plants, rock, fuel, chemicals, etc.), and services (e.g. dirt work, water well development, repairs, etc.) It was assumed for the analysis that the costs summarized in Table 4-1 would represent spending patterns under Refuge Management Alternative A (No Action).

(2). Value of Production from Refuge Agricultural Programs

This section presents data that is used to estimate the value of agriculture production within the Refuge Complex, specifically grazing operations and rice production.

(a). Cattle Grazing

Information from the USFWS and the Texas Agricultural Statistical Service was used to value current grazing operations within the Refuge Complex. First, information concerning the historical grazing use within the Refuge Complex over the last 6 years was accumulated. The annual grazing rate is expressed in Animal Unit Months (AUMs) which is the standard industry measure for cattle grazing. Cattle grazing on the Refuge Complex for the last 6 years is summarized in Table 4-2.

Year	Anahuac NWR	McFaddin NWR	Texas Point NWR
2001-2002	14,352	10,240	845
2000-2001	10,542	13,979	737
1999-2000	11,459	10,669	1,140
1998-1999	13,171	6,468	1,477
1997-1998	11,418	12,056	0*
1996-1997	12,778	9,689	1,283

*Grazing did not occur on Texas Point NWR during this year due to a late decision of a permittee not to graze.

¹⁰ The Value of USFWS Operations Table is essentially done for the Refuge Management Alternative A (No Action). Under the remaining Refuge Management Alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

The value of grazing AUMs for cattle was then estimated as summarized in Table 4-3. For cattle AUMS, as shown in columns 2 and 3, data were obtained from the Texas Agricultural Statistical Service and include the value of cattle sold in Texas each year between 1998 to 2002. Total cattle sales were divided by the number of cows that have calved each year, which provided a value per cow sold as summarized in column 4. The value per cow was then divided by an AUM conversion factor, which resulted in an estimated value per AUM per year. This annual value was adjusted for inflation each year as summarized in column 7. The economic analysis for this report used the 5-year average value of AUMs, or \$88.02/AUM in inflation-adjusted dollars.

Year	Value of Production (1,000\$s)a	Cows that have Calved (1,000 Head)a	Value Per Cow	Conversion to AUMs (AUMs/cow)b	Value of Production Per AUM Nominal \$	Value of Production Per AUM Real (2002\$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1998	\$7,830,000	5,880	\$1,332	16	\$83.23	\$89.97
1999	\$7,050,000	5,870	\$1,201	16	\$75.06	\$80.10
2000	\$7,784,000	5,780	\$1,347	16	\$84.17	\$88.00
2001	\$8,357,000	5,810	\$1,438	16	\$89.90	\$91.87
2002	\$8,296,000	5,750	\$1,443	16	\$90.17	\$90.17
5-yr Average						\$88.02

a Texas Agricultural Statistical Service, "Texas Agriculture Statistics, 2001", Austin, Texas.
b J.P. Workman, Range Economics, 1986, McMillian Publishing, Inc. New York, New York.

Using the value per AUM and the five-year average grazing use, the value of current grazing operations within the Refuge Complex were estimated as shown in Table 4-4.

	Anahuac NWR	McFaddin NWR	Texas Point NWR
Annual Ave.	12,287	10,517	1,096
Value Per AUM	\$88.02	\$88.02	\$88.02
Total Output	\$1,081,532	\$925,743	\$96,510

*A similar process was used to estimate the value of grazing operations under the other alternatives. This effort included some development assumptions regarding the number of annual AUMs expected to occur under each alternative. For instance, grazing use is expected to increase under Alternative B and D in varying ways due to the change in management while grazing use is expected to decrease under Alternative C. The most dramatic change will occur under Alternative E where the controlled grazing program would be eliminated.

(b). Rice Production

The USFWS manages a cooperative farming program within the Refuge Complex. The program supports rice farming and occurs solely on Anahuac NWR. The refuge has 1,713 base acres registered with the USDA used currently by four permittees on a three-year rotational basis. Thus, approximately 500 to 700 acres of rice are currently produced on an annual basis and would continue under Refuge Management Alternative A. The USFWS recognizes the benefits of having rice produced on the refuge as a potential food source for migratory birds. Rice operations within the refuge must be compatible with these wildlife goals. In accordance, USFWS requires permittees to meet certain stipulations including: use of only approved herbicides, maintenance schedules, use of certified rice seed and restrictions on second growth harvests. Currently, nearly two-thirds of the total acreage within the cooperative farming program is managed as an organic rice farming operation.

Using information from the Texas Agriculture Extension Service, an estimate of average returns for rice production was prepared. A summary is provided in Table 4-5.

	Quantity (cwt)	\$/cwt (2002\$)	Estimated Value Per Acre
Rice 1st Crop	56.9	\$7.32	\$416

Source: Texas Agriculture Extension Service, Rice, First and Second Crop, Texas Gulf Coast, 2000 Projected Costs and Returns per Acre

Using the estimated value per acre from Table 4-5 and the average number of acres actually farmed each year, an estimate of the value of annual rice production occurring on the Refuge Complex was prepared and is summarized in Table 4-6.

	Average Acres	Value Per Acre	Estimated Value of Production
Rice 1st Crop	600	\$416.45	\$249,867

(3) Value of Refuge Recreational Programs

Economic impacts occur within the local economy as recreationalists spend money while visiting the Refuge Complex. From a regional economic standpoint, the importance of this spending is dependent on where the funds originate. If funds originate outside the region, it generates additional economic activity. If they originate from inside the region and would have occurred anyway, it does not increase economic activity though it may still be important to local businesses. This analysis focused on the number of visitors that originate from outside the study area (e.g. outside Jefferson and Chambers counties) and travel to the Refuge Complex to enjoy recreational activities.

The value of refuge current recreational programs under Refuge Management Alternative A was estimated using several steps as follows:

- Estimate visitation by activity to the refuges open for recreation (uses considered included hunting, fishing, wildlife observation)
- Determine the number of out-of-area visitors that come to the Refuge Complex
- Estimate the average expenditures per Recreational Visitor Days (RVDs) at the Refuge Complex

First, estimates were generated on the number of visits made to each refuge open to recreational use (e.g. Texas Point, McFaddin and Anahuac NWRs). These estimates are based on currently available data from the USFWS on recreational use and on a series assumptions regarding how management actions will affect recreational uses during the study period. Most of the data used to estimate refuge visitation comes from the Recreation Management Information System (RMIS), which includes data on visitation reported by Refuge Complex staff. Estimated refuge visitation is expressed in RVDs, and the annual estimates of RVDs is used to calculate the logarithmic trend for each activity. The trend is then applied over the 15-year study period to determine projected visitation.

Next, the origin of recreational visitors to the Refuge Complex was determined based on USFWS data and information. This includes visitor origin for fishing and hunting which was estimated from actual licenses or staff observations. The determination also used visitor origin estimates for wildlife observation as published by the USFWS for Laguna Atascosa National Wildlife Refuge in Texas.¹¹ It was determined that approximately 90% of the visitors participating in wildlife observation were not local, while only about 10% of the visitors participating in hunting or fishing were not local.

11U.S. Fish and Wildlife, "Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge", June 1997, p. 94.

Annual RVDs by activity for non-resident recreationalists was estimated using the above factors and the estimated annual RVDs for the Refuge Complex based on USFWS data. Annual non-resident RVDs for 2003 using this method is provided in Table 4-7. Wildlife observation attracts the greatest percentage of non-resident recreationalists accounting for over 83 percent of annual non-resident visits. Because visitors may spend less than one day at the Refuge, counting brief visits as full RVDs would overstate visitor spending that can be attributed to the Refuge Complex. However, observations by USFWS staff indicated that individuals using the Refuge Complex do spend most of the day on site while recreating. Therefore, no additional adjustments were made to the RVD estimates.

Wildlife Observation	Waterfowl Hunting	Other Hunting	Fishing	Total Non-Resident Visitors
29,099	1,167	0	4,744	35,010

Average daily expenditures made by recreators visiting the Refuge Complex were extracted from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Texas.¹² This survey is administered every five years to recreators throughout the country. Each respondent who indicated participation in an activity were asked about the trips made to a particular state to pursue this activity including trip expenditures. Data published for Texas regarding trip expenditures associated with wildlife observation, migratory bird hunting and fishing were used to estimate an average expenditure per day as summarized in Table 4-8. This data was used to estimate total recreational expenditures that can be attributed to recreational visitors to the Refuge Complex.

Total annual direct expenditures associated with recreation at the Refuge Complex was estimated for fiscal year 2003 by multiplying the non-resident RVDs provide in Table 4-7 by the average daily expenditures provided in Table 4-8. The summary provided in Table 4-9 shows that annual direct recreational expenditures exceeds \$1 million in the secondary study area on an annual basis.

Itemized Expenditures	Fishing	Migratory Bird Hunting	Wildlife Observation and Photography
Food and lodging	\$10.80	\$21.07	\$19.77
Food	\$7.83	\$16.13	\$11.00
Lodging	\$2.97	\$4.94	\$8.76
Transportation	\$7.27	\$12.38	\$8.26
Other trip costs	\$9.55	\$0.00	\$2.84
Privilege and other fees	\$2.77	\$6.13	Na
Boating costs	\$4.09	\$1.31	Na
Bait	\$1.97	\$0.00	Na
Ice	\$0.57	\$0.00	Na
Heating and cooking fuel	\$0.14	\$0.00	Na
Average Daily Costs	\$47.97	\$61.96	\$50.63

*Estimated with data from the U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

12 U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

Table 4-9

Annual Direct Expenditures Associated with Recreational Visitors at the Refuge Complex (2003)

Expenditure Type	Total Recreational Expenditures (2003\$)
Food	\$415,563
Lodging	\$284,225
Transportation (Gas)	\$313,534
Other trip costs (Misc.)	\$82,552
Boating costs	\$3,049
Bait	\$0
Ice	\$0
Sum	\$1,098,923

b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

Employment: The annual average estimated employment is measured as Full-Time Equivalent (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

Labor Income: Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

Other Property Type Income: This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

Indirect Business Taxes: Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

(1). Refuge Operations

The largest economic contribution results from the direct expenditures made by the USFWS to support operations at the Refuge Complex. These operations currently support approximately 45 FTEs per year. This includes direct employment at the Refuge Complex of approximately 30 FTEs at this time, as well as an additional 15 FTEs supported in the surrounding area. Current operations generate approximately

\$1.2 million in income and nearly \$450,000 in indirect business taxes to local government entities. The economic impacts of refuge operations are summarized in Table 4-10.

Impacts on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)	45	45	45
Labor Income	\$1,066,457	\$1,066,457	\$1,066,457
Other Property Type Income	\$222,664	\$222,664	\$222,664
Indirect Business Taxes	\$493,149	\$493,149	\$493,149

(2). Refuge Agricultural Program

Current agricultural activities on the Refuge Complex, cattle grazing and rice farming, support approximately 20 FTEs per year, about \$859,000 in annual income and \$87,000 in indirect business taxes. See Table 4-11.

Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)	20	20	20
Labor Income	\$587,382	\$587,382	\$587,382
Other Property Type Income	\$272,759	\$272,759	\$272,759
Indirect Business Taxes	\$87,668	\$87,668	\$87,668

(3). Refuge Recreational Programs

Recreational activities on the Refuge Complex also generate economic activity in the regional economy by supporting approximately 25 FTEs, and generating \$883,000 in annual income and \$136,000 in indirect business taxes. Under this Alternative there would be a slight increase in employment during the study period which is attributed to expected growth in demand for recreational activities under current management.

Total recreational expenditures by activity were estimated by multiplying average daily expenditures by the number of RVDs that are likely to occur annually each year at the Refuge Complex for each alternative. A series of economic multipliers, estimated with IMPLAN were then applied to the total annual expenditures to estimate the impacts to employment, income and indirect business taxes in the study area that can be attributable to recreation at the Refuge Complex. See Table 4-12.

Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)	25	26	26
Labor Income	\$609,908	\$621,374	\$629,040
Other Property Type Income	\$224,963	\$229,144	\$231,939
Indirect Business Taxes	\$136,816	\$139,559	\$141,394

2. Population Impacts

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives

under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under current management is expected to continue to support approximately 90 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

3. Fiscal Impacts on Local Governments

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and/or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under current management or any of the proposed alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers-Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area.

4. Social Impacts

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, ecosystem management actions such as those made by the USFWS within the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

a. Impacts to Social Structures and Lifestyles

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and/or community cohesiveness and stability)
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there

would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and/or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause/effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

b. Impacts to Relationships between the USFWS and Stakeholder Groups

General categories of stakeholder groups describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole.

Residents and/or Employees – those persons who live and/or work within the area would generally continue their existing relationships with the USFWS. The reactions of those persons to any changed relationship with the USFWS would be individualistic in nature, and could range from very positive to very negative feelings depending on the goals, values and beliefs of those affected.

Landowners – existing land management issues such as water management and prescribed fire activities may continue to be controversial for some landowners in the area.

Recreationalists – the land and water of the Texas Chenier Plain region have a rich heritage of public and commercial recreational activity. While recreation plays an important part in the economy of the area, outdoor recreation opportunities are also a traditional and substantial part of the social structure and lifestyles of the area. The USFWS is constantly struggling to balance recreational opportunities with its goal of protecting natural resources. Under any of the Refuge Management Alternatives being considered, this struggle would continue, and no matter which Alternative is implemented, there would continue to be major disagreement within the nearby population over the proper amount, locations, and access to recreational resources within the Refuge Complex.

Governmental or Quasi-Governmental Agencies – relationships between governmental or quasi-governmental agencies in the area would continue existing trends under any of the Refuge Management Alternatives, with coordination of these agencies with the USFWS sometimes being difficult because of conflicting goals and objectives. The perception of the USFWS being “outsiders” who have a substantial influence on local residents and governments would continue to exist, and associated issues would likely not be resolved easily.

Business-Persons and/or Business-Owners – as with current conditions, businesspersons and/or business owners would generally have economic development and growth as major future goals that could conflict with USFWS management actions under any of the Refuge Management Alternatives. Many persons supporting economic growth as a high priority may continue to be frustrated with USFWS

actions that could be perceived as limiting or preventing economic growth. There may be a smaller portion of business persons and business owners who would support USFWS activities in recognition that these activities could bring an expanded visitor base to the area, with the resulting expansion of the ecotourism industry providing economic benefits to at least some portion of local and regional business.

Conservation or Environmental Protection Advocates – those supporting conservation of natural resources and environmental protection would generally be supportive of current USFWS management actions under Refuge Management Alternative A. However, there would also continue to be instances where conservationists and environmental protection advocates may believe that the USFWS is not doing enough or taking the correct actions to adequately preserve or protect natural resources within the Refuge Complex.

Overall, USFWS management activities and objectives under all of the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

c. Impacts to USFWS Public Outreach Programs and Activities

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and/or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative A, current USFWS public outreach efforts would continue.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the alternatives for potential management actions:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and/or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved, and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternative A, the No Action Alternative, existing conditions and trends would generally remain the same. The management of the Refuge Complex would not change in substantive ways.

Under the other Refuge Management Alternatives (B through E), management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure/lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

d. Environmental Justice

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex EIS/CCP/LPP is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse effects and some beneficial effects by the continued operation and/or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and/or low-income population components. Overall, the identified minority and/or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

II. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE B: EMPHASIS ON INTENSIFYING MANAGEMENT OF WETLAND HABITATS FOR WATERFOWL, SHOREBIRDS, WADING BIRDS, AND OTHER WETLAND-DEPENDENT MIGRATORY BIRDS.

Overview

Under this Alternative, the Refuge Complex would focus its management efforts on active management of wetland habitats to benefit waterfowl, shorebirds, wading birds, and other wetland-dependent migratory and resident birds. Two new marsh semi-impoundments totaling 6,500 acres would be constructed and water management capabilities enhanced in existing impoundments through installation of new water control structures and levees. The cooperative rice farming program, moist soil management, and haying and mowing programs on Anahuac NWR would be expanded to enhance shallow freshwater wetland habitats and adjacent upland prairies for resident Mottled Ducks and for wintering and migrating waterfowl, shorebirds and wading birds. In marsh habitats, grazing intensity, annual prescribed burn acreage and the frequency of burning would be increased to substantially increase the amount of marsh habitat in early successional plant communities. The Refuge Complex would also continue to provide and promote opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses, with an emphasis on providing more public hunting opportunities.

A. Natural Resources Section

1. Impacts to Air Quality

The USFWS fire management program on the Refuge Complex has the greatest potential of all refuge management actions to impact the region's air quality. Fire management activities include both the suppression of unplanned wildland fires and prescribed burning. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Under Refuge Management Alternative B, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Reducing smoke impacts to surrounding communities is also an important consideration in planning and implementing suppression actions on all wildland fires occurring on the Refuge Complex.

Under Refuge Management Alternative B, the prescribed burning program would be expanded relative to Refuge Management Alternative A. The USFWS would continue to use prescribed burning on the Refuge Complex primarily to maintain and improve habitat for wintering and migrating waterfowl and other migratory birds and to reduce accumulations of hazardous fuels. Most burning would be conducted in emergent marsh habitats on the Refuge Complex, with an annual burning objective of 35,000 acres (compared to 12,000 – 15,000 acres under Refuge Management Alternative A).

Although prescribed burning under Refuge Management Alternative B would continue to be beneficial to the Refuge Complex's habitats and wildlife (as discussed under *Impacts to Vegetation/Habitats* and *Impacts to Fish and Wildlife Resources* below), this management action could also negatively impact local air quality, primarily through the production of smoke. Because prescribed burning is conducted on the Refuge Complex under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality from the USFWS fire management program would nonetheless remain minimal. The potential for smoke impacts to air quality due to unpredicted climatic events would

increase relative to Refuge Management Alternative A because of increased prescribed burning activities and the additional smoke produced.

Conversely, additional prescribed burning on the Refuge Complex under controlled conditions would reduce the potential for smoke impacts to air quality from unplanned wildland fires by reducing vegetative fuels. Additional prescribed burning activities on the Refuge Complex under Refuge Management Alternative B would result in larger areas with reduced vegetative fuel loads. Most lightning-caused natural fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires are less likely to start in areas with reduced fuel loads because of prescribed burning, and fires that do start burn with less intensity, produce less smoke, and are easier to suppress than in unburned areas with excessive accumulations of hazardous fuels.

2. Impacts to Geology and Soils

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under Refuge Management Alternative B. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Impacts of these activities on soils and geological processes would be similar to those described under Refuge Management Alternative A. As with Alternative A, it is unlikely that the limited scope of these activities under Refuge Management Alternative B would be sufficient to counteract the effects of future relative sea level rise and altered hydrological regimes. Accelerated rates of shoreline retreat and coastal land loss would likely continue.

Both structural marsh management and prescribed burning can affect soil formation and marsh vertical accretion or elevation gain (impacts are fully described under Refuge Management Alternative A). Under Refuge Management Alternative B, the USFWS would increase the acreage of coastal marsh under structural marsh management by approximately 6,500 acres and would increase prescribed burning from 12,000 to 15,000 acres annually to approximately 35,000 acres annually. USFWS water management activities in fresh to brackish coastal marshes typically reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. In meeting these objectives, marsh management should benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils. Fire may have positive or negative impacts on soil formation and marsh accretion. Insufficient information currently exists to fully evaluate these effects.

3. Impacts to Hydrology and Water Quality

a. Hydrology

Under Refuge Management Alternative B, the USFWS would continue wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. The USFWS would expand structural marsh management under this Alternative through construction of 2 additional marsh semi-impoundments totaling approximately 6,500 acres, enhance hydrologic management in several existing marsh units by developing new infrastructure,

and expand cooperative rice farming and moist soil management programs. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass.

The wetland management and restoration activities implemented by the USFWS under Refuge Management Alternative B would help maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats would continue to support a natural diversity of native plant, fish and animal communities. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes on the Refuge Complex also would help to prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain (accretion).

As with Refuge Management Alternative A, the relatively small-scale hydrologic and shoreline restoration projects to be maintained and implemented in the future on the Refuge Complex under Refuge Management Alternative B are not likely to be sufficient to counter the effects of relative sea level rise and altered hydrological regimes on coastal land loss. Current rates of shoreline retreat and conversion of vegetated marshes to open water will likely continue, and may accelerate, under this Alternative. For example, restoration of the historic barrier beach and dunes on McFaddin NWR would require a large-scale project affecting an additional 16 miles of Gulf shoreline. Under this Alternative, increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes on McFaddin and Texas Point NWRs will continue to negatively impact soil formation and vertical accretion by causing plant mortality and an overall reduction in above and below-ground plant productivity. Under this scenario, these marshes will become increasingly susceptible to submergence and conversion to open water.

b. Water Quality

Under Refuge Management Alternative B, the USFWS would continue activities described under Alternative A. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills to water quality, habitats and fish and wildlife resources.

4. Impacts to Vegetation and Habitats

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative B would include all of the habitat management and restoration activities in wetland and upland habitats described under Alternative A. Changes from Alternative A would include expanded structural water management in coastal marshes, expanded rice farming and moist soil management programs, and intensified use of prescribed burning and controlled grazing.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, and environmental education and interpretation would continue under Refuge Management Alternative B. Additional waterfowl hunting opportunities would be provided and some changes to administration of the hunt programs would occur. Impacts to vegetation and habitats would be similar to those described for these uses under Refuge Management Alternative A.

Current systematic monitoring of vegetation and habitats as part of the Refuge Complex biological program would continue under Refuge Management Alternative B.

Management of oil and gas activities through issuance of Special Use Permits would continue as under Refuge Management Alternative A, and would be aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

The USFWS would also continue to work with private landowners to facilitate implementation of wetland habitat restoration and enhancement projects. Community outreach efforts would include ongoing partnerships with Refuge Friends groups, agencies, volunteers, conservation organizations, community

groups and industry to further natural resource conservation on the Refuge Complex and throughout the project area.

a. Impacts to Vegetation and Habitats from Habitat Management and Restoration Activities

(1). Wetland Specific Management and Restoration

Wetland management and restoration activities under Refuge Management Alternative B would influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

(a). Water Management in Coastal Marshes

In addition to management activities described under Refuge Management Alternative A, the USFWS would expand structural marsh management through construction of 2 additional marsh semi-impoundments totaling approximately 6,500 acres on McFaddin and Anahuac NWRs, and would enhance management capabilities in several existing managed marsh units by installing new infrastructure including water control structures and levees under Refuge Management Alternative B. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization, allowing both emergent and submergent vegetation to flourish (Hess *et al.* 1989). Monitoring on and adjacent to McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

The additional structural marsh management on the Refuge Complex would maintain or restore approximately 6,500 acres of intermediate marsh in areas which have become brackish due to channelization and saltwater intrusion. Expanded and enhanced hydrologic management and reducing water turbidities through construction of marsh terraces under this Alternative would increase production and diversity of submerged aquatic vegetation open water habitats within managed marsh units. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) would help to prevent the conversion of vegetated marsh in these areas to open water. By promoting plant productivity, this management activity may also contribute to marsh soil formation and surface elevation gain (marsh accretion).

The above notwithstanding, periodic climatic events such as flooding during periods of high rainfall or due to tidal storm surge and prolonged drought would continue to influence and sometimes be the dominant factors controlling hydrologic regimes and the response of vegetative communities in the Refuge Complex coastal marshes.

(b). Marsh Restoration

Under the Refuge Management Alternative B, the level and scope of marsh restoration using dredge material would continue as described under Alternative A. Marsh restoration efforts under Refuge Management Alternative B would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife.

(c). Moist Soil Management

Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). Like coastal marshes, shallow freshwater prairie wetlands provide important food resources and cover to a diversity of wetland-dependent resident and migratory birds and wildlife.

Under the Refuge Management Alternative B, moist soil management capabilities would be developed on an additional 1,100 acres on the Refuge Complex (900 acres on Anahuac NWR and 200 acres on McFaddin and Texas Point NWRs). This would create additional shallow freshwater wetland habitat for migratory birds and other wetland-dependent wildlife.

Expanded moist soil management would increase biological diversity on the Refuge Complex. Moist-soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Water management and mechanical soil manipulations in new moist soil units would promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Additional moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime would favor the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

Expansion of the moist soil management program under this Alternative would reduce the overall area on the Refuge Complex available for native prairie restoration.

(d). Cooperative Rice Farming Program

Under Refuge Management Alternative B, the USFWS would expand its cooperative rice farming program on Anahuac NWR by farming an additional 300-500 acres annually, from existing levels of 500-700 acres. This expanded program would provide additional shallow freshwater wetland habitat for migrating and wintering waterfowl, shorebirds, wading birds and other wetland-dependent wildlife. Currently, almost 80% of the rice produced on the refuge is organically grown, and the expanded program would give preference to organic producers. Organically produced rice reduces the overall input of herbicides on the refuge.

Rice production has declined during the last decade in counties surrounding the Refuge Complex, reducing this type of agricultural wetland habitat for waterfowl, shorebirds and other wetland-dependent species. Other changes in rice cultivation practices may also have deleterious effects on waterbird populations. Abandoned rice fields and pasturelands are susceptible to invasion by Chinese tallow, eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality and will require extensive restoration efforts.

Expansion of the cooperative rice farming program on Anahuac NWR under Refuge Management Alternative B would serve several outcomes for migratory bird management: creating forage for migrating and wintering waterfowl, habitat for migrating shorebirds, and fresh water habitat for breeding and brood rearing Mottled Ducks and Fulvous and Black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also left for wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest ricefields that were cultivated and at least partially flooded (Czech and Parsons 2002).

Expansion of the cooperative rice farming program would reduce the overall area on Anahuac NWR available for native prairie restoration.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Under Refuge Management Alternative B, upland grassland habitats would continue to be managed using the management tools described in Refuge Management Alternative A. Under this Alternative, no additional native prairie habitat would be restored. Together, the management actions undertaken under Refuge Management Alternative B would continue to protect and enhance the 5,774 acres of non-saline grasslands on the Refuge Complex. Impacts of burning, grazing, invasive species management and mowing/haying to vegetation and habitats are discussed below. Overall, prairie management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity.

(b). Woodlot Restoration and Protection

Under Refuge Management Alternative B, the USFWS would continue management activities as described under Alternative A on the 127 acres of existing woodlots: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

Overall, implementation of the USFWS management actions under this Alternative would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

(3). General Habitat Management Activities

Under Refuge Management Alternative B, the USFWS would expand prescribed burning, controlled livestock grazing and mowing and haying to enhance wetland and upland habitats for migratory birds. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Invasive species management and shoreline restoration and protection activities would continue as described under Refuge Management Alternative A.

(a). Fire Management - Prescribed Burning and Wildland Fire Suppression

Under Refuge Management Alternative B, the fire management program would continue to involve both suppression of unplanned wildland fires and prescribed burning. Suppression activities would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). The prescribed burning program would be expanded to an annual objective of approximately 35,000 acres (primarily in marsh habitats), and increase of 20,000 acres above current levels. Although most burning would continue to be conducted on a three-year rotation, annual and bi-annual burning in selected fresh and intermediate marsh habitats would be conducted. Most prescribed burning would be conducted from October through January in marsh habitats. Prescribed burning of upland grassland units would occur primarily in late winter and early spring.

Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, and seashore saltgrass. Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.) and forbs such as purple ammenia and Delta duck potato, increases after a fire, particularly when followed by grazing and suitable hydrology.

The impacts of prescribed burning in upland grassland habitats include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased.

In summary, beneficial impacts of an expanded (larger areas burned annually and more frequent burning) prescribed burning program under this Alternative would be similar to but more extensive than those described for burning under Refuge Management Alternative A, and include:

- Hazardous fuels would be reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning over larger areas annually and more frequent burns would further lessen the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds would be enhanced by maintaining a larger proportion of marsh habitats on the Refuge Complex in early successional plant communities which provide important food resources, by increasing production and nutritional quality of these foods, and by enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, would be further suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife.

While fire, whether planned or unplanned, can have positive ecological effects, detrimental impacts to vegetation and habitats ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water can also occur. For example, burning under excessively dry conditions could result in plant mortality and consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Proper timing of prescribed burns under appropriate environmental and climatic conditions is essential to minimize negative impacts. Under Refuge Management Alternative B, the USFWS prescribed burning program would continue to consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive wetland and upland habitats on the Refuge Complex. Potential for some adverse affects to vegetation and habitats to occur would increase under this Alternative because of the additional acreage burned annually and the increased frequency of burning.

(b). Controlled Livestock Grazing

Controlled grazing on the Refuge Complex is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats. Under Refuge Management Alternative B, grazing intensity and duration would be increased in most fresh and intermediate marsh habitats on the Refuge Complex. Controlled grazing would still be applied on approximately 41,000 acres of the Refuge Complex, but higher stocking rates would be used and grazing periods would be extended in selected refuge units.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relationship of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Studies conducted on Sabine National Wildlife Refuge in Cameron Parish, Louisiana (Valentine 1961) determined that increased grazing can change tall climax marshhay cordgrass stands to a more diverse community such as seashore paspalum, *Setaria*, and longtom (*Paspalum lividum*), that are more beneficial to certain types of wildlife. Depending on site conditions (elevation, soil, and hydrology) annual grasses and forbs (including millets, fall Panicum (*Panicum dichotomiflorum*), sprangletop, and *Setaria*) can be produced through proper grazing.

Pate (2001) found that grazed marshes remained in a sub-climax state, while habitat within grazing exclosures reverted to marshhay cordgrass. At the onset of the study *Spartina* spp. made up 20% of the plant community, while seashore paspalum comprised 80%. By the end of the study, communities within grazing exclosures changed to 65% *Spartina* spp. and 25% seashore paspalum. In contrast, the grazed area maintained high cover of seashore paspalum throughout the study. Shallowly-flooded seashore paspalum provides habitat for many species of waterfowl, wading birds and shorebirds, while dense stands of marshhay cordgrass preclude use by these species.

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Increased grazing intensity and duration in marsh habitats under this Alternative would increase the abundance of target plant species and communities in intermediate and brackish marsh habitats on the Refuge Complex, including Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. The grazing regime under this Alternative would provide additional areas with optimal physical structure of vegetation for waterfowl utilization by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Specifically, the beneficial impacts of grazing in wetland habitats would be similar but more extensive than those described under Refuge Management Alternative A, and include:

- Rank vegetation would be reduced, enabling migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Competing growth of marshhay cordgrass and other dominant climax plant communities would be reduced, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Additional open water habitat would be created, which provides loafing areas for birds and allow them to access aquatic invertebrates.
- Marsh burning would be complemented by prolonging the time that browse is available for goose use.
- Plant vigor and plant productivity would be increased, nutrient recycling enhanced, and excessive build-up of residual plant material prevented.

- Hazardous fuel loading would be reduced, reducing the amount and intensity of wildfires.
- Capped soils would be broken through hoof action, assisting in seedling establishment of many preferred food plants.
- Vegetation in recently burned areas would be maintained in more palatable stages for wintering waterfowl.

Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1995). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged intensive grazing, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative B, the USFWS would continue to monitor grazing programs and adjust grazing strategies so as to avoid detrimental impacts. The potential for some adverse impacts to vegetation and habitats to occur would increase under this Alternative. Upland areas adjacent to marshes but contiguous within an individual grazing unit would be subject to higher grazing intensities and be most susceptible to potential adverse impacts.

(c). Invasive Species Management

Under Refuge Management Alternative B, the level and scope of invasive species management activities, as well as their impacts to native vegetation and habitats on the Refuge Complex, would generally continue as described for Alternative A. The USFWS would continue to control invasive plant species to conserve native biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program would be implemented to control the following exotic and invasive plant species (USFWS 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice.
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies.

In wetland habitats, these activities would result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

Control of Chinese tallow and deep-rooted sedge in prairie and woodlots would result in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub

abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

Under Refuge Management Alternative B, the USFWS would also continue to control exotic animals on the Refuge Complex to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral hog control would be conducted as described under Alternative A. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants. Control activities for nutria under this Alternative would be the same as those under Refuge Management Alternative A, and if implemented would decrease damage to wetland habitats.

(d). Shoreline Protection and Restoration

Under Refuge Management Alternative B, shoreline protection and restoration activities would continue as described under Alternative A. These activities would positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier dunes and beaches along the Gulf of Mexico would protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events, as well as restoring an upland native habitat type which has been almost completely lost. Use of dredged material along existing shorelines would protect existing marshes by slowing erosion and shoreline retreat, providing a substrate for reestablishment of marsh vegetation and restoration, and increasing net sediment supply to marshes which would provide nutrients and increase plant productivity (Chabreck 1976, 1994). Breakwaters would continue to enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have converted to open water. The stands of smooth cordgrass also would provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

The relatively small scale of ongoing shoreline restoration projects under Refuge Management Alternative B on the Refuge Complex is not likely to effectively counter the future effects of relative sea level rise and altered hydrological regimes, however, and accelerated rates of shoreline retreat and land loss would likely continue to occur. For example, total restoration of the barrier beaches and dunes on McFaddin NWR would require work along an additional 16 miles of Gulf shoreline. Increased saltwater intrusion from more frequent tidal flooding from the Gulf into inland marshes would continue to negatively impact vegetation and habitats on McFaddin and Texas Point NWRs by causing direct mortality of some plant species and an overall reduction in plant productivity.

(e). Mowing and Haying

Under the Refuge Management Alternative B, approximately 400 acres of upland grassland habitats would be mowed or hayed annually on the Refuge Complex, an increase of approximately 300 acres from current levels. Mowing and haying would result in invigorating growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis. Reduction of this herbaceous and woody cover often results in the “release” of native prairie plants.

b. Impacts from Public Use Programs

Assuming an increase in visitation to the Refuge Complex under Refuge Management Alternative B due to improved and expanded waterfowl hunting opportunities and new hunting programs for doves and snipe, rails and gallinules and to development of new visitor facilities, impacts to vegetation and habitats described below would likely increase over current levels.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and

fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

Although visitation would increase under this Alternative, administration and management of these uses would continue and impacts to vegetation and habitats would be expected to remain localized and not substantial. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts. New facilities would be designed and located in such as manner so as to further reduce these impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative B, the USFWS would continue routine patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative B. Continued habitat and vegetation monitoring activities and research studies on the Refuge Complex would support an adaptive management approach, by providing information which helps refine and improve existing management practices.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative B, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and/or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduction of impacts to vegetation and habitats from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative B, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance wetland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative B would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

5. Impacts to Fish and Wildlife Resources

Under Refuge Management Alternative B, habitat management and restoration and biological program activities on the Refuge Complex would be focused on wetlands and migratory birds, with continued consideration of the conservation of the following fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS would continue to administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development and expanded community outreach and partnership programs would contribute to conservation of fish and wildlife resources on the Refuge Complex and throughout the project area.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made

hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on a landscape scale has increased the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland loss to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.¹³ Many wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Overall and all else being equal, expanding and enhancing wetland management and restoration under Refuge Management Alternative B can be expected to increase wintering and migrating waterfowl populations on the Refuge Complex. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

Under the Refuge Management Alternative B, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations on the Refuge Complex.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative B, approximately 36,500 acres of marsh habitats would be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems, and management capabilities would be enhanced on several existing managed units. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

Approximately 1,100 additional acres of moist soil units would be developed on the Refuge Complex under Refuge Management Alternative B, specifically to provide additional high quality habitat for wintering and migrating waterfowl. Moist soil management would provide optimal conditions for germination and growth of preferred waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia.

On Anahuac NWR, rice production through the cooperative rice farming program would be expanded to approximately 1,000 acres annually under this Alternative to provide additional habitat for wintering and

¹³ During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

migrating waterfowl. Management of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Marsh restoration using dredge material would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

(b). General Habitat Management and Restoration Activities

Under Refuge Management Alternative B, the USFWS would continue an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex to promote optimal habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, enhanced water management capabilities, expanded prescribed burning and more intensive grazing under Refuge Management Alternative B would provide enhanced habitat conditions for wintering waterfowl on the Refuge Complex. Prescribed burning and grazing would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing would also result in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing also would help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Waterfowl habitat on the Refuge Complex would also be enhanced under Refuge Management Alternative B through the control of undesirable invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would also be controlled to restore and maintain open water habitats. Maintaining an interspersion of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source for migratory birds. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

Continuation of shoreline protection and restoration activities under Refuge Management Alternative B would enhance waterfowl habitat on the Refuge Complex by decreasing saltwater intrusion into inland marshes and addressing threats of additional saltwater intrusion. However, the scope of these activities under Alternative B will likely not counteract the ongoing and future impacts of relative sea level rise, loss of coarse sediment supply, and altered hydrological regimes, especially on McFaddin and Texas Point NWRs. Declines in habitat quality caused by regular tidal overwash are adversely affecting migratory waterfowl use on these refuges. As beach ridges and the banks of the GIWW erode they are less effective barriers to tidal inundation and salt water intrusion during storm and other high tidal events. Overwash events create sudden and drastic spikes in salinities, often killing submerged aquatic vegetation and seed producing annual plants. Inundation of the marshes with sea water provides the sulphates which are reduced to hydrogen sulfide under conditions of high water temperatures. Hydrogen sulfide toxicity and low dissolved oxygen cause large scale die-offs of plants and animals, including many invertebrates which provide an important food source for waterfowl and other migratory birds. Survey data indicate that waterfowl numbers have dropped to below five birds per thousand acres in affected areas following overwash events, and below one bird per thousand acres after severe events (USFWS, unpublished data). Areas that can be heavily impacted by overwash events now encompass nearly 15,000 acres on McFaddin NWR and near 1,500 acres on Texas Point NWR.

Increased saltwater intrusion from frequent tidal overwash from the Gulf into inland marshes on these refuges will continue to negatively impact habitat quality for waterfowl, other migratory birds, and other native fish and wildlife species. If present erosion problems persist, total acreage of impacted marsh could increase to nearly 30,000 acres over the next 5 to 10 years. Declining habitat conditions due to increased saltwater inundation could result in further significant declines in wintering waterfowl use on McFaddin and Texas Point NWRs.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Under Refuge Management Alternative B, many habitat management and restoration activities currently conducted on the Refuge Complex would be continued, and all would be expected to have positive impacts on this species. Several habitat management and restoration activities will be expanded specifically to benefit Mottled Ducks. Management and enhancement of nesting and brood-rearing habitats would be targeted.

(a). Wetlands Management and Restoration

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative B would provide additional enhanced habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Expanded and enhanced structural marsh management would maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. It would enhance diversity and productivity of submerged aquatic vegetation in open water habitats, providing an important year-round food source for Mottled Ducks. Expanded moist soil management and cooperative rice farming programs would provide additional shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. Rice farming would provide an additional 300-500 acres and moist soil management an additional 1,100 acres of wetland habitat over current levels on the Refuge Complex under this Alternative. Approximately 400 acres of moist soil units would be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

(b). Uplands Management and Restoration

Native prairie management activities under Refuge Management Alternative B would generally remain the same as under Alternative A, and would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The integrated application of prescribed burning, controlled livestock grazing, herbicide application and expanded mowing and haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies (and on levees and along fence lines) would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as "sennabean ponds," as valuable brood rearing habitat. Protecting extant coastal prairie and restoring adjacent prairie and wetland habitats under Refuge Management Alternative B on the Refuge Complex would increase the quality of habitats important to Mottled Duck recruitment and overall reproductive success.

(c). General Habitat Management Activities

Annual prescribed burning would increase under Refuge Management Alternative B, to a target of 35,000 acres. Grazing intensity (higher stocking rates) and duration in fresh and intermediate marshes would be increased. The integrated combination of expanded water level and salinity management, and increased

prescribed burning and controlled livestock grazing in wetland habitats on the Refuge Complex under this Alternative would increase the acreage of optimal wetland habitat for Mottled Ducks. Invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex. These cordgrass ridges are dominated by Gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania* spp.) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks.

Improper application of these habitat management practices has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988). The potential for some negative impacts to Mottled Duck nesting habitat would increase under Refuge Management Alternative B. Higher cattle stocking rates and grazing durations and more frequent burning in fresh and intermediate marshes could reduce availability of suitable nesting cover in contiguous salty prairies and non-saline grassland habitats under this Alternative.

Marsh habitats being impacted by tidal overwash of the eroding beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck nesting and brood rearing habitat. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50% to 65% over the last 10 years. If erosion problems persist and result in increased frequency of saltwater intrusion events, Mottled Duck use and reproductive success on the Refuge Complex will likely further decline.

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least Sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-

round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migratory, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Refuge Management Alternative B would continue to positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative B, expanded and enhanced structural marsh management would improve habitat conditions in a wide variety of vegetation and habitat types used by many avian species in this group. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species.

Under Refuge Management Alternative B, the cooperative rice farming and moist soil management programs would be expanded to provide additional shallow freshwater wetland habitat. In total, rice farming would provide approximately 1,000 acres on Anahuac NWR, and Complex-wide moist soil management would provide 1,600 acres under this Alternative. Approximately 300 acres of the Anahuac NWR's moist soil units would be managed specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species would include Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. Under this Alternative, 1,200 acres of moist soil units would provide wetland habitat for shorebirds, wading birds, and other marsh and waterbirds over the winter months. Wading and marsh bird species using moist soil habitats on the Refuge Complex include American Bittern, Great Blue Heron, Great Egret, Snowy Egret, Little Blue Heron, Tri-colored Heron, Black-crowned and Yellow-crowned Night Herons, White Ibis, White-faced Ibis, and Roseate Spoonbill.

In general, shorebirds and wading birds would also benefit from expanded moist soil management and rice farming activities under this Alternative. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields influences the type of and intensity of use by such birds (Huner *et al.* 2002).

(b). Uplands Management and Restoration

Under Refuge Management Alternative B, restoration and enhancement of native prairie habitats would continue as described under Alternative A. Some avian species in this category would benefit, primarily from improved habitat for migrating and wintering birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

Under Refuge Management Alternative B, the USFWS would continue the integrated combination of water level and salinity management, prescribed burning and controlled livestock grazing in wetland habitats on the Refuge Complex. The USFWS would expand prescribed burning and controlled livestock grazing programs under this Alternative. These management activities promote optimum habitat

conditions for wintering and migrating waterfowl and also enhance wetland and upland habitats used by many shorebird, wading bird and marsh bird species.

These management tools would help create optimal physical structure of vegetation for many species of shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds and wading birds. Conversely, expanded burning and grazing under this Alternative may reduce habitat availability for some marsh bird species which require dense, tall stands of vegetation. Higher grazing intensities would increase the potential for some negative impacts. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979).

Some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. However, most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. As under Refuge Management Alternative A, overall management under Alternative B would be aimed at maintaining a mosaic of available habitats. This should provide an adequate range of habitats for this group of avian species.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS uses these techniques in prescribed burning operations on the Refuge Complex.

Exotic and invasive plant and animal control activities would continue as described under Refuge Management Alternative A, and would also enhance wetland and upland habitats for many avian species in this group. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative B, the USFWS would continue to maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

Overall, species requiring less dense, more open marsh habitats would benefit from expanded prescribed burning and intensified controlled grazing under Refuge Management Alternative B, while the amount of habitat for species requiring dense stands of vegetation would decrease.

(4). Impacts to Landbirds

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative B would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management, and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative B, several wetland management and restoration activities would continue to have positive impacts on several land bird species including managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and the cooperative rice farming program. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow, Nelson's Sharp-tailed Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

(b). Uplands Management and Restoration

Prairie Restoration and Management

Under Refuge Management Alternative B, approximately 5,774 acres of upland grassland habitats would be maintained and enhanced using an integrated combination of prescribed fire, controlled livestock grazing, herbicide application and expanded mowing/haying.

Native prairie remnants and other upland grassland habitats on the Refuge Complex provide wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow and Nelson's Sharp-tailed Sparrow, and nesting habitat for species including Dicksissel and Eastern Meadowlark. These are also important nesting habitats for Mottled Ducks. Several species of raptors commonly observed on the Refuge Complex include Red-tailed Hawk, Red-shouldered Hawk, Turkey Vulture, American Kestrel, White-tailed Kite, Northern Harrier, and Short-eared Owl (USFWS 1997a). Many other raptor species are observed during spring and fall migrations. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative B are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as "Avian Species of Conservation Concern" in the Gulf Prairies Bird Conservation Region (USFWS 2005). For example, White-tailed Hawk, Loggerhead Shrike, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, Henslow's Sparrow, and LeConte's Sparrow are all Avian

Species of Conservation Concern that would benefit from conservation of prairie habitats on the Refuge Complex under this Alternative.

No additional restoration of native prairie would take place under Refuge Management Alternative B. Benefits to several grassland-dependent songbirds and other native wildlife from ongoing restoration of 270 additional acres of prairie under Alternative A would not be realized.

Woodlot Restoration and Management

Under Refuge Management Alternative B, the USFWS would continue current management activities to protect 127 acres of existing coastal woodlots: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

Overall, implementation of the USFWS management actions under this Alternative would have similar impacts to those described under Alternative A. These activities would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler.

(c). General Habitat Management Activities

Prescribed burning, controlled grazing, invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative B. The integrated combination of water level and salinity management, fire management and controlled livestock grazing on the Refuge Complex which promotes optimum habitat conditions for wetland-dependent migratory birds also enhances wetland and upland habitats used by many land bird species. Invasive plant and animal control activities would also enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

The USFWS would expand prescribed burning and controlled livestock grazing programs under Refuge Management Alternative B. Seaside Sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding Seaside Sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersion of nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife. Increased burning frequency under Refuge Management Alternative B has potential to either positively or negatively impact some landbird species.

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Under Refuge Management Alternative B, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, exotic plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments on the Refuge Complex support highly diverse aquatic vertebrate and invertebrate communities. Disruption of salinity gradients would likely cause adverse impacts on blue crabs (Guillory 1996). Many of the refuge marshes would exceed these thresholds without some type of hydrologic management.

Under Refuge Management Alternative B, an additional 6,500 acres of marsh would be structurally managed. Managing water levels and salinities using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). These design features and management regimes would be also be incorporated under Refuge Management Alternative B.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative B, protection, restoration and management of coastal wetland habitats on the Refuge Complex would continue as under Alternative A, and would benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large

concentrations of wintering waterfowl. Brown Pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative B would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative B which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative B which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) would be particularly beneficial to amphibians and reptiles. Expanded structural marsh management, cooperative rice farming and moist soil management programs under this Alternative would provide additional reliable freshwater habitat critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Under Refuge Management Alternative B, some management activities would continue to have negative impacts on some wildlife species. Control of invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Under Refuge Management Alternative B, the USFWS would prescribe burn more acres annually and initiate annual burning in some habitats. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying “Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil-litter stabilize.” Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

b. Impacts from Public Use Programs

Assuming an increase in visitation to the Refuge Complex under Refuge Management Alternative B, impacts to fish and wildlife resources would likely increase over current levels described under Refuge Management Alternative A. This assumption is based upon the expanded waterfowl hunting opportunities and new hunting programs for doves and snipe, rails and gallinules and the new visitor facilities to support fishing, wildlife observation and photography, and environmental education and interpretation provided under this Alternative.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

Under Refuge Management Alternative B, additional waterfowl hunting opportunities would be provided by opening additional areas of the Refuge Complex for September teal hunting, providing additional hunting days (7-days per week) on a portion of McFaddin NWR, allowing guided hunting on portions of the Refuge Complex, and opening the refuges for snipe, gallinule and rail hunting. Assuming an increase in visitation for hunting, the impacts discussed below would increase over current levels.

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually under the USFWS migratory bird hunting regulation frameworks, and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Refuge Management Alternative B will not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting -intensity on the number of birds utilizing an area (Reichhoff 1973, Wolder 1993, Madsen *et al.* 1992 as cited by Fox and Madsen 1997). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton *et al.* 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995). Cumulatively, the expanded hunting programs under this Alternative would increase disturbance impacts to waterfowl. Of these activities, 7-days per week hunting and the hunting of snipe, rails and gallinules have the greatest potential to reduce waterfowl utilization within hunt areas on the Refuge Complex.

Means of access to and within Refuge Complex hunt areas would remain the same as under Refuge Management Alternative A and would include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required and additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Afton and Saylor in Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and/or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary areas of adequate size, encompassing and/or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998). Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

The continued maintenance of sanctuary areas on the Refuge Complex would be required to mitigate for disturbance impacts from hunting activities under Refuge Management Alternative B. Maintaining existing and developing new refuge-specific hunting regulations under this Alternative would also be necessary help mitigate the impacts of hunting activity-related disturbance to waterfowl. Monitoring would be required to assess impacts of modified/expanded hunting programs, and to make necessary future adjustments. As with the current hunting program, it is possible that hunting activities under Refuge Management Alternative B would result in reduced abundance of wintering waterfowl on the Refuge Complex in years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances.

(b). Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

Under Refuge Management Alternative B, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. Means of access for these uses and the presence of visitors result in disturbance impacts to waterfowl, as described under Refuge Management Alternative A. Increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from "out of vehicle" approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation

platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

(2). Impacts to other Migratory Birds, Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds

(a). Waterfowl Hunting

Although the disturbance impacts of waterfowl hunting under Refuge Management Alternative B on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

Under Refuge Management Alternative B, the Refuge Complex would be opened to the hunting of snipe, rails and gallinules. Harvest would result in direct mortality of individuals of these species. Because regulations governing harvest in the Central and Mississippi Flyways are developed annually and are designed to ensure that viable migratory bird populations are sustained over the long-term, harvest should not have any measurable effect on overall populations and the long-term viability of these populations. Hunting of snipe and rails on the Refuge Complex would likely be accomplished by walking and non-motorized boating, with hunters freely moving through hunt areas rather than hunting a specific location (as over a decoy spread for waterfowl). Additional movement would increase potential for disturbance to migratory birds, and increase the likelihood of conflicts with waterfowl hunters.

Under Refuge Management Alternative B, a small portion of Anahuac NWR would be open to hunting of doves. Harvest of doves would result in direct mortality, but Federal and State regulations governing harvest would ensure that dove populations are sustained over the long-term. Additional refuge-specific regulations would be in place to reduce impacts to habitat and wildlife including means of access and required use of non-toxic ammunition.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

Under Refuge Management Alternative B, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. As described under Refuge Management Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Refuge Management Alternative B, increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines

can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

(3). Impacts to Fisheries

(a). Fishing

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term.

Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative B, including expanding the hours that McFaddin NWR is open to the public, should not have any measurable effect on overall populations and the long-term viability of these species' populations.

b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative B.

(4). Impacts to Threatened and Endangered Species

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities under Refuge Management Alternative B. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative B.

(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex, under Refuge Management Alternative B. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

(b). Commercial Alligator Harvest

Under Refuge Management Alternative B, the current adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Refuge Management Alternative B should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

(c). Control of Muskrat Populations

Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Under Refuge Management Alternative B, muskrat populations could be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

Under Refuge Management Alternative B, all current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue. In addition, the USFWS would work with partners to expand the annual Mottled Duck breeding pair survey and to conduct additional research on factors affecting vital rates for this species, and would expand monitoring of colonial nesting waterbird nesting and fledgling success at a managed site on McFaddin NWR.

Surveys and monitoring and research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information facilitates implementation of an adaptive management approach which allows continual refinement and improvement of management activities. In some cases, monitoring activities are providing baseline information, previously not available. Under Refuge Management Alternative B, the USFWS would focus additional monitoring and research activities on Mottled Ducks in order to gain information needed for the long-term conservation of this important species and in light of growing concern for declining populations of Mottled Ducks on national wildlife refuges in Texas.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative B, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduced impact on fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative B, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by:

1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as the Galveston Bay Foundation, Ducks Unlimited and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that expanded outreach and partnership efforts under Refuge Management Alternative B would result in increased benefits to fish and wildlife resources as important habitats are restored and enhanced. Projects such as those implemented to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat. Ongoing partnerships with the Refuge Friends groups, conservation organizations and volunteers would support a variety of habitat restoration and biological program activities on the Refuge Complex, contributing directly to conservation of fish and wildlife resources.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements:

- 1) Direct expenditures made by USFWS to manage operations at the Refuge Complex,
- 2) Value of production from agricultural programs on the Refuge Complex, and
- 3) Expenditures made by recreational visitors to the Refuge Complex.

Second, there are **indirect and induced economic** impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this management alternative were estimated using the data and methods discussed below. The analysis compares the impacts from this management alternative to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

a. Direct Economic Impacts

(1). Value of Refuge Operations (Direct Expenditures)

Based on information about the activities proposed under Refuge Management Alternative B, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this Refuge Management Alternative. Because projects would occur throughout the study period, project costs will

vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. The estimate of the annual average cost, per five-year period, for Alternative B is summarized in Table 4-13. The estimate of Refuge Operation's direct expenditures under this alternative shows a modest increase [no more than 10%] compared to the \$2,695,184 estimate under the Refuge Management Alternative A (No Action).

Table 4-13
Average Annual Operational Costs for the Refuge Complex – Refuge Management Alternative B (Direct Expenditures)

Cost Category	Annual Average Expenditures		
	Year 1 – 5	Year 5 - 10	Year 10 - 15
Staff Salaries	\$1,736,727	\$1,775,894	\$1,819,561
Utilities	\$38,500	\$38,500	\$38,500
Travel	\$43,035	\$43,035	\$43,035
Heavy Equip. Rental and Replacement	\$77,000	\$77,000	\$77,000
Annual and Deferred Maintenance	\$1,065,217	\$940,883	\$944,217
Special Programs	\$16,500	\$16,500	\$16,500
Total Average Annual Expenditures	\$2,976,980	\$2,891,813	\$2,938,813

(2). Value of Production from Refuge Agricultural Programs

(a). Cattle Grazing

The estimate for the value of grazing included some development assumptions regarding the annual average number of AUMs expected to occur under Refuge Management Alternative B. The annual average AUMs are expected to increase from 23,900 under the Refuge Management Alternative A (No Action) to about 29,875 under this Alternative. Using the estimated value of \$88.02/AUM determined in the analysis for the Alternative A, there is an increase in the estimate of the production value of grazing in excess of \$500,000. A summary comparing the changes in AUMs and value of production between Refuge Management Alternatives A and B is contained in Table 4-14.

Table 4-14
Estimated Production Value of Grazing Activities On Refuge Complex - Refuge Management Alternative B

Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
Refuge Mgmt. Alternative B	29,875	\$2,629,598

(b). Rice Production

Under the development assumptions for this alternative the annual acreage in rice production is expected to increase from 600 acres under Refuge Management Alternative A (No Action) to approximately 1000 acres under Refuge Management Alternative B. Using the estimated value for rice production of \$416.45/acre determined in the "No Action" alternative, there is about a 2/3 increase in the estimate of value for rice production on the Refuge Complex. A summary comparing the changes in annual average acreage produced and value of production between Refuge Management Alternatives A and B is contained in Table 4-15.

Table 4-15

Estimated Value of Rice Production On Refuge Complex - Refuge Management Alternative B

Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
Refuge Mgmt. Alternative B	1000	\$416,450

(3) Value of Refuge Recreational Programs

For each Refuge Management Alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under the "No Action" alternative. The estimated changes in recreational visitors under this alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	10% Increase
Upland Bird Hunting	New activity - 100 hunter/days per year
Fishing	No change
Wildlife Observation	5% Increase

These changes were then applied to the estimate of annual non-resident visits and the estimates of itemized expenditures by recreational activity which were developed for Refuge Management Alternative A (No Action). Table 4-16 contains a summary of the comparison of the annual direct expenditures associated with Recreational visitors to the Refuge Complex between Refuge Management Alternatives A and B.

Table 4-16

Annual Direct Expenditures Associated with Recreational Visitors on Refuge Complex - RM Alternative B

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
Refuge Mgmt. Alternative B	36,682	\$1,189,014

b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

Employment: The annual average estimated employment is measured as Full-Time Equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of

employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

Labor Income: Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

Other Property Type Income: This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

Indirect Business Taxes: Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Alternative B and the "No Action" alternative is summarized in Table 4-17.

Table 4-17 Indirect & Induced Economic Impacts of Refuge Operations at Refuge Complex – Refuge Management Alternative B			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	45	45	45
Refuge Management Alternative B	48	47	47
Labor Income			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative B	\$1,199,076	\$1,157,810	\$1,171,821
Other Property Type Income			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative B	\$272,669	\$257,929	\$257,417
Indirect Business Taxes			
No Action Alternative	\$493,149	\$493,149	\$493,149
Refuge Management Alternative B	\$502,252	\$511,181	\$522,302

(2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternatives A (No Action) and B is summarized in Table 4-18.

Table 4-18. Indirect and Induced Economic Impacts of Agricultural Activities at Refuge Complex - Refuge Management (RM) Alternative B			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	20	20	20
Refuge Management Alternative B	27	27	27
Labor Income			
No Action Alternative	\$587,382	\$587,382	\$587,382
Refuge Management Alternative B	\$785,861	\$785,861	\$785,861
Other Property Type Income			
No Action Alternative	\$272,759	\$272,759	\$272,759
Refuge Management Alternative B	\$371,550	\$371,550	\$371,550
Indirect Business Taxes			
No Action Alternative	\$87,668	\$87,668	\$87,668
Refuge Management Alternative B	\$118,065	\$118,065	\$118,065

Table 4-19 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex - RM Alternative B			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	25	26	26
RM Alternative B	26	27	27
Labor Income			
No Action Alternative	\$609,908	\$621,374	\$629,040
RM Alternative B	\$634,780	\$647,953	\$656,417
Other Property Type Income			
No Action Alternative	\$224,963	\$229,144	\$231,939
RM Alternative B	\$234,159	\$238,962	\$242,048
Indirect Business Taxes			
No Action Alternative	\$136,816	\$139,559	\$141,394
RM Alternative B	\$142,266	\$145,414	\$147,438

to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

(3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Refuge Management Alternative B and the "No Action" alternative is summarized in Table 4-19.

2. Population Impacts

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under this management alternative is expected to continue to support in excess of 90 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

3. Fiscal Impacts on Local Governments

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and/or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under current management or any of the other Refuge Management Alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers-Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area.

4. Social Impacts

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, ecosystem management actions such as those made by the USFWS within the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

a. Impacts to Social Structures and Lifestyles

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and/or community cohesiveness and stability)
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of "new" impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and/or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause/effect relationship is not of concern in this EIS analysis.

Overall, most people's lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would

arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

b. Impacts to Relationships between the USFWS and Stakeholder Groups

General categories of stakeholder groups describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and/or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and/or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

c. Impacts to USFWS Public Outreach Programs and Activities

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and/or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative B, current USFWS public outreach efforts would continue and be expanded.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the alternatives for potential management actions:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and/or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions

- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure/lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

d. Environmental Justice

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex EIS/CCP/LPP is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse effects and some beneficial effects by the continued operation and/or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and/or low-income population components. Overall, the identified minority and/or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

III. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE C: EMPHASIS ON NATIVE HABITAT RESTORATION AND ADDRESSING MAJOR THREATS TO THE ECOSYSTEM

Overview

Under this Alternative, the Refuge Complex would focus its management efforts on restoring wetlands, native prairie and woodlots, and on reversing trends of loss and degradation of these native habitats by increasing efforts to address ongoing and future threats from relative sea level rise and altered hydrological regimes. Restoration of native prairie and prairie wetlands would occur on all suitable upland sites. A portion of the historic fresh and intermediate component of the Refuge Complex's coastal marshes would be restored. Efforts to address coastal habitat loss and degradation resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW and to restore emergent marshes would be intensified by increasing coordination among agencies and other stakeholders. Goals would include implementing a major barrier beach/dune restoration project on McFaddin NWR and marsh restoration on Texas Point NWR through the beneficial use of dredge material. Ongoing interior marsh loss would also be addressed by working with agencies and other stakeholders on major hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion for entire watersheds, and through several smaller hydrologic restoration projects on the refuges. Management efforts to control exotic and invasive plant and animal species would be expanded. The Refuge Complex would continue to provide the current level of opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses.

A. Natural Resources Section

1. Impacts to Air Quality

The USFWS fire management program on the Refuge Complex has the greatest potential of all refuge management actions to impact the region's air quality. Fire management activities include both the suppression of unplanned wildland fires and prescribed burning. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Under Refuge Management Alternative C, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Whenever feasible, natural fires ignited by lightning would be allowed to burn.

Under Refuge Management Alternative C, the USFWS' prescribed burning program on the Refuge Complex would be substantially modified relative to Refuge Management Alternative A. The USFWS would use prescribed burning on the Refuge Complex primarily to reduce accumulations of hazardous fuels and to restore and enhance native marsh and prairie habitats. The annual burning objective under this Alternative would be 5,000 to 6,000 acres (compared to 12,000 – 15,000 acres under Refuge Management Alternative A), and most prescribed burning would occur during spring and summer to mimic the historic fire regime.

Although prescribed burning under Refuge Management Alternative C would continue to be beneficial to the Refuge Complex's habitats and wildlife (as discussed under *Section III.A.4. Impacts to Vegetation and Habitats* and *Section III.A.5. Impacts to Fish and Wildlife Resources* below); this management action could also negatively impact local air quality, primarily through the production of smoke. The scope of this impact would decrease relative to Refuge Management Alternative A because of the reduced amount

of smoke produced from decreased prescribed burning activities. Prevailing wind directions and other climatic parameters are generally unfavorable for conducting prescribed burns during the spring and summer, and smoke management issues would limit the USFWS' ability to meet annual goals under this Alternative. In addition, the prevalence of unfavorable conditions during spring and summer would increase the potential for unintentional smoke management impacts.

Decreased prescribed burning activities on the Refuge Complex under Refuge Management Alternative C would also result in larger areas with higher vegetative fuel loads. Most lightning-caused wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires would be more likely to start in areas with higher fuel loads, and fires that did start would burn with higher intensity, produce more smoke, and would be more difficult to suppress than in areas where prescribed burning reduced accumulations of hazardous fuels.

2. Impacts to Geology and Soils

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under this Alternative. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline.

Under Refuge Management Alternative C, the USFWS would expand coordination efforts with a goal of substantially increasing the scope and extent of these projects, including implementing a major project to restore the barrier beach/dune system on McFaddin NWR and large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. The USFWS would also implement several small-scale erosion abatement projects on the Refuge Complex.

Although shoreline erosion and retreat along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach/dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (2004) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and much of the

McFaddin NWR shoreline is eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of habitat, loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Restoration of the barrier beach/dune system on McFaddin NWR and increased use of dredged material on Texas Point NWR would contribute to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). If successfully implemented, large-scale restoration of the barrier beach/dune system on McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR could substantially reduce current rates of land loss. These projects would also restore historic elevations along the shoreline and protect inland marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring would also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines will reduce land loss and increase sedimentation and vertical accretion within vegetation stands.

Other USFWS management activities on the Refuge Complex under Refuge Management Alternative C would also impact soils and soil formation. Under this Alternative, the USFWS would coordinate with other Federal and State agencies to implement major watershed-based hydrological restoration projects to restore freshwater inflows and restrict saltwater intrusion. Once these projects were implemented, the USWS would replace intensively-manipulated water control structures in some marsh semi-impoundments with more passive rock weir structures. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different

hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter from plant productivity, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana.

Watershed-scale hydrologic restoration projects would reduce saltwater intrusion and increase freshwater and sediment inflows to marshes, resulting in increased plant productivity important to soil formation and marsh surface elevation gain. Hydrologic restoration at a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands. Conversion to more passive water management infrastructure on the Refuge Complex would reduce overall water level and salinity management capabilities in individual managed units, but this may be mitigated by the larger projects.

Prescribed burning could also affect soils and vertical accretion in marshes. Insufficient data exists to adequately address the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). In most situations, root and peat fires are avoided by carefully monitoring water levels and soil moisture. Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood.

The USFWS would also coordinate and support expanded monitoring and scientific research under Refuge Management Alternative C to determine impacts of shoreline and marsh restoration efforts and the effects of habitat management activities such as structural marsh management and prescribed burning on marsh soils and vertical accretion. This would lead to a greater understanding of how to reduce the impacts of ongoing and future relative sea level rise and altered hydrological regimes. For example, monitoring and research would help ensure that structural marsh management and prescribed burning programs are being conducted in a way to maximize marsh accretion while meeting short-term habitat objectives.

3. Impacts to Hydrology and Water Quality

a. Hydrology

Under Refuge Management Alternative C, the USFWS would continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass, and would expand coordination with stakeholders to evaluate ways to provide additional freshwater inflows to marshes south of the GIWW in Jefferson County. Once these projects were implemented, the USFWS would replace some traditional water control structures on the Refuge Complex with more passive rock weir structures. Under this Alternative, the USFWS would also conduct the following hydrologic restoration activities on the Refuge Complex: 1) acquire additional water rights in order to provide additional freshwater inflows, 2) restore natural channels to historical dimensions and several constructed channels to marsh, 3) restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure, and 4) coordinate local agencies and other partners to repair saltwater barriers.

Hydrologic management and restoration activities would reduce saltwater intrusion, reduce tidal energies in formerly non-tidal or micro-tidal marshes, establish freshwater and sediment inflows and manage water levels to mimic historic hydroperiods (wetting and drying cycles). All would help maintain the historic continuum of fresh to saline marshes, and the diverse plant and animal communities associated with these habitats. All would help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, hydrological management and restoration activities may also contribute to marsh soil formation and surface elevation gain (marsh accretion). Hydrologic restoration on a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands.

b. Water Quality

Under Refuge Management Alternative C, the USFWS would expand efforts to protect water quality on the Refuge Complex. In addition to activities under Alternative A, this would involve developing enhanced spill response capabilities, supporting additional water quality monitoring, and assessing threats from abandoned oil and gas infrastructure and accumulations of lead shot pellets and remediation of any known problem areas. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills on water quality, habitats and fish and wildlife resources.

4. Impacts to Vegetation and Habitats

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative C would include all of the habitat management and restoration activities in wetland and upland habitats described under Alternative A. Changes from Alternative A would include a long-term transition to less intensive water management in coastal marsh habitats following completion of watershed-scale hydrologic restoration projects, phasing out of the cooperative rice farming and moist soil management programs, modified use of prescribed burning and controlled grazing, and expanded restoration of native coastal prairie on suitable upland sites.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, environmental education and interpretation, would continue under Refuge Management Alternative C. Impacts to vegetation and habitats would be similar to those described for these uses under Refuge Management Alternative A.

Systematic monitoring of vegetation and habitats under the Refuge Complex Biological Program would be expanded under Refuge Management Alternative C.

Management of oil and gas activities through issuance of Special Use Permits would continue as under Alternative A, and would be aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

a. Impacts to Vegetation and Habitats from Habitat Management and Restoration Activities

(1). Wetland Specific Management and Restoration

Wetland management and restoration activities under Refuge Management Alternative C would influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

(a). Water Management in Coastal Marshes

Under Refuge Management Alternative C, the USFWS would continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass. The USFWS would expand coordination with stakeholders to evaluate watershed-scale hydrologic restoration projects, including providing additional freshwater inflows to marshes south of the GIWW in Jefferson County. Use of strategically located below-ground siphons to move freshwater beneath the GIWW to these marshes is one option which would be fully assessed. Once these projects were implemented, the USFWS would replace some traditional water control structures on the Refuge Complex with more passive rock weir structures. Under this Alternative, the USFWS would also conduct the following hydrologic restoration activities on the Refuge Complex: 1) acquire additional water rights in order to provide additional freshwater inflows; 2) restore some natural channels to historical dimensions, and restore several constructed channels to marsh; 3) restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure; and 4) coordinate with local agencies and other partners to repair saltwater barriers.

Hydrologic management and restoration activities would reduce saltwater intrusion, reduce tidal energies in formerly non-tidal or micro-tidal marshes, establish freshwater and sediment inflows and manage water levels to mimic historic hydroperiods (wetting and drying cycles). All would help maintain the historic continuum of fresh to saline marshes, and the diverse plant and animal communities associated with these habitats. All would help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, hydrological management and restoration activities may also contribute to marsh soil formation and surface elevation gain (marsh accretion). Hydrologic restoration on a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands.

(b). Marsh Restoration

Under the Refuge Management Alternative C, the USFWS would expand coordination with State and Federal agencies with a goal of increasing the level and scope of wetland restoration activities through the beneficial use of dredge material from the maintenance and improvement of navigation channels including the GIWW and the Sabine-Neches Ship Channel. All opportunities to use dredge material in this manner will be fully evaluated. Expanded marsh restoration efforts under Refuge Management Alternative C would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife. Beneficially used dredge material would provide a substrate for reestablishment of marsh vegetation, and increase net sediment supply to marshes which would provides nutrients and increase plant productivity (Chabreck 1976, 1994). Increasing mineral sediment input to marshes through the beneficial use of dredge material would contribute to marsh surface elevation gain. This practice may represent the most practical alternative available to augment marsh vertical accretion and ensure the viability of the region's coastal wetlands in the face of projected relative sea level rise.

Under Refuge Management Alternative C, the USFWS would restore approximately 300 acres of shallow freshwater wetlands in areas currently in the cooperative rice farming program's rotation. Restoration would involve removal of rice field levees to restore surface hydrology and earth moving from designated portions of the lower elevation cuts of the fields to recreate these "pothole" wetlands. Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). These freshwater habitats would support submerged, floating and emergent plant communities valuable to migratory birds and other wetland-dependent fish and wildlife.

(c). Moist Soil Management

Under Refuge Management Alternative C, the USFWS would continue to conduct moist soil management at current levels. Moist soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). On Anahuac NWR, 300-400 acres of moist soil units would continue to be managed annually, primarily to provide habitat for wintering waterfowl. This would involve continued water management and mechanical soil manipulations timed to promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Approximately 150 acres of the Anahuac's NWR's moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime favors the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

(d). Cooperative Rice Farming Program

Under Refuge Management Alternative C, the USFWS would phase out the cooperative rice farming program on Anahuac NWR. Fallowed rice fields would be restored to native prairie and shallow prairie wetlands. Abandoned rice fields would be susceptible to rapid invasion by Chinese tallow, Eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality for native wildlife. Extensive and expensive restoration of areas impacted by these invasive plants would be required to restore and maintain native habitats.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Under Refuge Management Alternative C, approximately 4,535 acres would be restored to native coastal prairie on the Anahuac NWR. This would include restoration of existing fallowed former croplands (2223 acres) and newly-fallowed areas (2312 acres) created as the cooperative rice farming program is discontinued. Of the five Refuge Management Alternatives, native prairie restoration would be most extensive under Alternative C. The newly restored sites, along with existing native prairie remnants, previously restored native prairie sites and other grasslands would be managed using the variety of management tools described in Refuge Management Alternative A. Together, the management and restoration activities undertaken under Refuge Management Alternative C would protect and enhance approximately 5,774 acres of non-saline grasslands on the Refuge Complex. Impacts of burning, grazing, invasive species management and mowing/haying to vegetation and habitats are discussed below in *Section C.4.1.c*.

Over 9 million acres of native tallgrass prairie once occurred along the western Gulf Coast in Texas and Louisiana (Smeins *et al.* 1991). Based on remnant stands of native grasslands, prairies on the upper Texas coast were characterized by little bluestem, brownseed paspalum, and Indiangrass or eastern gammagrass and switchgrass associations, depending on hydrology (Diamond and Smeins 1984). It is now estimated that 99.8% and 99.6% of little bluestem and eastern gamma grass/switchgrass prairies, respectfully, have been lost in Texas (McFarland 1995). The little bluestem/brownseed paspalum community has been identified as a threatened natural community and the eastern gammagrass/switchgrass community has been identified as an endangered natural community by the Texas Organization for Endangered Species (Diamond *et al.* 1992). Both communities are assigned a Global conservation status rank of "Critically Imperiled" (G1) by The Nature Conservancy (2002).

Prairie restoration and management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity. Many management activities would help control invasive weed and woody species infestations. Restoration and management of native prairie habitat on the Refuge Complex would help conserve an increasingly rare component of the western Gulf Coast ecosystem by restoring and maintaining native prairie plant

associations including little bluestem/brownseed paspalum and eastern gamma grass/switchgrass prairie plant communities.

Seed viability in prairie plants is believed to be reduced in highly fragmented prairie landscapes due to loss of genetic variability as remnant stands become smaller and more isolated. Conservation of existing coastal prairie remnants in the project area is critical because they represent reservoirs of genetic material, and are extremely valuable sources of viable local seed and plant materials. Prairie plants on the upper Texas Coast evolved under relatively unique climatic conditions of high annual rainfall and hydric soils, and future restoration of native prairie in the region depends on the protection of existing viable local seed and plant material sources. Native prairie restoration on the Refuge Complex under Refuge Management Alternative C would help maintain a small but potentially important source of native prairie seed.

(b). Woodlot Restoration and Protection

Under Refuge Management Alternative C, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR.

Overall, implementation of the USFWS management actions under this Alternative would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

(3). General Habitat Management Activities

Under Refuge Management Alternative C, the USFWS would reduce the use of prescribed burning and controlled livestock grazing on the Refuge Complex, depending more on lightning-ignited fires and herbivory by native wildlife to create habitat diversity. Efforts to control and monitor invasive species would be intensified to enhance native habitats. Coordination in interagency efforts to address threats posed by relative sea level rise would be expanded with a goal of implementing major shoreline restoration projects.

(a). Fire Management - Wildland Fire Suppression and Prescribed Burning

Under Refuge Management Alternative C, the USFWS fire management program would continue to involve both suppression of unplanned wildland fires and prescribed burning. Suppression activities would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of “Appropriate Management Response” to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Whenever feasible under this Alternative, natural fires ignited by lightning would be allowed to burn.

Under Refuge Management Alternative C, the USFWS’ prescribed burning program on the Refuge Complex would be substantially modified relative to Refuge Management Alternative A. The USFWS would use prescribed burning on the Refuge Complex primarily to reduce accumulations of hazardous fuels and to restore and enhance native marsh and prairie habitats. The annual burning objective under this Alternative would be 5,000 to 6,000 acres (compared to 12,000 – 15,000 acres under Refuge Management Alternative A), and most prescribed burning would occur during spring and summer to mimic the historic fire regime.

Beneficial impacts of the prescribed burning program under this Alternative would be similar but less extensive than those described for burning under Refuge Management Alternative A, and include:

- Hazardous fuels would be reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning would lessen the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds would be enhanced in burned areas by maintaining early successional plant communities which provide important food resources, by increasing production and nutritional quality of these foods, and by enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, would be suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife.

Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, and seashore saltgrass. Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.) and forbs such as purple ammenia and Delta duck potato, increases after a fire, particularly when followed by grazing and suitable hydrology. Under Refuge Management Alternative C, the proportion of marsh habitat with early successional plant communities would decrease on the Refuge Complex relative to current conditions as fewer acres would be burned. Herbivory by native species such as snow geese and muskrats would also decrease, as burning during fall and early winter provides optimal habitat for these species.

The impacts of prescribed burning in upland grassland habitats under Refuge Management Alternative C would remain the same as under Alternative A and include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased. Under this Alternative, increased summer burning would be expected to be more effective in controlling woody plant encroachment.

Prescribed burning can have detrimental impacts to vegetation and habitats, ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water when fires occur at the wrong time. Proper timing of burns under appropriate conditions of soil moisture, fuel loads and fuel moisture is essential to minimize negative impacts. For example, burning under excessively dry conditions could result in plant mortality, consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Fire increases soil erosion potential until plant regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Under Refuge Management Alternative C, the USFWS prescribed burning program would continue to consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive at wetland and upland habitats on the Refuge Complex. Potential for some adverse affects to vegetation and habitats to

occur would decrease under this Alternative because of the reduced acreage burned annually and the reduced frequency of burning.

(b). Controlled Livestock Grazing

Controlled grazing on the Refuge Complex is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats.

Under Refuge Management Alternative C, grazing intensity would be decreased in most fresh and intermediate marsh habitats on the Refuge Complex. Controlled grazing would be applied only in recently burned areas following prescribed burns and natural fires, and lower stocking rates would be used. In upland prairie habitats, where feasible more high intensity/short duration grazing treatments would be used.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relation of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant species and communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Decreased grazing intensity and duration in marsh habitats under this Alternative would decrease the abundance of these early successional plant communities. The impacts of grazing on the physical structure of vegetation would be reduced. Overall, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards more tall, dense stands of vegetation than under current grazing management practices.

In general, the beneficial impacts of grazing in wetland habitats under this Alternative would be similar but less extensive than those described under Refuge Management Alternative A, and include:

- Rank vegetation would be reduced, enabling migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Competing growth of marshhay cordgrass and other dominant climax plant communities would be reduced, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Additional open water habitat would be created, which provides loafing areas for birds and allow them to access aquatic invertebrates.
- Marsh burning would be complemented by prolonging the time that new growth is available for goose use as green browse.
- Plant vigor and plant productivity would be increased, nutrient recycling enhanced, and excessive build-up of residual plant material prevented.
- Hazardous fuel loading would be reduced, reducing the amount and intensity of wildfires.

- Capped soils would be broken through hoof action, assisting in seedling establishment of many preferred food plants.
- Vegetation in recently burned areas would be maintained in more palatable stages for wintering waterfowl.

Carefully managed grazing in coastal prairie habitats increases plant vigor of native prairie grasses and increases overall plant species composition and structural diversity.

Prairie ecosystems in North America are adapted to episodic short duration and high intensity grazing, as bison and other native herbivores concentrated on recently burned areas feeding on new growth and moved on to new recently burned areas as the vegetation matured. Fire and grazing regimes generated a mosaic of prairie habitats, ranging from recently burned and heavily grazed areas to areas with mature grassland plant communities with no recent history of fire or grazing. On a landscape level, this diverse habitat mosaic supported a wide variety of grassland-dependent wildlife species. Under this Alternative, a similar regime would be applied on selected upland units. It is expected that this management regime would increase the diversity of upland habitats (structurally and in plant species composition) on the Refuge Complex, and therefore increase natural biological diversity.

Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1995). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing intensity, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and cattle can spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative C, the USFWS would continue to monitor grazing programs and adjust grazing strategies so as to avoid detrimental impacts. The potential for adverse impacts to vegetation and habitats to occur would decrease under this Alternative.

(c). Invasive Species Management

Under Refuge Management Alternative C, the USFWS would expand invasive species management activities on the Refuge Complex, treating additional areas and increasing partnership efforts. Additional field monitoring and research and enhanced GIS capabilities would be utilized to evaluate the effectiveness of ongoing treatments, to map existing infestations, and to quickly discover and initiate control activities on new infestations. The USFWS would continue to invasive plant species to conserve native biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program would be implemented to control the following invasive plant species (USFWS 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice.

- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies.

In wetland habitats, these activities would result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of invasive floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

The control of Chinese tallow and deep-rooted sedge in prairie and woodlots results in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

Under Refuge Management Alternative C, the USFWS would also continue to control exotic animal species on the Refuge Complex to conserve biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral hog control would be conducted as described under Alternative A. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants. Control activities for nutria under this Alternative would be the same listed for Refuge Management Alternative A and if implemented, would decrease damage to wetland habitats.

(d). Shoreline Protection and Restoration

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under Alternative C. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Under this Alternative, the USFWS would implement similar projects.

Under Refuge Management Alternative C, the USFWS would expand interagency coordination efforts with a goal of substantially increasing the scope and extent of these projects. Objectives would include implementing major partnership projects to restore the barrier beaches and dunes on McFaddin NWR, beneficially use dredge material along the Gulf shoreline on Texas Point NWR, and construct large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. Potential offshore sand sources for the restoration of the barrier beaches and dunes on McFaddin NWR are currently being investigated through the U.S. Army Corps of Engineers "Sabine Pass to San Luis Pass Shoreline Erosion Feasibility Study." Preliminary data indicate viable offshore sand sources may be present.

Restoration of barrier beaches and dunes and placement of dredged material along existing shorelines would reduce rates of shoreline retreat and resulting direct loss of coastal habitats. These activities would positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier beaches and dunes the Gulf of Mexico would restore an upland native habitat type which has been almost completely lost, and protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events. Rock breakwaters in Galveston Bay and the GIWW would also slow erosion and loss of habitat. They would also enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have

converted to open water. The stands of smooth cordgrass also would provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

(e). Mowing and Haying

Under the Refuge Management Alternative C, approximately 100 acres of upland grassland habitats would be mowed or hayed annually on the Refuge Complex, the same as current levels. Mowing and haying would result in invigorating growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis. Reduction of this herbaceous and woody cover often results in the “release” of native prairie plants.

b. Impacts from Public Use Programs

Assuming only a small overall increase in visitation to the Refuge Complex (decrease in waterfowl hunting, increase for wildlife observation and photography) under Refuge Management Alternative C, impacts to vegetation and habitats described below would remain similar to those described for Alternative A.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

Although visitation would increase under this Alternative, administration and management of these uses would continue and impacts to vegetation and habitats would be expected to remain localized and not substantial. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative C, the USFWS would continue routine patrols of the Gulf beaches within McFaddin NWR to protect public safety and natural resources.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative C. Continued habitat and vegetation monitoring activities and research studies on the Refuge Complex would support an adaptive management approach, by providing information which helps refine and improve existing management practices.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative C, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and/or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex under this Alternative would be a reduction of impacts to vegetation and habitats from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative C, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance native prairie and coastal woodlot habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program. It is anticipated that outreach and partnership efforts under Refuge Management Alternative C would result in additional native prairie and coastal woodlot habitat restoration and enhancement throughout the project area.

5. Impacts to Fish and Wildlife Resources

Under Refuge Management Alternative C, habitat management and restoration and biological program activities on the Refuge Complex would be focused on restoring native habitats and addressing threats to biological integrity and biological diversity, with impacts to conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS would continue to administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development and community outreach and partnership programs would also impact fish and wildlife resources.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Under Refuge Management Alternative C, USFWS habitat management and restoration activities would have impacts on wintering and migrating waterfowl populations on the Refuge Complex. Overall and all else being equal, less intensive water level and salinity management, reducing acres of prescribed burning and grazing intensity in marsh habitats, and phasing out of the cooperative rice farming program under this Alternative would be expected to result in a decrease in wintering and migrating waterfowl populations on the Refuge Complex. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative C, approximately 30,000 acres of marsh habitats would continue be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems. Following implementation of large-scale watershed hydrologic restoration projects, some water control structures would be replaced with more passively managed rock weir structures. Hydrologic restoration and marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. Structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl. Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976).

On Anahuac NWR, the cooperative rice farming program would be phased out under this Alternative. This would result in loss of 500-700 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and weed seeds in these habitats. Although this would partially be mitigated for by prairie wetland restoration, it is expected that elimination of the rice farming program would result in decreased wintering waterfowl populations on the Refuge Complex.

Under Refuge Management Alternative C, 300 acres of shallow freshwater “prairie wetlands” would be restored in fallowed rice fields, and approximately 300-400 acres of moist soil units would continue to be managed on Anahuac NWR (no change from current levels). Moist soil management provides optimal conditions for germination and growth of preferred waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia.

Marsh restoration and prairie wetland restoration project implemented under this Alternative would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

(b). General Habitat Management and Restoration Activities

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex promotes optimum habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, reduced prescribed burning and less intensive grazing in marsh habitats under Refuge Management

Alternative C would reduce the amount of optimal habitat for wintering waterfowl on the Refuge Complex. Overall under Refuge Management Alternative C, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards more tall, dense stands of vegetation than under current grazing and prescribed burning management practices.

Waterfowl habitat on the Refuge Complex would be enhanced under this Alternative through expanded control efforts for invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would also be controlled to restore and maintain open water habitats. Maintaining an interspersed of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source for migratory birds. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

If successfully implemented, large-scale restoration of the barrier beach/dune system on McFaddin NWR and beneficial use of dredge material projects on Texas Point NWR under Refuge Management Alternative C would enhance wetland habitats for wintering waterfowl on these refuges by reducing tidal overwash of the eroding beach ridge into inland marshes. This would eliminate the salinity spikes in these intermediate marshes caused by overwash events, which increase salinities over large areas for extended periods of time and kill submerged and floating aquatic plants and invertebrates which provide important food resources for waterfowl. Smaller shoreline protection and restoration projects implemented on the Refuge Complex under this Alternative would also protect and enhance wetland habitats important to wintering waterfowl.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Under Refuge Management Alternative C, several habitat management and restoration activities currently conducted on the Refuge Complex would be expected to have positive impacts on Mottled Ducks. Conversely, less intensive water level and salinity management, reducing acres of prescribed burning and grazing intensity in marsh habitats, and phasing out of the cooperative rice farming program under this Alternative would be expected to result in a decrease in the amount of optimal Mottled Duck habitat on the Refuge Complex as compared to current conditions.

(a). Wetlands Management and Restoration

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative C would provide enhanced habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Large-scale hydrologic restoration projects would restore and maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. Structural marsh management would enhance diversity and productivity of submerged aquatic vegetation in open water habitats, providing an important year-round food sources for Mottled Ducks.

On Anahuac NWR, the cooperative rice farming program would be phased out under this Alternative. This would result in loss of 500-700 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and weed seeds in these habitats. Although this would partially be mitigated for by prairie wetland restoration, it is expected that elimination of the rice farming program would negatively impact Mottled Ducks on the Refuge Complex. Rice farming provides reliable shallow freshwater wetland habitat throughout the year, including during the key recruitment periods of nesting and brood rearing.

Under Refuge Management Alternative C, 300 acres of shallow freshwater "prairie wetlands" would be restored in fallowed rice fields, and approximately 300-400 acres of moist soil units would continue to be managed on Anahuac NWR (no change from current levels). Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as "sennabean ponds," as valuable brood rearing habitat. Restoring these natural "prairie wetlands" would provide brood-rearing habitat in close proximity

to quality nesting habitat (see below). Approximately 100-150 acres of moist soil units would be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

(b). Uplands Management and Restoration

Expanded native prairie restoration and management activities under Refuge Management Alternative C would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The USFWS would restore an additional 4,606 acres of native prairie under this Alternative (the most of any Refuge Management Alternative), and use the integrated application of prescribed burning, controlled livestock grazing, herbicide application and mowing and haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies. All would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Protecting extant stands of coastal prairie and restoring adjacent prairie and prairie wetland habitats under Refuge Management Alternative C on the Refuge Complex would increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

(c). General Habitat Management Activities

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex promotes optimum habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, reduced prescribed burning and less intensive grazing in marsh habitats under Refuge Management Alternative C would reduce the amount of optimal habitat for Mottled Ducks on the Refuge Complex. Overall under Refuge Management Alternative C, plant succession would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards more tall, dense stands of vegetation than under current grazing and prescribed burning management practices.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. These cordgrass ridges are dominated by Gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex.

Fire is necessary in the management of Mottled Duck nesting habitat in salty and non-saline prairies. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Under Refuge Management Alternative C, increased reliance on natural fire starts to achieve management objectives in prairie habitats would result in a less predictable results than under the current burning regime.

Improper application of fire and grazing has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988). The potential for negative impacts to Mottled Duck nesting habitat would generally decrease under Refuge Management Alternative C due to lower cattle stocking rates and grazing durations and reduced prescribed burning in fresh and intermediate marshes.

Expanded control efforts for invasive plants and exotic animals under this Alternative would enhance wetland and upland habitats for Mottled Ducks.

Marsh habitats being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck production and brood rearing habitats. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. If implemented under Refuge Management Alternative C, large-scale restoration of the barrier beach/dune system on McFaddin NWR would enhance wetland habitats important to Mottled Ducks by preventing saltwater intrusion currently resulting from frequent tidal overwash from the Gulf into inland marshes. Smaller shoreline protection and restoration project implemented under this Alternative would also protect and enhance marsh and salty prairie habitats important to Mottled Ducks.

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Refuge Management Alternative C would positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex. Decreased prescribed burning and reduced grazing intensity and duration under this Alternative would reduce the amount of optimal habitat as compared to current conditions for species requiring more open habitats, but increase habitat availability for some species requiring more dense stands of vegetation. Discontinuation of the cooperative rice farming program would eliminate approximately 500-700 acres of shallow freshwater wetland habitat of high importance to many shorebird and wading bird species.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative C, approximately 30,000 acres of marsh habitats would continue be structurally managed on the Refuge Complex. Following implementation of large-scale watershed hydrologic restoration projects, some water control structures would be replaced with more passively managed rock weir structures. Hydrologic restoration and marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities. Structural management of brackish and intermediate marshes may directly increase the abundance of submerged aquatic vegetation, providing habitat for many invertebrates which serve as an important food source. Management of water levels can provide optimal conditions for foraging and resting shorebirds and wading birds.

Shorebirds and wading birds would benefit from continued moist soil management under Refuge Management Alternative C, but discontinuation of the cooperative rice farming program would result in loss of important shallow freshwater wetland habitat. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source for many avian species in this group (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002).

(b). Uplands Management and Restoration

Under Refuge Management Alternative C, expanded restoration and enhancement of native prairie habitats would provide improved habitat for several species of migrating and wintering marsh birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

As compared to current conditions, reduced prescribed burning and less intensive grazing in marsh habitats under Refuge Management Alternative C would reduce the amount of optimal habitat for shorebirds and wading bird species requiring more open habitats, but may provide additional habitat for some marsh bird species which utilize denser stands of vegetation. Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn. Overall, species requiring denser stands of vegetation in marsh habitats would benefit from burning and grazing regimes under Refuge Management Alternative C, while the amount of habitat for species requiring more open habitats would decrease.

Expanded invasive plant and exotic animal control activities under Refuge Management Alternative C would enhance wetland and upland habitats for many avian species in this group. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including beach/dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative C, the USFWS would continue to maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

(4). Impacts to Landbirds

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other land bird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative C would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative C, wetland management and restoration activities including large-scale hydrologic restoration, structural marsh management and marsh and prairie wetlands restoration would have positive impacts on several land bird species. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow, Nelson's Sharptailed Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

(b). Uplands Management and Restoration

Prairie Restoration and Management

Under Refuge Management Alternative C, 4,606 acres of existing and newly-fallowed rice fields and other upland areas would be restored to native coastal prairie. This Alternative includes restoration of greatest amount of native prairie of the five Refuge Management Alternatives. The newly restored sites, along with existing native prairie remnants, previously restored native prairie sites and other grasslands would be managed using the variety of management tools described in Refuge Management Alternative A. Together, the management and restoration activities undertaken under Refuge Management Alternative C would protect and enhance approximately 5,774 acres of grassland habitats on the Refuge Complex.

Native prairie remnants, restored sites and other upland grassland habitats on the Refuge Complex provide wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow, and nesting habitat for species including Dicksissel and Eastern Meadowlark. These are also important nesting habitats for Mottled Ducks. Several species of raptors commonly observed on the Refuge Complex include Red-tailed Hawk, Red-shouldered Hawk, Turkey Vulture, American Kestrel, White-tailed Kite, Northern Harrier, and Short-eared Owl (USFWS 1997a). Many other raptor species are observed during spring and fall migrations. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative C are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005). White-tailed Hawk, Loggerhead Shrike, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, Henslow's Sparrow, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from restoration and management of prairie habitats on the Refuge Complex under this Alternative.

Woodlot Restoration and Management

Under Refuge Management Alternative C, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR.

Overall, implementation of the USFWS management actions under this Alternative would have similar impacts to those described under Alternative A, with additional benefits provided by the new woodland habitats. These activities would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler

(c). General Habitat Management Activities

Under Refuge Management Alternative C, the USFWS would reduce prescribed burning and decrease grazing intensity and duration. Seaside Sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding Seaside Sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersion of nesting and foraging habitat, though this theory has yet to be tested. Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first

winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife. Decreased burning frequency and increased reliance on natural fire starts to meet habitat objectives under Refuge Management Alternative C has potential to either positively or negatively impact some land bird species.

Under this Alternative, the USFWS would expand invasive plant and exotic animal control activities. Control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Under Refuge Management Alternative C, the USFWS would expand its coordination with other agencies in support of implementing large-scale hydrologic restoration projects, continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, and exotic plant and animal control. The USFWS would implement additional shoreline restoration and protection, and increase interagency coordination with a goal of implementing major barrier beach/dune restoration on McFaddin and Texas Point NWRs. These activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments on the Refuge Complex supports highly diverse aquatic vertebrate and invertebrate communities.

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Structural marsh management using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement

of tidal waterways (as opposed to traditional fixed crest weirs). These design features and management regimes would be also be incorporated under Refuge Management Alternative C. Increased use of rock weirs under this Alternative may further enhance fisheries access as these structures are semi-permeable and typically contain larger openings than traditional water control structures.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Knieb and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are experiencing rapid subsidence, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, activities which restore productive wetland habitats and help reduce rates of marsh loss (hydrologic restoration, marsh restoration using dredge material, structural marsh management and shoreline restoration and protection) would help sustain healthy fisheries resources in the long-term.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative C, protection, restoration and management of coastal wetland habitats on the Refuge Complex would benefit the three avian T&E species. Bald Eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown Pelicans utilize shorelines tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative C would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative C which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative C which maintain and restore freshwater wetland habitats (major hydrologic restoration projects, structural management of marshes, moist soil management, and restoration of freshwater prairie wetlands) would be particularly beneficial to amphibians and reptiles. Conversely, loss of freshwater wetland habitat provided by rice farming under this Alternative would reduce this habitat type on Anahuac NWR. Freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Expanded control of invasive woody species in wetland and upland habitats under this Alternative may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Under Refuge Management Alternative C, the USFWS would prescribe burn fewer acres annually, burn primarily in the spring and summer, and depend more on natural fire starts to meet habitat objectives. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize." Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

b. Impacts from Public Use Programs

Assuming a slight increase in visitation to the Refuge Complex under Refuge Management Alternative C, overall impacts to fish and wildlife resources would likely increase slightly over current levels described under Alternative A. Visitation for waterfowl hunting is projected to decrease slightly under this Alternative, while visitation for wildlife observation, photography, environmental education and interpretation is expected to increase.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually under the USFWS migratory bird hunting regulation frameworks, and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Refuge Management Alternative C will not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichholz 1976, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been

shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton *et al.* 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas would remain the same as under Refuge Management Alternative A and would include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

The continued maintenance of sanctuary areas on the Refuge Complex would be required to mitigate for disturbance impacts from hunting activities under Refuge Management Alternative C. Maintaining existing regulations under this Alternative would also be necessary to help mitigate the impacts of hunting activity-related disturbance to waterfowl. It is possible that hunting activities under Alternative C would result in reduced abundance of wintering waterfowl on the Refuge Complex in years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation

Under Refuge Management Alternative C, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. Means of access for these uses and the presence of visitors result in disturbance impacts to waterfowl, as described under Refuge Management Alternative A. Increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

(2). Impacts to other Migratory Birds, Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds

(a). Waterfowl Hunting

Although the disturbance impacts of waterfowl hunting under Refuge Management Alternative C on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

Under Refuge Management Alternative C, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. As described under Refuge Management Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Alternative C, increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

(3). Impacts to Fisheries

(a). Fishing

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term.

Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative C should not have any measurable effect on overall populations and the long-term viability of these species' populations.

b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative C.

(4). Impacts to Threatened and Endangered Species

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities under Alternative C. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative C.

(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex under Alternative C. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

(b). Commercial Alligator Harvest

Under Refuge Management Alternative C, the current adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Alternative B should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

(c). Control of Muskrat Populations

Under Refuge Management Alternative C, muskrat populations could be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to be most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

Under Refuge Management Alternative C, all current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue.

Surveys and monitoring and research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information facilitates implementation of an adaptive management approach which allows continual refinement and improvement of management activities. In some cases, monitoring activities are providing baseline information, previously not available.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative C, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduced impact on fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative C, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance native prairie and coastal woodland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program. It is anticipated that expanded outreach and partnership efforts under Refuge Management Alternative C would result in increased benefits to fish and wildlife resources, and in particular those species dependent upon coastal prairie and woodland habitats.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements: 1) direct expenditures made by the USFWS to manage operations at the Refuge Complex, 2) value of production from agricultural programs on the Refuge Complex; and 3) expenditures made by recreational visitors to the Refuge Complex.

Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements.. Total economic impacts (direct, indirect and induced) of for this Refuge Management Alternative were estimated using the data and methods discussed below. The analysis compares the impacts from this management alternative to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

a. Direct Economic Impacts

(1). Value of Refuge Operations (Direct Expenditures)¹⁴

Based on information about the activities proposed under Refuge Management Alternative C, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this Refuge Management Alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. The estimate of the annual average cost, per five-year period, for Alternative C is summarized in Table 4-20.

The estimate of Refuge Operation's direct expenditures under Refuge Management Alternative C shows a moderate increase [approximately 25%] compared to the \$2,695,184 estimate under the "No Action" alternative.

Table 4-20 Average Annual Operational Costs for the Refuge Complex - Alternative C (Direct Expenditures)			
Cost Category	Annual Average Expenditures		
	Year 1 – 5	Year 5 - 10	Year 10 - 15
Annual Staff Salaries	\$1,768,527	\$1,814,394	\$1,867,894
Utilities	\$43,750	\$43,750	\$43,750
Travel	\$46,948	\$46,948	\$46,948
Water Purchases	\$16,000	\$0	\$0
Heavy Equip. Rental and Replacement	\$93,900	\$84,500	\$84,500
Annual and Deferred Maintenance	\$1,409,283	\$1,325,257	\$1,332,693
Special Programs	\$18,000	\$18,000	\$18,000
Total Average Expenditures	\$3,396,409	\$3,332,849	\$3,393,785

(2). Value of Production from Refuge Agricultural Programs

(a). Cattle Grazing

The estimate for the value of grazing included some development assumptions regarding the annual average number of AUMs expected to occur under this management scenario. The annual average AUMs are expected to decrease from 23,900 under Refuge Management Alternative A (No Action) alternative to about 11,950 under Refuge Management Alternative C. Using the estimated value of \$88.02/AUM determined in the analysis for Refuge Management Alternative A, there is about a 50% decrease in the estimate of the production value of grazing. A summary comparing the changes in AUMs and value of production between Refuge Management Alternatives A and C is contained in Table 4-21.

¹⁴ The Value of USFWS Operations Table is essentially done for Refuge Management Alternative A (No Acton). Under the remaining Refuge Management Alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

Table 4-21
Estimated Production Value of Grazing Activities On Refuge Complex – Refuge Management Alternative C

Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
Refuge Mgmt. Alternative C	11,950	\$1,051,839

(b). Rice Production

Under the development assumptions for this alternative the annual acreage in rice production is will decrease from 600 acres under Refuge Management Alternative A (No Action) to ultimately 0 acres as the cooperative farming program is phased out under Refuge Management Alternative C. The estimated annual value for current rice production of \$249,867 determined in the "No Action" alternative would be completely eliminated by the end of the 15-year planning period. A summary comparing the changes in annual average acreage produced and value of production between Refuge Management Alternatives A and C is contained in Table 4-22.

Table 4-22
Estimated Value of Rice Production On Refuge Complex – Refuge Management Alternative C

Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
Refuge Mgmt. Alternative C	0	0

(3) Value of Refuge Recreational Programs

For each management alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under Refuge Management Alternative A (No Action). The estimated changes in recreational visitors under this alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	5% Decrease
Upland Bird Hunting	No change
Fishing	No change
Wildlife Observation	5% Increase

These changes were then applied to the estimate of annual non-resident visits and the estimates of itemized expenditures by recreational activity which were developed for Refuge Management Alternative A (No Action). Table 4-23 contains a summary of the comparison of the annual direct expenditures associated with Recreational visitors to the Refuge Complex between Refuge Management Alternatives A and C.

Table 4-23
Annual Direct Expenditures Associated with Recreational Visitors on Refuge Complex - RM Alternative C

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
Refuge Mgmt. Alternative C	36,407	\$1,168,996

b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to estimate the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

Employment: The annual average estimated employment is measured as Full-Time Equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

Labor Income: Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

Other Property Type Income: This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

Indirect Business Taxes: Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

(1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Refuge Management Alternatives A and C is summarized in Table 4-24.

Table 4-24 Economic Impacts of USFWS Operations at Chenier Plain NWR Complex			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	45	45	45
Refuge Management Alternative C	56	54	54
Labor Income			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative C	\$1,398,105	\$1,364,523	\$1,383,730
Other Property Type Income			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative C	\$380,427	\$360,019	\$361,088
Indirect Business Taxes			
No Action Alternative	\$493,149	\$493,149	\$493,149
Refuge Management Alternative C	\$527,874	\$537,309	\$551,526

2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternatives A (No Action) and C is summarized in Table 4-25. These impacts reflect a 50% reduction in cattle grazing and a gradual phasing out of the rice farming over the planning period.

Table 4-25 Indirect and Induced Economic Impacts of Agricultural Activities on Refuge Complex – Alternative C			
Impact on:	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	20	20	20
Alternative C	12	11	9
Labor Income			
No Action Alternative	\$587,382	\$587,382	\$587,382
Alternative C	\$347,390	\$314,345	\$273,037
Other Property Type Income			
No Action Alternative	\$272,759	\$272,759	\$272,759
Alternative C	\$173,100	\$148,620	\$124,139
Indirect Business Taxes			
No Action Alternative	\$87,668	\$87,668	\$87,668
Alternative C	\$52,653	\$47,226	\$40,442

(3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Refuge Management Alternative A (No Action) and C is summarized in Table 4-26.

Table 4-26 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex - Alternative C			
Impact on:	Year 1-5	Year 6 – 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	25	26	26
Alternative C	26	27	27
Labor Income			
No Action Alternative	\$609,908	\$621,374	\$629,040
Alternative C	\$631,754	\$644,737	\$653,076
Other Property Type Income			
No Action Alternative	\$224,963	\$229,144	\$231,939
Alternative C	\$233,073	\$237,808	\$240,849
Indirect Business Taxes			
No Action Alternative	\$136,816	\$139,559	\$141,394
Alternative C	\$141,569	\$144,674	\$146,669

2. Population Impacts

Management actions associated with the Refuge Complex under any of the Refuge Management Alternatives are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under this management alternative is expected to continue to support nearly 90 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

3. Fiscal Impacts on Local Governments

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and/or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under any of the Refuge Management Alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers-Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area. Under Refuge Management Alternative C, purchase of water from the District would likely cease with the phasing out the cooperative rice program.

4. Social Impacts

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, natural resource management actions such as those made by the USFWS on the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

a. Impacts to Social Structures and Lifestyles

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and/or community cohesiveness and stability)

- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and/or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause/effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

b. Impacts to Relationships between the USFWS and Stakeholder Groups

General categories of stakeholder groups describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and/or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and/or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities.. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

c. Impacts to USFWS Public Outreach Programs and Activities

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and/or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative C, current USFWS public outreach efforts would continue and be expanded.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues.. Under any of the Refuge Management Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and/or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure/lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however, the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among Alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

d. Environmental Justice

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex EIS/CCP/LPP is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse and some beneficial effects by the continued operation and/or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and/or low-income population components. Overall, the identified minority and/or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

IV. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE D – PREFERRED ALTERNATIVE: EMPHASIS ON AN INTEGRATED MANAGEMENT APPROACH COMBINING: 1) EXPANDED HABITAT MANAGEMENT AND RESTORATION PROGRAMS, 2) NEW RESEARCH AND WILDLIFE POPULATION MONITORING, AND 3) INCREASED EFFORTS TO ADDRESS MAJOR THREATS TO THE ECOSYSTEM

Overview

Under this Alternative, the Refuge Complex would continue and expand current habitat management and native habitat restoration programs, with increased monitoring and research to assess management actions and facilitate a more effective adaptive management approach. Wetland habitat management activities for waterfowl, shorebirds and other wetland-dependent migratory birds including structural water management in marshes, prescribed burning, controlled grazing, and moist soil management would be refined and enhanced, and in some cases expanded through development of new infrastructure. Concurrently, additional restoration of native habitats including wetlands, prairie and woodlots would be undertaken to benefit a variety of native fauna, with a focus on priority species identified as in need of conservation through national and international conservation initiatives.

Efforts to address coastal habitat loss and degradation resulting from shoreline erosion along the Gulf, Galveston Bay and the GIWW and to restore emergent marshes would be intensified by increasing coordination among agencies and other stakeholders. Goals would include implementing large-scale partnership projects including barrier beach/dune restoration on McFaddin NWR, marsh and shoreline restoration on Texas Point NWR through the beneficial use of dredge material, and structural shoreline protection along the GIWW and East Galveston Bay. Ongoing interior marsh loss would be addressed by working with agencies and other stakeholders on watershed-scale hydrologic restoration projects that restore freshwater inflows and further restrict saltwater intrusion. The USFWS would also implement several smaller hydrologic restoration and shoreline protection projects on the Refuge Complex. Management efforts to control exotic and invasive plant and animal species would be expanded, and additional efforts implemented to monitor and reduce impacts of contaminants.

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. Expanded outreach to local communities and private landowners would be aimed at developing new partnerships to further conservation and promote awareness of the region's natural resources.

A. Natural Resources Section

1. Impacts to Air Quality

The USFWS fire management program on the Refuge Complex activities include both the suppression of unplanned wildland fires and prescribed burning. Under Refuge Management Alternative D, suppression of wildland fires would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of “Appropriate Management Response” to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under Refuge Management Alternative D, the USFWS would continue to implement a rotational prescribed burning program on the Refuge Complex. Burning would be conducted in emergent marsh habitats during fall and early winter, and burning in upland grassland habitats during late winter and early spring. Limited summer burning would be initiated where needed to control invasive woody vegetation. The overall annual burning objective would remain unchanged from current levels of 12,000 - 15,000 acres.

The USFWS fire management program has the greatest potential of all refuge management actions to impact the region’s air quality. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Smoke is made up primarily of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organics, nitrogen oxides, and trace minerals. The composition of smoke varies with fuel type. In general, particulate matter is the major pollutant of concern from wildland fire and prescribed fire smoke. Particulate matter is a general term for a mixture of solid particles and liquid droplets found in the air. Particulate matter from smoke tends to be very small (less than one micron in diameter) and, as a result, is more of a health concern than the coarser particles that typically make up road dust. Because of their size range, particulates scatter light effectively and therefore, reduce visibility easily.

The human health effects from smoke run from irritation of the eyes and respiratory tract to more serious disorders including asthma, bronchitis, reduced lung function, and premature death. Particulate matter is the main source of health effects, but carbon dioxide and toxic air pollutants from wildfires can also cause health concerns (Therriault 2001).

The atmospheric conditions that affect the movement and dispersal of smoke include the following: wind direction, wind speed, mixing height (the elevation in the atmosphere that the smoke mixes and disperses), transport wind speed and direction (the direction and speed of upper level winds responsible for moving the smoke from the immediate area), and Category day/dispersion (a combination of mixing height and transport wind speed to give an over all indicator of smoke dispersion potential). The Category Day 1, 2, 3, 4 or 5 equates to poor, fair, good, very good and excellent smoke dispersal (USFWS 2003).

The USFWS uses prescribed burning on the Refuge Complex primarily to maintain and improve habitat for wintering and migrating waterfowl and other migratory birds and to reduce accumulations of hazardous fuels. Prescribed burning under Refuge Management Alternative D would continue to be beneficial to the Refuge Complex’s habitats and wildlife (as discussed under *Section IV.A.4 Impacts to Vegetation and Habitats* and *Section IV.A.5 Impacts to Fish and Wildlife Resources* below).

Prescribed burning has the potential to negatively impact local air quality through the production of smoke. Because prescribed burning is conducted on the Refuge Complex under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality from the USFWS fire management program will be minimal. Prescription parameters which must be met prior to ignition and for the predicted duration of a prescribed burn specifically aimed at preventing smoke

impacts include surface and transport wind direction and speed, mixing height, ambient air temperature and humidity, and fuel moisture. Both current and predicted climatic conditions are considered when deciding whether to proceed with a burn, and are regularly monitored during the burns as a further safeguard. Reducing smoke impacts to surrounding communities is also an important consideration in planning and implementing suppression actions on all wildland fires occurring on the Refuge Complex.

Prescribed burning on the Refuge Complex under these controlled conditions also reduces the potential for smoke impacts to air quality from unplanned wildland fires by effectively managing vegetative fuels. Most lightning-caused wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires are less likely to start in areas with reduced fuel loads because of prescribed burning, and fires that do start burn with less intensity, produce less smoke, and are easier to suppress than in unburned areas with excessive accumulations of hazardous fuels.

Wildlife can also be negatively impacted by smoke, particularly where large areas are ignited in a short period of time. The USFWS utilizes techniques to minimize air quality hazards for wildlife on the Refuge Complex, specifically by conducting ignition in a way that provides interspersions of clean air for wildlife to escape to.

Under Refuge Management Alternative D, the USFWS would use updated technologies associated with predictive modeling of climatic conditions and smoke dispersal and movement. The USFWS would conduct additional monitoring of fire behavior, fuel loading, fuel and soil moisture, and climatic conditions and research on the relationship of these variables with smoke production. These tools and information would help to further reduce risks of adverse impacts to local and regional air quality from USFWS fire management program activities.

2. Impacts to Geology and Soils

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations under Refuge Management Alternative D to address threats which are resulting in ongoing coastal land loss. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Under Refuge Management Alternative D, the USFWS would expand coordination efforts with a goal of substantially increasing the scope and extent of these projects, including implementing a major project to restore the barrier beach/dune system on McFaddin NWR, expanded beneficial use of dredge material on Texas Point NWR, and large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. The USFWS would also implement several smaller scale projects on the Refuge Complex.

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent

scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise may be underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Although shoreline erosion and retreat along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach/dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (1998) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline is eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of habitat, loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Restoration of the barrier beach/dune system on McFaddin NWR and increased use of dredged material on Texas Point NWR under Refuge Management Alternative D would contribute to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). If successfully implemented, large-scale restoration of the barrier beach/dune system on McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR could substantially reduce current rates of land loss. These projects would also restore historic elevations along the shoreline and protect inland

marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring would also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines will reduce land loss and increase sedimentation and vertical accretion within vegetation stands.

Other USFWS management activities on the Refuge Complex under Refuge Management Alternative D would also impact soils and soil formation. Under this Alternative, the USFWS would enhance hydrologic management in several existing marsh units by developing additional infrastructure. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter from plant productivity, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana.

Large and small hydrologic restoration projects implemented under Refuge Management Alternative D would reduce saltwater intrusion and/or increase freshwater inflows to marshes on the Refuge Complex, resulting in increased plant productivity important to soil formation and marsh surface elevation gain.

Prescribed burning could also affect soils and vertical accretion in marshes. Insufficient data exists to adequately address the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). In most situations, root and peat fires are avoided by carefully monitoring water levels and soil moisture. Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood.

The USFWS would also coordinate and support expanded monitoring and scientific research through partnerships with the U.S. Geological Survey and universities under Refuge Management Alternative D to determine impacts of shoreline and marsh restoration efforts and the effects of habitat management activities such as structural marsh management and prescribed burning on marsh soils and vertical

accretion. This would lead to a greater understanding of how to reduce the impacts of ongoing and future relative sea level rise and altered hydrological regimes. For example, monitoring and research would help ensure that structural marsh management and prescribed burning programs are being conducted in a way to maximize marsh accretion while meeting short-term habitat objectives.

3. Impacts to Hydrology and Water Quality

a. Hydrology

Under Refuge Management Alternative D, the USFWS would expand current wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. Under this Alternative, the USFWS would improve water management capabilities in managed marsh units by installing new infrastructure, attempt to adjudicate additional water rights in order to provide additional freshwater inflows, develop on-refuge capabilities to deliver additional freshwater inflows, reduce saltwater intrusion by restoring man-made channels and by working with partners to repair several off-refuge saltwater barriers, and restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure, and restore hydrology by restoring natural channels to historical dimensions. The USFWS would also continue to coordinate with State and Federal agencies on a large-scale hydrological restoration project for marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass and on projects to reestablish freshwater inflows to the marshes south of the GIWW in Jefferson County.

Watershed-scale and refuge-specific hydrologic management and restoration projects implemented under Refuge Management Alternative D would help maintain and/or restore the region's historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats would support a natural diversity of native plant, fish and animal communities. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes would also help to prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain.

b. Water Quality

Under Refuge Management Alternative D, the USFWS would expand efforts to protect water quality on the Refuge Complex. In addition to activities under Alternative A, this would involve developing enhanced spill response capabilities, supporting additional water quality monitoring, assessing threats from abandoned oil and gas infrastructure and accumulations of lead shot pellets, and remediation of any known problem areas. Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills on water quality, habitats and fish and wildlife resources.

4. Impacts to Vegetation and Habitats

USFWS management activities affecting vegetation and habitats on the Refuge Complex under Refuge Management Alternative D would include all of the habitat management and restoration activities in wetland and upland habitats described under Refuge Management Alternative A. The USFWS would refine and in some cases expand these programs, as directed by new research and monitoring programs aimed at facilitating an adaptive approach to management.

Public uses on the Refuge Complex, including hunting, fishing, wildlife observation and photography, environmental education and interpretation, would continue under Refuge Management Alternative D. The USFWS would seek to provide additional recreational opportunities and improve the quality of visitor services and of the visitor experience through construction of additional public use facilities, expanding law enforcement efforts to protect public safety and natural resources, providing additional hunting and fishing opportunities, and developing additional educational programs. Impacts to vegetation and habitats would be similar to those described for these uses under Refuge Management Alternative A.

Systematic monitoring of vegetation and habitats under the Refuge Complex Biological Program would be expanded under Refuge Management Alternative D.

Management of oil and gas activities through issuance of Special Use Permits would continue as under Alternative A, and would be aimed at minimizing and mitigating for the impacts of these activities on habitats and fish and wildlife resources.

a. Impacts to Vegetation and Habitats from Habitat Management and Restoration Activities

(1). Wetland Specific Management and Restoration

As discussed under *Sections IV.A.2 Impacts to Geology and Soils* and *IV.A.3. Impacts to Hydrology and Water Quality*, wetlands management and restoration activities on the Refuge Complex impact geology, soils and hydrologic regimes. Such activities also strongly influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetland habitats.

(a). Water Management in Coastal Marshes

Under Refuge Management Alternative D, the USFWS would expand current wetland management and restoration activities aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. The USFWS would continue to coordinate with State and Federal agencies on watershed-scale hydrological restoration projects including projects to reestablish freshwater inflows to the marshes south of the GIWW in Jefferson County. A second major project would reduce saltwater intrusion in marshes in the eastern Salt Bayou watershed affected by the Keith Lake Fish Pass. Use of strategically located below-ground siphons to move freshwater beneath the GIWW to these marshes is one option which would be fully assessed. Under Refuge Management Alternative D, the USFWS would expand use of GIS and remote sensing technologies to detect and track changes in emergent marsh to open water ratios and in vegetative communities relative to hydrologic management and restoration activities.

The USFWS would continue to structurally manage approximately 12,000 and 18,000 acres of marsh habitats on the Anahuac NWR and McFaddin NWR, respectively. Water management on Texas Point NWR would continue to be conducted in a passive manner, primarily using rock weirs in man-made ditches and canals. The USFWS would improve water management capabilities in managed marsh units by installing new infrastructure. Under this Alternative, the USFWS would also conduct the following hydrologic restoration activities on the Refuge Complex: 1) adjudicate additional water rights in order to provide additional freshwater inflows; 2) restore some natural channels to historical dimensions, and restore several constructed channels to marsh; 3) restore surface hydrology by removing abandoned agricultural and oil and gas infrastructure; and 4) coordinate with partners to repair saltwater barriers.

Coastal marshes provide important food resources and cover to a diversity of wetland-dependent resident and migratory fish and wildlife species. These marshes also provide buffering of tidal storm surge, reduce flooding, and filter excessive nutrients and other contaminants. Threats to the Chenier Plain region's coastal marshes include altered hydrology resulting in increased saltwater intrusion and loss of freshwater and sediment inflows, and rising sea levels and land subsidence. These processes are resulting in coastal land loss as shorelines are eroded and recede and as inland vegetated wetlands convert to open water, which in turn is decreasing habitat quantity and quality for native fish and wildlife.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization (Hess *et al.* 1989). This restoration project caused both emergent and submergent vegetation to flourish. Monitoring efforts on and around McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower

salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exacerbate flooding, further reducing plant vigor. USFWS water management activities in fresh to brackish coastal marshes on the Refuge Complex reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. These management activities therefore benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils.

Hydrologic management and restoration activities on the Refuge Complex under this Alternative would help to maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes and the native plant, fish and animal communities that depend on these habitats. On a watershed scale, restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater and sediment inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes would also help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, these activities may also contribute to marsh soil formation and surface elevation gain (marsh accretion). Hydrologic restoration on a watershed scale will likely be necessary to effectively counter the future effects of relative sea level rise on the region's coastal wetlands.

(b). Marsh Restoration

Under the Refuge Management Alternative D, the USFWS would expand coordination with State and Federal agencies with a goal of increasing the level and scope of wetland restoration activities through the beneficial use of dredge material from the maintenance and improvement of navigation channels including the GIWW and the Sabine-Neches Ship Channel. All opportunities to use dredge material in this manner will be fully evaluated. Expanded marsh restoration efforts under Refuge Management Alternative D would increase the amount of vegetated emergent marsh in areas which have converted to open water, providing more productive habitat for native fish and wildlife. Beneficially used dredge material would provide a substrate for reestablishment of marsh vegetation, and increase net sediment supply to marshes which would provides nutrients and increase plant productivity (Chabreck 1976, 1994). Increasing mineral sediment input to marshes would contribute to marsh surface elevation gain. This practice may represent the most practical alternative available to augment marsh vertical accretion and ensure the viability of the region's coastal wetlands in the face of projected relative sea level rise.

Under Refuge Management Alternative D, the USFWS would restore approximately 100 acres of shallow freshwater wetlands. Restoration would involve removal of rice field levees to restore surface hydrology and earth moving from designated portions of the lower elevation cuts of the fields to recreate these "pothole" wetlands. Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). These freshwater habitats would support submerged, floating and emergent plant communities valuable to migratory birds and other wetland-dependent fish and wildlife.

(c). Moist Soil Management

Approximately 690 additional acres of moist soil units would be developed on the Refuge Complex under Refuge Management Alternative D (590 acres on Anahuac NWR, 100 acres on McFaddin NWR).

Expanded moist soil management would increase biological diversity on the Refuge Complex. Moist-soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Water management and mechanical soil manipulations in new moist soil units would promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Additional moist soil units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime would favor the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

(d). Cooperative Rice Farming Program

Under the Refuge Management Alternative D, the USFWS would continue to implement a cooperative rice farming program on Anahuac NWR to provide shallow freshwater wetland habitat and nutritious food resources for wintering and migrating waterfowl, resident Mottled Ducks, shorebirds, and wading birds. Rice farming would continue on 500 to 700 acres annually on a three-year rotation, leaving approximately 1,000 to 1,200 acres of the Refuge farm as "maintenance" acreage. Almost 80% of the rice produced on the Refuge is now organically grown. Under this Alternative, the USFWS would continue the trend towards increased use of organic farming in the cooperative farming program.

Continuation of the cooperative rice farming program on Anahuac NWR under Refuge Management Alternative D would provide shallow freshwater wetland habitat and serve several management outcomes for migratory bird management on the Refuge Complex: creating forage for migrating and wintering waterfowl, habitat for migrating shorebirds, and freshwater habitat for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also left for wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest ricefields that were cultivated and at least partially flooded (Czech and Parsons 2002). Managed rice fields on the Refuge Complex provide wintering and migrational habitat for Blue-winged Teal, Northern Pintail, Green-winged Teal and Snow Geese, several shorebird species including Long-billed Dowitchers and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted sandpipers, and for several wading bird species. Mottled Ducks also heavily use habitats adjacent to rice fields for nesting (Stutzenbaker 1988). Rice farming also helps to offset waterfowl consumption of crops on adjacent privately-owned croplands.

Rice production has declined during the last decade in counties surrounding the Refuge Complex, reducing this type of agricultural wetland habitat for waterfowl, shorebirds and other wetland-dependent species. Other changes in rice cultivation practices may also have deleterious effects on waterbird populations. Abandoned rice fields and pasturelands are susceptible to invasion by Chinese tallow, eastern baccharis, common rush, and deep-rooted sedge, all of which decrease habitat quality and will require extensive restoration efforts.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Under Refuge Management Alternative D, approximately 2,223 acres of native prairie would be restored on fallowed former croplands on Anahuac NWR. The USFWS would continue to protect and manage newly and previously restored sites, existing prairie remnants and other grasslands using an integrated program which includes: 1) conducting a rotational prescribed burning program on remnant and restored prairies which includes initiation of summer burning where needed to control invasive woody species; 2) conduct a rotational livestock grazing program on upland grassland habitats which includes more short duration, high intensity grazing applications; 3) utilize an integrated pest management program, consisting of herbicide application, mechanical removal, burning and controlled livestock grazing to

manage invasive plant species such as Chinese tallow and deep-rooted sedge which are negatively impacting upland habitats; and 5) mow or hay approximately 100 acres annually. In addition, the USFWS would develop a 5-acre native prairie propagation area to increase availability viable seeds for future restoration efforts.

Over 9 million acres of native tallgrass prairie once occurred along the western Gulf Coast in Texas and Louisiana (Smeins *et al.* 1991). Based on remnant stands of native grasslands, prairies on the upper Texas coast were characterized by little bluestem, brownseed paspalum, and Indiangrass or eastern gammagrass and switchgrass associations, depending on hydrology (Diamond and Smeins 1984). It is now estimated that 99.8% and 99.6% of little bluestem and eastern gamma grass/switchgrass prairies, respectfully, have been lost in Texas (McFarland 1995). The little bluestem/brownseed paspalum community has been identified as a threatened natural community and the eastern gammagrass/switchgrass community has been identified as an endangered natural community by the Texas Organization for Endangered Species (Diamond *et al.* 1992). Both communities are assigned a Global conservation status rank of "Critically Imperiled" (G1) by The Nature Conservancy (2002).

Together, the management and restoration activities undertaken under Refuge Management Alternative D would protect and enhance approximately 5,774 acres of non-saline grasslands on the Refuge Complex. Impacts of burning, grazing, exotic/invasive species management and mowing and haying to vegetation and habitats are discussed below in *Section IV.A.4.(3) Other Habitat Management Activities*. Overall, prairie restoration and management activities on the Refuge Complex would increase the abundance of native prairie grasses and forbs, helping to restore and maintain natural biological diversity. Many management activities would help control invasive weed and woody species infestations. Management and restoration of native prairie habitat on the Refuge Complex would help conserve an increasingly rare component of the western Gulf Coast ecosystem by restoring and maintaining native prairie plant associations including little bluestem/brownseed paspalum and eastern gamma grass/switchgrass prairie plant communities.

Seed viability in prairie plants is believed to be reduced in highly fragmented prairie landscapes due to loss of genetic variability as remnant stands become smaller and more isolated. Conservation of existing coastal prairie remnants in the project area is critical because they represent reservoirs of genetic material, and are extremely valuable sources of viable local seed and plant materials. Prairie plants on the upper Texas Coast evolved under relatively unique climatic conditions of high annual rainfall and hydric soils, and future restoration of native prairie in the region depends on the protection of existing viable local seed and plant material sources. Native prairie restoration on the Refuge Complex under Refuge Management Alternative D would help maintain a small but potentially important source of native prairie seed.

(b). Woodlot Restoration and Protection

Under Refuge Management Alternative D, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR under this Alternative, and assess site suitability for woodlot restoration throughout the Refuge Complex.

Overall, implementation of the USFWS management actions under this Alternative would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

(3). Other Habitat Management Activities

Under Refuge Management Alternative D, the USFWS would refine and enhance prescribed burning and controlled livestock grazing programs to increase benefits to migratory birds and other wildlife. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Efforts to control and monitor invasive species would be intensified to enhance native habitats. Coordination in interagency efforts to address threats posed by relative sea level rise would be expanded with a goal of implementing major shoreline restoration projects.

(a). Fire Management - Wildland Fire Suppression and Prescribed Burning

Under Refuge Management Alternative D, the USFWS fire management program would continue to involve both suppression of unplanned wildland fires and prescribed burning. Suppression activities would continue as described in the Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of “Appropriate Management Response” to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources.

Under Refuge Management Alternative D, the USFWS would initiate summer prescribed burning in wetland and upland habitats on the Refuge Complex. The USFWS would continue to use prescribed burning on the Refuge Complex primarily to reduce accumulations of hazardous fuels and to restore and enhance native marsh and prairie habitats. The annual burning objective under this Alternative would remain at current levels of 12,000 to 15,000 acres annually.

Beneficial impacts of the prescribed burning program under this Alternative would be similar to those described for burning under Refuge Management Alternative A, and include:

- Hazardous fuels would be reduced within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning would lessen the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds would be enhanced in burned areas by maintaining early successional plant communities which provide important food resources, by increasing production and nutritional quality of these foods, and by enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, would be suppressed. Without fire disturbance, both marsh and prairie habitats on the Refuge Complex are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife.

Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats on the Refuge Complex would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, and seashore saltgrass. Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.) and forbs such as purple ammenia and Delta duck potato, increases after a fire, particularly when followed by grazing and suitable hydrology. Under Refuge Management Alternative D, the proportion of marsh habitat with early successional plant communities would increase over current conditions due the application of more intensive grazing in some areas. Initiation of summer burning under this Alternative would be expected to be more effective in controlling woody plant encroachment.

The impacts of prescribed burning in upland grassland habitats under Refuge Management Alternative D would remain the same as under Alternative A and include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased. Under this Alternative, initiation of summer burning would be expected to be more effective in controlling woody plant encroachment. An example of an adaptive management approach likely to be implemented in prairie habitats under this Alternative is as follows. Once healthy stands of native warm-season grass cover has been established through late dormant-season burning, growing season burning would be initiated to reduce Chinese tallow and Eastern baccharis and increase diversity of native prairie grasses and forbs. It is expected that healthy stands of native prairie grasses would provide sufficient fuels to induce fire behavior and intensity capable of reducing infestations of invasive woody vegetation. A complete change to growing season burning is not anticipated. The frequency and seasonality of burning would be adjusted based on continuous monitoring of habitat conditions.

Under Refuge Management Alternative D, the USFWS would establish partnerships with the U.S. Geological Survey and universities to conduct research to further define the relationship between seasonality of fire and its effects on Chinese tallow and native grasses. Winter and early spring burning promotes warm-season grasses, but the overall diversity is low compared to the nearly 600 species that are found in prairie remnants in Texas and Louisiana (Allain and Johnson 1997). Ideally, burn regimes should be varied to promote greater overall species diversity and simulate the conditions under which these grasslands evolved (Howe 1994). However, while summer fires may increase overall species diversity in coastal prairies, they might also reduce the cover of native warm-season grasses and thus increase the competitive advantage of invasive species such as Chinese tallow. Native grasses contribute greatly to fuel loading and continuity. If summer burning reduces the relative abundance of warm season grasses, it may compromise the ability to control Chinese tallow with fire.

Prescribed burning can have detrimental impacts to vegetation and habitats, ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water when fires occur at the wrong time. Proper timing of burns under appropriate conditions of soil moisture, fuel loads and fuel moisture is essential to minimize negative impacts. For example, burning under excessively dry conditions could result in destruction of desirable vegetation, consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986).

Under Refuge Management Alternative D, the USFWS prescribed burning program would continue to consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive wetland and upland habitats on the Refuge Complex. Potential for some adverse effects to vegetation and habitats would remain under this Alternative. The USFWS would conduct short- and long-term fire effects monitoring to more clearly define relationships between fire and vegetation communities.

(b). Controlled Livestock Grazing

Under Refuge Management Alternative D, the USFWS would continue a rotational controlled grazing program on approximately 41,000 acres of the Refuge Complex. Grazing intensity would be increased in selected fresh and intermediate marsh habitats and applications of short-duration, high-intensity grazing would be initiated in selected upland units. To effectively implement these changes, additional infrastructure including fencing and watering sources would be developed.

Controlled grazing on the Refuge Complex is used (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats. Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relation of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant species and communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Grazing also helps provide optimal physical structure of vegetation for waterfowl utilization in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Increased grazing intensity and duration in selected fresh and intermediate marsh habitats under this Alternative would increase the abundance of early successional plant communities. The impacts of grazing on the physical structure of vegetation would be increased in areas grazed more intensively. Overall, plant succession in marshes would trend toward more area with lower successional plant communities, and physical structure towards more openings and more stands of low-growing plants such as seashore paspalum.

Studies conducted on Sabine National Wildlife Refuge in Cameron Parish, Louisiana (Valentine 1961) determined that increased grazing can change tall climax marshhay cordgrass stands to more diverse community such as seashore paspalum, *Setaria*, and longtom (*Paspalum lividum*), that are more beneficial to certain types of wildlife. Depending on site conditions (elevation, soil, and hydrology) annual grasses and forbs (including millets, fall Panicum (*Panicum dichotomiflorum*), sprangletop, and *Setaria*) can be produced through proper grazing.

Pate (2001) found that grazed marshes remained in a sub-climax state, while habitat within grazing exclosures reverted to marshhay cordgrass. At the onset of the study *Spartina* spp. made up 20% of the plant community, while seashore paspalum comprised 80%. By the end of the study, communities within grazing exclosures changed to 65% *Spartina* spp. and 25% seashore paspalum. In contrast, the grazed area maintained high cover of seashore paspalum throughout the study. Seashore paspalum provides habitat for many species of waterfowl, wading birds and shorebirds, depending on hydrology, while marshhay cordgrass largely precludes these species.

In general, the beneficial impacts of grazing in wetland habitats under this Alternative would be similar to those described under Refuge Management Alternative A, and include:

- Rank vegetation would be reduced, enabling migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Competing growth of marshhay cordgrass and other dominant climax plant communities would be reduced, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.

- Additional open water habitat would be created, which provides loafing areas for birds and allow them to access aquatic invertebrates.
- Marsh burning would be complemented by prolonging the time that browse is available for goose use.
- Plant vigor and plant productivity would be increased, nutrient recycling enhanced, and excessive build-up of residual plant material prevented.
- Hazardous fuel loading would be reduced, reducing the amount and intensity of wildfires.
- Capped soils would be broken through hoof action, assisting in seedling establishment of many preferred food plants.
- Vegetation in recently burned areas would be maintained in more palatable stages for wintering waterfowl.

Prairie ecosystems in North America are adapted to episodic short duration and high intensity grazing, as bison and other native herbivores concentrated on recently burned areas feeding on new growth and moved on to new recently burned areas as the vegetation matured. Fire and grazing regimes generated a mosaic of prairie habitats, ranging from recently burned and heavily grazed areas to areas with mature grassland plant communities with no recent history of fire or grazing. On a landscape level, this diverse habitat mosaic supported a wide variety of grassland-dependent wildlife species. Under this Alternative, a similar regime would be applied on selected upland units. It is expected that this management regime would increase the diversity of upland habitats (structurally and in plant species composition) on the Refuge Complex, and therefore increase natural biological diversity.

Potential detrimental affects of grazing includes the risk of overgrazing, excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay National Estuary Program 1992). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and cattle can spread seed of undesirable plant species by physically carrying them or ingesting them.

Under Refuge Management Alternative D, the USFWS would expand monitoring of grazing programs and adjust grazing strategies as needed. The potential for detrimental impacts should decrease as management is refined in response to monitoring information.

(c). Invasive Species Management

Under Refuge Management Alternative D, the USFWS would expand invasive species management activities on the Refuge Complex, treating additional areas and increasing partnership efforts. Additional field monitoring and research and enhanced GIS capabilities would be used to evaluate the effectiveness of ongoing treatments, to map existing infestations, and to quickly discover and initiate control activities on new infestations. The USFWS would continue to control invasive plant species to conserve native biological diversity of the Refuge Complex and to maintain habitat quality for migratory birds and other native wildlife. An Integrated Pest Management (IPM) program would be implemented to control the following invasive plant species (USFWS 1996):

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice.
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies.

Under Refuge Management Alternative D, the IPM program would include evaluating the use of approved and permitted biological control agents for control of particularly problematic invasive species including Salvinia and water hyacinth.

In wetland habitats, these activities would result in removal of undesirable invasive plant species including cattail, common reed, and California bulrush that form dense, homogeneous stands which result in loss of open water as ponds close. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats, and promotes the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

The control of Chinese tallow and deep-rooted sedge in prairie and woodlots results in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance is likely to increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

Under Refuge Management Alternative D, the USFWS would also continue to control exotic animal species on the Refuge Complex to conserve native biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral hog control would be expanded under this Alternative.. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants. Control activities for nutria under this Alternative could be implemented if populations reach levels which threaten wetland habitats.

(d). Shoreline Protection and Restoration

As under Refuge Management Alternative A, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss under Alternative D. On McFaddin and Texas Point NWRs, these partnerships have focused on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Structural erosion abatement projects involving construction of rock breakwaters and shoreline armoring with rip rap along the GIWW on McFaddin NWR have also been implemented. On Anahuac NWR, these efforts have focused on protecting the East Galveston Bay shoreline through offshore breakwater construction and restoration of salt marsh along the shoreline. Under this Alternative, the USFWS would continue to implement similar projects.

Under Refuge Management Alternative D, the USFWS would expand interagency coordination efforts with a goal of substantially increasing the scope and extent of these projects. Objectives would include implementing major partnership projects to restore the barrier beaches and dunes on McFaddin NWR, beneficially use dredge material along the Gulf shoreline on Texas Point NWR, and construct large-scale structural erosion abatement projects using rock breakwaters along the GIWW and East Galveston Bay shorelines. Potential offshore sand sources for the restoration of the barrier beaches and dunes on McFaddin NWR are currently being investigated through the U.S. Army Corps of Engineers "Sabine Pass

to San Luis Pass Shoreline Erosion Feasibility Study.” Preliminary data indicate viable offshore sand sources may be present.

Restoration of barrier beaches and dunes and placement of dredged material along existing shorelines would reduce rates of shoreline retreat and resulting direct loss of coastal habitats. These activities would positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier beaches and dunes along the Gulf of Mexico would restore an upland native habitat type which has been almost completely lost, and protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events. Rock breakwaters in Galveston Bay and the GIWW would also slow erosion and loss of habitat. They would also enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have converted to open water. The stands of smooth cordgrass also would provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

(e). Mowing and Haying

Under Refuge Management Alternative D, approximately 100 acres of upland grassland habitats would be mowed or hayed annually on the Refuge Complex, the same as current levels. Mowing and haying would result in invigorating growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis. Reduction of this herbaceous and woody cover often results in the “release” of native prairie plants.

b. Impacts from Public Use Programs

Assuming an overall increase in visitation to the Refuge Complex for additional and enhanced opportunities for hunting, fishing, wildlife observation and photography and environmental education and interpretation under Refuge Management Alternative D, impacts to vegetation and habitats described below would remain similar to but have the potential to increase over to those described for Alternative A.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

These impacts would be expected to remain localized and minimal under this Alternative. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts.

Recreational beach uses and associated vehicular traffic on beaches within the McFaddin NWR has led to habitat damage inland of beaches. Motorized vehicles sometimes illegally travel in vegetated habitats

inland of the beach, particularly when high water conditions limit or preclude travel on the beach itself. Under Refuge Management Alternative D, the USFWS would expand law enforcement efforts on Gulf beaches within McFaddin NWR to provide enhanced protection of public safety and natural resources. The USFWS would also initiate coordination with the Texas General Office and local counties to begin jointly addressing public safety and natural resource issues associated with recreational use of this area.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative D.

Under Alternative D, the USFWS would expand systematic habitat monitoring and develop additional partnerships with the U.S. Geological Survey and universities to conduct research on the effects of management activities on habitats. This will include determining effects of fire on marsh accretion and to define the relationship between seasonality of fire and its effects on Chinese tallow and native grasses. The USFWS will also expand the use of GIS technology to track habitat trends such as changes in open water in wetland habitats and in support of invasive/exotic plant management. Expanded habitat and vegetation monitoring activities and research studies on the Refuge Complex would facilitate more effective adaptive management by providing information which helps refine and improve management practices.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative D, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and/or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities. Under this Alternative, the USFWS would develop a comprehensive Oil and Gas Management Plan to enhance management of oil and gas activities on the Refuge Complex.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex under this Alternative would be a reduction of impacts to vegetation and habitats from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative D, the USFWS would increase efforts to develop partnerships with private land owners to restore and enhance wetland, native prairie and coastal woodlot habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, the Texas General Land Office and the Galveston Bay Estuary Program, conservation organizations such as Ducks Unlimited, the Galveston Bay Foundation and local Audubon Society chapters, community

organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs, including native habitat restoration.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative D would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

5. Impacts to Fish and Wildlife Resources

Under Refuge Management Alternative D, habitat management and restoration and biological program activities on the Refuge Complex would be focused on conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS also would administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development and community outreach and partnership programs would continue to have positive impacts on fish and wildlife resources.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on landscape scale has increased the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.¹⁵ Many wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and

¹⁵ During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Expanding and enhancing wetland management and restoration under Refuge Management Alternative D can be expected to increase wintering and migrating waterfowl populations on the Refuge Complex. On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

Under the Refuge Management Alternative D, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations on the Refuge Complex.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative D, approximately 30,000 acres of marsh habitats would be structurally managed on the Refuge Complex to enhance habitat for wintering waterfowl, utilizing water control structures, levees, and water delivery systems. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

Approximately 590 additional acres of moist soil units would be developed on the Refuge Complex under Refuge Management Alternative D, specifically to provide additional high quality habitat for wintering and migrating waterfowl. Moist soil management would provide optimal conditions for germination and growth of preferred waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia.

On Anahuac NWR, rice production through the cooperative rice farming program would be continue at current levels of 500-700 acres annually under this Alternative to provide habitat for wintering and migrating waterfowl. Management of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Marsh restoration and other wetland restoration activities would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

Marsh and wetland restoration activities would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

(b). General Habitat Management and Restoration Activities

Under Refuge Management Alternative D, the USFWS would continue an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex to create optimal habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, enhanced water management capabilities and more intensive grazing in selected marsh units under Refuge Management Alternative D would provide enhanced habitat conditions for wintering waterfowl on the Refuge Complex. Prescribed burning and grazing would promote the germination, growth and reproduction of several "early successional" target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950,

Gosselink *et al.* 1979). Burning and moderate grazing also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing would also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Under Alternative D, waterfowl habitat on the Refuge Complex would be enhanced through expanded control programs for invasive vegetation such as common reed, cattail, and California bulrush which have formed dense homogeneous stands and resulted in loss of open water habitats. Infestations of invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would also be controlled to restore and maintain open water habitats. Maintaining an interspersed of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

Declines in habitat quality caused by regular tidal overwash are currently adversely affecting migratory waterfowl use, especially on McFaddin and Texas Point NWRs. If successfully implemented, large-scale restoration of the barrier beach/dune system on McFaddin NWR and beneficial use of dredge material projects on Texas Point NWR under Refuge Management Alternative D would significantly enhance wetland habitats for wintering waterfowl on these refuges by reducing tidal overwash of the eroding beach ridge into inland marshes. This would eliminate the salinity spikes in these intermediate marshes caused by overwash events, which increase salinities over large areas for extended periods of time and kill submerged and floating aquatic plants and invertebrates which provide important food resources for waterfowl. Smaller shoreline protection and restoration projects implemented on the Refuge Complex under this Alternative would also protect and enhance wetland habitats important to wintering waterfowl. Implementation of these projects would be expected to increase wintering waterfowl populations on the Refuge Complex.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Mottled ducks are year-round residents of the Chenier Plain region. This species prefers fresh to slightly brackish marshes (Gosselink *et al.* 1979), although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled ducks on the Refuge Complex are part of the western Gulf Coast population of Mottled Ducks. Banding studies have indicated that WGC Mottled Ducks do move between Mexico, Texas, Louisiana and Mississippi and Alabama, but no interchange occurs between this population and the Florida population of Mottled Ducks.

Mottled Duck numbers on the Refuge Complex (and other national wildlife refuges on the Texas Coast) have declined precipitously during the last 20 years, as indexed by annual breeding pair surveys and monthly aerial counts conducted September through March (USFWS, Division of Migratory Birds, unpublished reports). Stutzenbaker (1988) reported that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include conversion of native habitats for agricultural and urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988, Morton and Paine 1990), as well as increased pollutants (Cain 1988). Saltwater intrusion into wetlands that range from fresh to moderately brackish probably affects growth and survival of ducklings (Moorman *et al.* 1991). Encroachment of Chinese tallow into nesting habitat probably leads to abandonment of nesting areas (Stutzenbaker 1988). Other potential factors influencing Mottled Duck populations in Texas include declines in rice agriculture, extended periods of drought, mortality from predation due to increasing populations of alligators and possible increases in

mammalian predators, a continued high incidence of lead pellet ingestion, and harvest (USFWS Division of Migratory Birds, unpublished reports).

Under Refuge Management Alternative D, many habitat management and restoration activities currently conducted on the Refuge Complex would be continued, and all would be expected to have positive impacts on this species although the landscape level issues described above are likely to control population dynamics of the WGC Mottled Duck population. Several habitat management and restoration activities would be expanded specifically to benefit Mottled Ducks. Management and enhancement of nesting and brood-rearing habitats would be targeted.

(a). Wetlands Management and Restoration

Wetland management and restoration activities on the Refuge Complex under Refuge Management Alternative D would provide additional enhancement of habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Expanded and enhanced structural marsh management would maintain existing and restore additional fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. It would enhance diversity and productivity of submerged aquatic vegetation in open water habitats, providing an important year-round food sources for Mottled Ducks. Moist soil management and cooperative rice farming programs would provide shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. Rice farming would continue to provide 500-700 acres of wetland habitat annually, and moist soil management an additional 690 acres over current levels on the Refuge Complex under this Alternative. Approximately 400 acres of moist soil units would be managed each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

Under Refuge Management Alternative D, 100 acres of shallow freshwater “prairie wetlands” would be restored in fallowed rice fields. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as “sennabean ponds,” as valuable brood rearing habitat. Restoring these natural “prairie wetlands” would provide brood-rearing habitat in close proximity to quality nesting habitat (see below).

(b). Uplands Management and Restoration

Expanded native prairie restoration and management activities under Refuge Management Alternative D would benefit Mottled Ducks primarily by restoring and enhancing nesting habitat. The USFWS would restore an additional 2,223 acres of native prairie under this Alternative and use the integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing and haying to maintain and enhance grassland habitats and reduce brush encroachment (exotic and native plants) in salty and non-saline prairies. All would be expected to improve nesting success of Mottled Ducks and other ground-nesting avian species.

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Protecting extant stands of coastal prairie and restoring adjacent prairie and prairie wetland habitats under Refuge Management Alternative D on the Refuge Complex would increase quality of habitats important to Mottled Duck recruitment and overall reproductive success.

(c). General Habitat Management Activities

Under Refuge Management Alternative D, prescribed burning would be continued at current levels and grazing intensity (higher stocking rates) and duration in selected fresh and intermediate marshes would be increased. The integrated combination of expanded water level and salinity management, prescribed burning and intensified livestock grazing in wetland habitats on the Refuge Complex under this Alternative

would increase the acreage of optimal wetland habitat for Mottled Ducks. Expanded invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex. These cordgrass ridges are dominated by gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania spp.*) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Initiation of summer burning under this Alternative would be expected to improve nesting habitat in salty prairies by more effectively controlling Eastern baccharis and other woody vegetation.

Improper application of these habitat management practices has the potential to negatively impact Mottled Ducks. For example, prescribed burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Overgrazing by cattle may reduce desirable nesting habitat for Mottled Duck in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988). The potential for some negative impacts to Mottled Duck nesting habitat would increase under Refuge Management Alternative D. Higher cattle stocking rates and grazing durations in fresh and intermediate marshes could reduce availability of suitable nesting cover in contiguous salty prairies and non-saline grassland habitats under this Alternative.

Marsh habitats currently being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck production and brood rearing habitats. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. If implemented under Refuge Management Alternative D, large-scale restoration of the barrier beach/dune system on McFaddin NWR would significantly enhance wetland habitats important to Mottled Ducks by preventing saltwater intrusion currently resulting from frequent tidal overwash from the Gulf into inland marshes. Smaller shoreline protection and restoration projects implemented under this Alternative would also protect and enhance marsh and salty prairie habitats important to Mottled Ducks.

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally-listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least Sandpiper, to waters about 8-12 cm deep, such as the Black-bellied

Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migratory, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. As such, most of the wetland and upland habitat management and restoration activities to be continued under Alternative D would continue to positively impact the shorebird, wading bird and marsh bird species currently found on the Refuge Complex.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative D, expanded and enhanced structural marsh management would improve habitat conditions for many avian species in this group. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species.

Under Refuge Management Alternative D, cooperative rice farming would continue at current levels and moist soil management programs would be expanded to provide additional shallow freshwater wetland habitat. In total, rice farming would provide approximately 500-700 acres on Anahuac NWR, and Complex-wide moist soil management would provide approximately 1,200 acres under this Alternative. Approximately 300 acres of the Anahuac NWR's moist soil units would be managed specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species would include Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. Under this Alternative, 1,200 acres of moist soil units would provide wetland habitat for shorebirds, wading birds, and other marsh and water birds over the winter months. Wading and marsh bird species using moist soil habitats on the Refuge Complex include American Bittern, Great Blue Heron, Great Egret, Snowy Egret, Little Blue Heron, Tri-colored Heron, Black-crowned and Yellow-crowned Night Herons, White Ibis, White-faced Ibis, and Roseate Spoonbill.

In general, shorebirds and wading birds would also benefit from expanded moist soil management under this Alternative. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields influences the type of and intensity of use by such birds (Huner *et al.* 2002).

(b). Uplands Management and Restoration

Under Refuge Management Alternative D, expanded restoration and enhancement of native prairie habitats would provide improved habitat for several species of migrating and wintering marsh birds. Three Avian Species of Conservation Concern (USFWS 2005) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

Under Refuge Management Alternative D, the USFWS would continue the integrated combination of water level and salinity management, prescribed burning and controlled livestock grazing in wetland habitats on the Refuge Complex. The USFWS would enhance water management capabilities, continue

prescribed burning at current levels and intensify grazing in selected marsh units under this Alternative. These management activities would enhance wetland and upland habitats used by many shorebird, wading bird and marsh bird species.

These management tools would help create optimal physical structure of vegetation for many species of shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds. Conversely, intensified grazing under this Alternative may reduce habitat availability in some refuge units for some marsh bird species which require dense, tall stands of vegetation. Higher grazing intensities would increase the potential for some negative impacts. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979). Overall, species requiring less dense, more open marsh habitats would benefit from intensified controlled grazing under Refuge Management Alternative D, while the amount of habitat for species requiring dense stands of vegetation would decrease.

Some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. However, most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. As under Refuge Management Alternative A, overall management under Alternative D would be aimed at maintaining a mosaic of available habitats. This should provide an adequate range of habitats for this group of avian species.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (Emberizidae) and wrens (Troglodytidae, Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS uses these techniques in prescribed burning operations on the Refuge Complex.

Expanded invasive plant and exotic animal control activities under Refuge Management Alternative D would enhance wetland and upland habitats for many avian species in this group. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure (such as common reed, cattail, and California bulrush), would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including beach/dune

restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Under Refuge Management Alternative D, the USFWS would continue to maintain a 1-acre nesting site for Least Terns and Black Skimmers on McFaddin NWR. This site is intensively managed to promote increased nesting success for these species, including providing ideal nesting substrate, excluding mammalian predators, and minimizing disturbance.

(4). Impacts to Landbirds

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., Red-tailed Hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted on the Refuge Complex under Refuge Management Alternative D would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats on the Refuge Complex, restoration, management and protection of native prairies and coastal woodlots are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory songbirds.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative D, the following wetland management and restoration activities would continue to have positive impacts on several landbird species including managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and the cooperative rice farming program. Several land bird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow, Nelson's Sharp-tailed Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

(b). Uplands Management and Restoration

Prairie Restoration and Management

Under Refuge Management Alternative D, 2,223 acres of fallowed rice fields and other upland areas would be restored to native coastal prairie. The newly restored sites, along with existing native prairie remnants, previously restored native prairie sites and other grasslands would be managed using a variety of management tools. Together, the management actions undertaken under Refuge Management Alternative D would protect and enhance approximately 5,774 acres of non-saline grassland habitats on the Refuge Complex.

Many animal species typical of northern prairies, such as Henslow's Sparrows, Smooth Green Snakes, and Prairie Voles, were all found year-round in the Gulf coastal prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf coastal prairies as wintering and/or migratory habitat. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Management Alternative D are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005). For example, White-tailed Hawk, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats on the Refuge Complex.

Native prairie remnants and other upland grassland habitats on the Refuge Complex provide wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow, and nesting habitat for species including Dicksissel and Eastern Meadowlark. These are also important nesting habitats for Mottled Ducks. Several species of raptors commonly observed on the Refuge Complex include Red-tailed Hawk, Red-shouldered Hawk, Turkey Vulture, American Kestrel, White-tailed Kite, Northern Harrier, and Short-eared Owl (USFWS 1997a). Many other raptor species are observed during spring and fall migrations. Land birds listed as Avian Species of Conservation Concern utilizing prairie grassland habitats and which would benefit from native prairie restoration and management activities on the Refuge Complex under Refuge Management Alternative D include LeConte's Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk.

Woodlot Restoration and Management

Under Refuge Management Alternative D, the USFWS would continue management activities as described under Alternative A to protect and diversify 127 acres of existing coastal woodlots and riparian woodlands: 1) native tree and shrub plantings; 2) invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts. In addition the USFWS would create 29 acres of additional woodland habitat on the Anahuac NWR, and assess opportunities for additional woodlot restoration on suitable sites throughout the Refuge Complex.

Although comprising less than 1 percent of the Refuge Complex acreage, woodlots help support a diverse avian community, which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in the Refuge Complex's coastal woodlots. Migratory birds also depend on coastal woodlots for cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier Plain region prior to or immediately after crossing the Gulf of Mexico (Barrow *et al.* 2000). Trans-Gulf or circum-Gulf migratory songbirds use Texas Coastal woodlots as stopover habitat (Mueller 1981), which is critical at a time when the birds are depleted of water and energy reserves (Leberg *et al.* 1996).

A primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially *Lepidopteron* larvae. Chinese tallow woodlots may thus be an "ecological trap" that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001). Feral hogs can damage understory vegetation and soils, as a result of their rooting habits, and may also cause a shift in plant succession. Such activities can also create disturbed areas that enable easier establishment of some exotic species. Feral hogs may also directly compete with several species of native wildlife for certain foods.

Overall, implementation of the USFWS management actions discussed above under the Refuge Management Alternative D would continue to improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodlot habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging. Species to benefit would include three neotropical migratory birds considered Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler. Since woodlot acreage is small relative to its importance to migrating neotropical migratory birds and other bird species that require trees and/or understory for cover, such positive impacts for each acre protected would be proportionately significant.

(c). General Habitat Management Activities

Prescribed burning, grazing, and invasive species management, and shoreline protection and restoration activities would continue on the Refuge Complex under Refuge Management Alternative D. The integrated combination of water level and salinity management, fire management and controlled livestock

grazing on the Refuge Complex which promotes optimum habitat conditions for wetland-dependent migratory birds also enhances wetland and upland habitats used by many land bird species. Invasive plant and animal control activities would enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

Seaside Sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding Seaside Sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife.

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Under Refuge Management Alternative D, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct management activities including prescribed burning, controlled livestock grazing, invasive plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments on the Refuge Complex support highly diverse aquatic vertebrate and invertebrate communities. Disruption of salinity gradients would likely cause adverse impacts on blue crabs (Guillory 1996). Many of the refuge marshes would exceed these thresholds without some type of hydrologic management.

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Structural marsh management is employed on portions of the Refuge Complex to reduce impacts of saltwater intrusion and subsequent marsh loss as well as to maintain the historic salinity gradient that characterized coastal marshes of the Chenier Plain.

Managing water levels and salinities using water control structures and levees in managed marsh units may restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers

et al. 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown. Target salinity ranges typical of structurally managed marshes on the Refuge Complex range from fresh to the low end of brackish, being primarily intermediate (0.5-5.0ppt). While these salinity ranges are used by estuarine species, a study of fisheries use along a salinity gradient in Galveston Bay (Zimmerman *et al.* 1990) found estuarine fisheries were not greatly attracted to intermediate (oligohaline) marshes of the Trinity River delta. This study concluded that the oligohaline environment was not favorable for development of preferred foods, primarily epiphytic algae and peracarid crustaceans. Further, while transient species such as juvenile shrimp, crabs, and fishes had ready access to oligohaline marshes in this area, they did not use them extensively. These data indicate that while water control structures may limit ingress/egress of estuarine organisms, the habitat within may not be optimum for these organisms compared to brackish and saline marshes available on the Refuge Complex.

Impacts of structural marsh management to fisheries resources have been reduced on the Refuge Complex by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). Ingress/egress slots allow more marine organism passage than fixed crest weirs, with larger openings allowing greater fisheries access (Herke *et al.* 1992). These slots provide a means of allowing movement of estuarine organisms in and out of structurally managed marshes, but assist in maintaining the fresher end of the coastal marsh continuum that so many of the Refuge Complex's priority species depend on. Periods of peak ingress and egress movements are associated with water level fluctuations and tidal cycles. Highest peak fisheries resource movements are often related to periods of combined lunar cycles and major tidal movements. Manipulating water control structures during the full moon and new moon of the lunar cycle allows opportunity for the maximum ingress potential of fisheries resources. Holding slight levels of excess water for several days prior to these cycles and releasing during peak ingress periods greatly increases access to the unit from fisheries species dependent on coastal estuaries. Many species will move towards fresher water during incoming tides (Guillory 1996). The USFWS would continue to use these techniques on the Refuge Complex to enhance fisheries utilization of managed marsh units under this Alternative.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Knieb and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are experiencing rapid subsidence, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, activities which restore productive wetland habitats and help reduce rates of marsh loss (hydrologic restoration, marsh restoration using dredge material, structural marsh management and shoreline restoration and protection) would help sustain healthy fisheries resources in the long-term.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon,

Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative D, protection, restoration and management of coastal wetland habitats on the Refuge Complex would benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown pelicans utilize shorelines and tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity and biological diversity under Refuge Management Alternative D would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species.

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, habitat management and restoration activities under Refuge Management Alternative D which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under Refuge Management Alternative D which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Expanded moist soil management and restoration of prairie wetlands would increase available wetland habitat over current levels. Habitat conditions which increase the abundance of insects, crustaceans, and other small prey benefit most species of amphibians and reptiles during at least a portion of their lifecycle. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Expanded control of invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Under Refuge Management Alternative D, suppression of wildland fires and prescribed burning would continue on the Refuge Complex unchanged from current programs. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in

numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize.” Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

b. Impacts from Public Use Programs

Assuming an increase in visitation to the Refuge Complex under Refuge Management Alternative D, impacts to fish and wildlife resources would likely increase over current levels described under Alternative A. This assumption is based upon the expanded and enhanced waterfowl hunting opportunities, new hunting programs for doves and the development of new visitor facilities to support and enhance fishing, wildlife observation and photography, and environmental education and interpretation programs provided under this Alternative.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

Under Refuge Management Alternative D, the USFWS would enhance waterfowl hunting opportunities on the Refuge Complex by improving access facilities, implementing administrative changes aimed at improving quality of the hunting experience, and providing additional services and informational materials to refuge hunters.

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest of migratory birds in the Central and Mississippi Flyways are developed annually under the USFWS national migratory bird hunting regulations frameworks, and are designed to ensure that viable waterfowl populations are sustained over the long-term, the hunting program on the Refuge Complex under Refuge Management Alternative D will not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichholf 1976, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton *et al.* 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas would remain the same under this Alternative and include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas

on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required an additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and/or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary areas of adequate size, encompassing and/or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998). Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

Overall, it is expected that the maintenance of sanctuary areas on the Refuge Complex under Refuge Management Alternative D will mitigate for disturbance impacts from hunting activities. In years of poor habitat quality due to climatic extremes or tidal flooding from tropical disturbances, however, it is possible that hunting activities would result in reduced abundance of wintering waterfowl on the Refuge Complex.

Refuge-specific hunting regulations under Refuge Management Alternative D would also help mitigate the impacts of hunting activity-related disturbance to waterfowl. Waterfowl hunting in hunt areas is allowed three days per week (with the exception of the 1,500-acre Pace Tract on Anahuac NWR which is open for hunting seven days per week), and all hunting activity is curtailed each day at noon. The non-hunted days and afternoon and evening closures provide undisturbed periods within the hunt areas, facilitating waterfowl utilization of hunt area habitats for foraging and resting. Boat use on the Refuge Complex occurs primarily in bayous, canals and ditches, limiting disturbance impacts to these narrow corridors (exceptions are Star Lake and Clam Lake on McFaddin NWR and Pole Lake on Texas Point NWR). The majority of the hunt areas therefore are not impacted by boating activity, being accessible primarily by foot. In addition, a variety of regulations govern means of access to hunt areas, including boat motor and horsepower restrictions, prohibition of airboat and all-terrain vehicle use, and establishment of areas in which only non-motorized boat access is allowed. While these regulations are in place primarily to protect habitats and public safety, they also reduce overall disturbance impacts to waterfowl and other migratory birds.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation

Under Refuge Management Alternative D, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. Means of access for these uses and the presence of visitors would result in disturbance impacts to waterfowl, as described under Alternative A. Increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Primary means of access to areas on the Refuge Complex use for fishing and wildlife observation and photography would include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors use bicycles on public roads and levee trails on all three refuges. An even smaller number ride horses on roads at Anahuac NWR and on the Gulf beach at McFaddin NWR. Motorized vehicles and walking are used to access areas used for environmental education and interpretation on Anahuac NWR. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

(2). Impacts to other Migratory Birds Shorebirds, Wading Birds and other Marsh and Waterbirds, Land Birds

(a). Waterfowl Hunting

Although the impacts of waterfowl hunting under Refuge Management Alternative D on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and land birds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

Under Refuge Management Alternative D, the USFWS would open a portion of Anahuac NWR to hunting of doves. The most direct effect of dove hunting on the Refuge Complex would be the mortality of harvested birds resulting from the hunting activities. However, because regulations governing harvest of migratory birds including doves are developed annually and are designed to ensure that viable populations are sustained over the long-term, this new hunting opportunity should not have any measurable effect on overall populations and the long-term viability of these populations. Disturbance impacts to other wildlife species would be localized and minimal. Refuge-specific regulations for this hunt would be developed to protect wildlife and habitats and public safety, and to minimize conflicts with refuge management activities and other public uses.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

Under Refuge Management Alternative D, existing visitor facilities on the Refuge Complex would be maintained and several new facilities would be developed to support these uses on Anahuac, McFaddin and Texas Point NWRs. As described under Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Alternative D, increased visitation and the presence of new facilities would increase these impacts and expand the areas within which impacts would occur.

Primary means of access to areas on the Refuge Complex for fishing, wildlife observation and photography would include motorized and non-motorized boating (primarily in bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), motorized vehicles on refuge roads open to the public, and walking on trails, boardwalks and observation platforms and along banks and shorelines. A very small number of visitors would use bicycles on public roads and levee trails on all three refuges. An even smaller number would ride horses on roads at Anahuac and McFaddin NWRs. Motorized vehicles and walking would be used to access areas used for environmental education and interpretation on Anahuac NWR.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

On Anahuac NWR, visitors would be allowed to access a 10-acre area within the Yellow Rail Prairie Management Unit to attempt to flush and view yellow rails. This is accomplished by walking slowly through the area, and is most successful when groups of people slowly walk parallel to each other dragging a rope in between participants. This activity occurs primarily during the months of March and April, and includes several guided “Yellow Rail Walks” led by refuge staff or trained volunteers. Disturbance of rails flushed during this activity undoubtedly occurs and likely leads to reduced utilization of this area by rails. Suitable undisturbed habitats exist adjacent to this site, and is unlikely that this disturbance results in long-term negative impacts to individual rails or rail populations.

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen, 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

(3). Impacts to Fisheries

(a). Fishing

Enhancement of fishing and crabbing opportunities on the Refuge Complex under Refuge Management Alternative D would include developing new access facilities and expanding the hours that McFaddin NWR is open to the public.

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term. Fishing on the Refuge Complex under this Alternative should not have any measurable effect on overall populations and the long-term viability of these species’ populations.

(b). Waterfowl Hunting, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach and other Uses

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative D.

(4). Impacts to Threatened and Endangered Species

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities on the Refuge Complex under this Alternative. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative D.

(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex under this Alternative. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

(b). Commercial Alligator Harvest

Under Refuge Management Alternative D, an adult alligator harvest program would continue to be administered as an economic use on the Refuge Complex. This program is administered under regulations promulgated by Texas Parks and Wildlife Department, and these regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS regulates the alligator harvest program on the Refuge Complex through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations are in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure within the Refuge Complex alligator population. Continuation of the commercial alligator harvest program under Alternative D should not have any measurable effect on the long-term viability of alligator populations on the Refuge Complex.

(c). Control of Muskrat Populations

Under Refuge Management Alternative D, muskrat populations could be controlled in specific locations as deemed necessary to protect wetland habitats on the Refuge Complex through issuance of Special Use Permits for trapping and removal by qualified individuals. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors

contributing to marsh loss. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

Under Refuge Management Alternative D, all current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue. In addition, the USFWS would work with partners to expand the annual Mottled Duck breeding pair survey and to conduct additional research on factors affecting vital rates for this important resident waterfowl species. The USFWS would also expand biological monitoring and research through expanded partnerships for several priority migratory birds (including shorebirds, wading birds, marsh and waterbirds and several migratory and resident land birds) which utilize Refuge Complex habitats and which have been identified as priority species for conservation.

Expanded surveys and monitoring and research activities conducted under Refuge Management Alternative D would be useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information will facilitate implementation of an adaptive management approach which allows continual refinement and improvement of management activities on the Refuge Complex. Additional information on Mottled Ducks and other priority migratory birds will enhance conservation efforts for these species.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative D, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls. Under this Alternative, the USFWS would develop a comprehensive Oil and Gas Management Plan to enhance management of oil and gas activities on the Refuge Complex.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be reduced impacts on fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative D, the USFWS would expand efforts to develop partnerships with private land owners to restore and enhance wetland, native prairie and coastal woodlot habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project; and 3) holding workshops for landowners to demonstrate habitat enhancement methods and techniques. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands. It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative D would result in additional habitat restoration and enhancement throughout the project area.

The USFWS would also continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as Ducks Unlimited, the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. These partnerships support and greatly enhance a variety of refuge management programs.

It is anticipated that continuation of outreach and partnership efforts under Refuge Management Alternative D would result in additional habitat restoration and enhancement on the Refuge Complex and throughout the project area.

It is anticipated that expanded outreach and partnership efforts under Refuge Management Alternative D would result in benefits to fish and wildlife resources as important habitats are restored and enhanced. Projects such as those implanted to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat. Restoration and enhancement of upland habitats including native prairie and coastal woodlots would benefit many avian species, including many Avian Species of Conservation Concern.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways.

First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements: 1) direct expenditures made by USFWS to manage operations at the Refuge Complex, 2) value of production from agricultural programs on the Refuge Complex; and 3) expenditures made by recreational visitors to the Refuge Complex.

Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this management alternative were estimated using the data and methods discussed below. The analysis compares the impacts from this management alternative to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

a. Direct Economic Impacts

(1). Value of Refuge Operations (Direct Expenditures)¹⁶

Based on information about the activities proposed under Refuge Management Alternative D, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this management alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. The estimate of the annual average cost, per five-year period, for Refuge Management Alternative D is summarized in Table 4-27 on the following page.

¹⁶ The Value of USFWS Operations Table is essentially done for the No Acton Alternative (Alt. A). Under the remaining management alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

Table 4-27

Average Annual Operational Costs for the Refuge Complex – Refuge Management Alternative D (Direct Expenditures)

Cost Category	Annual Average Expenditures		
	Year 1 - 5	Year 5 - 10	Year 10 - 15
Annual Staff Salaries	\$1,777,927	\$1,903,894	\$2,060,061
Utilities	\$24,500	\$17,500	\$17,500
Travel	\$27,386	\$19,562	\$19,562
Water Purchases	\$66,000	\$50,000	\$50,000
Heavy Equip. Rental and Replacement	\$115,600	\$87,333	\$86,667
Annual and Deferred Maintenance	\$1,707,883	\$1,552,050	\$1,454,050
Special Programs	\$19,500	\$19,500	\$19,500
Total Average Expenditures	\$3,738,797	\$3,649,839	\$3,707,339

The estimate of Refuge Operation's direct expenditures under this alternative shows an approximate \$1,000,000 increase compared to the \$2,695,184 estimate under the "No Action" alternative.

(2). Value of Production from Refuge Agricultural Programs

(a). Cattle Grazing

The estimate for the value of grazing included some development assumptions regarding the annual average number of AUMs expected to occur under this management scenario. The annual average AUMs are expected to increase somewhat from 23,900 under the "No Action" alternative to about 27,485 under this management alternative. Using the estimated value of \$88.02/AUM determined in the analysis for the "No Action" alternative, there is about a \$300,000 increase in the estimate of the production value of grazing. A summary comparing the changes in AUMs and value of production between the "No Action" alternative and Alternative D is contained in Table 4-28.

Table 4-28

Estimated Production Value of Grazing Activities on Refuge Complex - Refuge Management Alternative D

Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
RM Alternative D	27,485	\$2,419,230

(b). Rice Production

Under the development assumptions for this alternative the annual acreage in rice production will stay basically the same as the current 600 acres under the "No Action" alternative. Therefore, the estimated annual value for rice production under this alternative would be the same as the \$249,867 determined for the "No Action" alternative. A summary comparing the changes in annual average acreage produced and value of production between the "No Action" alternative and Alternative D is contained in Table 4-29.

Table 4-29

Estimated Value of Rice Production on Refuge Complex - Refuge Management Alternative D

Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
RM Alternative D	600	\$249,867

(3) Value of Refuge Recreational Programs

For each management alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under the "No Action" alternative. The estimated changes in recreational visitors under Refuge Management Alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	5% Increase
Dove Hunting	New activity - 100 hunter/days per year
Fishing	10% Increase
Wildlife Observation	10% Increase

These changes were then applied to the estimate of annual non-resident visits and the estimate of itemized expenditures by recreational activity which were developed for the "No Action" alternative. Table 4-30 contains a summary of the comparison of the annual direct expenditures associated with recreational visitors to the Refuge Complex between the "No Action" alternative and Refuge Management Alternative D.

Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
RM Alternative D	38,552	\$1,278,784

b. Indirect and Induced Economic Impacts

Indirect and induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

Employment: The annual average estimated employment is measured as Full-Time equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (Approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

Labor Income: Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

Other Property Type Income: This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

Indirect Business Taxes: Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

(1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Alternative D and the "No Action" alternative is summarized in Table 4-31.

Table 4-31 Indirect and Induced Economic Impacts of Operations at Refuge Complex – RM Alternative D			
	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	45	45	45
Refuge Management Alternative D	61	59	56
Labor Income			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative D	\$1,605,157	\$1,593,034	\$1,554,094
Other Property Type Income			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative D	\$226,829	\$423,406	\$401,978
Indirect Business Taxes			
No Action Alternative	\$493,149	\$493,149	\$493,149
Alternative D	\$551,300	\$578,967	\$614,541

(2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternative D and the "No Action" alternative is summarized on the following page in Table 4-32.

Table 4-32 Indirect and Induced Economic Impacts of Agricultural Activities at Refuge Complex – RM Alternative D			
	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	20	20	20
Refuge Management Alternative D	22	22	22
Labor Income			
No Action Alternative	\$587,382	\$587,382	\$587,382
Refuge Management Alternative D	\$656,901	\$656,901	\$656,901
Other Property Type Income			
No Action Alternative	\$272,759	\$272,759	\$272,759
Refuge Management Alternative D	\$302,657	\$302,657	\$302,657
Indirect Business Taxes			
No Action Alternative	\$87,668	\$87,668	\$87,668
Refuge Management Alternative D	\$97,766	\$97,766	\$97,766

(3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Alternative D and the "No Action" alternative is summarized in Table 4-33.

Table 4-33 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex – RM Alternative D			
	Year 1 - 5	Annual Average Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	25	26	26
Refuge Management Alternative D	28	29	29
Labor Income			
No Action Alternative	\$609,908	\$621,374	\$629,040
Refuge Management Alternative D	\$611,468	\$684,011	\$692,478
Other Property Type Income			
No Action Alternative	\$224,963	\$229,144	\$231,939
Refuge Management Alternative D	\$247,623	\$252,244	\$255,331
Indirect Business Taxes			
No Action Alternative	\$136,816	\$139,559	\$141,394
Refuge Management Alternative D	\$150,623	\$153,657	\$155,684

2. Population Impacts

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Although the Refuge Complex under this management alternative is expected to support over 100 FTEs per year, the Refuge Complex is not considered a major employer in the area and thus would not support a significant proportion of the population.

3. Fiscal Impacts on Local Governments

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and/or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under any of the Refuge Management Alternatives.

Management actions can also affect local government services directly. For instance, the USFWS purchases water from the Chambers Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area.

4. Social Impacts

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, natural resource management actions such as those made by the USFWS on the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

a. Impacts to Social Structures and Lifestyles

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and/or community cohesiveness and stability)
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and/or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause/effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

b. Impacts to Relationships between the USFWS and Stakeholder Groups

General categories of stakeholder groups describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and/or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and/or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

c. Impacts to USFWS Public Outreach Programs and Activities

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and/or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative D, current USFWS public outreach efforts would continue and be expanded.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the Refuge Management Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and/or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure/lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among Alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

d. Environmental Justice

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex EIS/CCP/LPP is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse effects and some beneficial effects by the continued operation and/or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and/or low-income population components. Overall, the identified minority and/or low-

income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

V. IMPACT ANALYSIS FOR REFUGE MANAGEMENT ALTERNATIVE E: EMPHASIS ON A PASSIVE MANAGEMENT APPROACH

Overview

Under this Alternative, the Refuge Complex would change its management focus from active habitat management and restoration to a more passive management approach, in which plant communities and wildlife populations would be influenced primarily by natural events such as lightning-caused fires, herbivory by native wildlife, and tidal or stream flooding. Active habitat management and restoration activities including structural management of water levels and salinities in marshes, prescribed burning, controlled cattle grazing, rice farming, moist soil management and control of invasive species would be discontinued. Efforts to address threats to ecosystem health would focus on monitoring rather than active restoration or protection. The Refuge Complex would continue to provide opportunities for all six of the National Wildlife Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation, but administrative oversight and management would occur at reduced levels.

A. Natural Resources Section

1. Impacts to Air Quality

The USFWS fire management program on the Refuge Complex has the greatest potential of all refuge management actions to impact the region's air quality. Fire management activities currently include both the suppression of unplanned wildland fires and prescribed burning. Smoke from unplanned wildland fires and from planned prescribed burning can be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities.

Under Refuge Management Alternative E, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001), and the USFWS would discontinue its prescribed burning program on the Refuge Complex. Suppression would involve utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under this Alternative, whenever feasible, natural fires ignited by lightning would be allowed to burn.

Discontinuation of prescribed burning activities on the Refuge Complex under Refuge Management Alternative E would eliminate potential air quality impacts from smoke generated from these burns. However, lack of prescribed burning would result in rapid accumulation of vegetative fuels over large areas on the Refuge Complex. Most lightning-caused wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires would be more likely to start in areas with higher fuel loads, and fires that did start would burn with higher intensity, produce more smoke, and would be more difficult to suppress than in areas where previous fires had reduced accumulations of hazardous fuels. Under this Alternative, the likelihood that smoke from unplanned wildland fires would be transported by prevailing winds and negatively impact air quality and transportation safety in the region would increase, both in terms of increased frequency of events which negatively impact regional air quality and an increase in the amount of smoke and associated particulates during these events.

2. Impacts to Geology and Soils

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water.

Under Refuge Management Alternative E, the USFWS would discontinue participation in current partnership efforts with other federal and state agencies and conservation organizations aimed at addressing threats which are resulting in ongoing coastal land loss, and would discontinue implementation of small scale shoreline and hydrologic restoration projects on the Refuge Complex. Habitat management activities on the Refuge Complex including structural management of water levels and salinities and prescribed burning which can impact soils and soil formation would be discontinued. Under this Alternative, the USFWS would monitor coastal land loss from shoreline erosion and conversion of vegetated marshes to open water.

Although shoreline erosion and retreat along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach/dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (1998) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline are eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of habitat, loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water (DeLaune *et al.* 1983, Nyman *et al.* 1993). (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995, Morton *et al.* 2001). It is likely that

conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Under Refuge Management Alternative E, the future effects of relative sea level rise and altered hydrological regimes on coastal habitats will likely be substantial. Without efforts to augment coarse sediment supply along the Gulf and to construct breakwaters along the GIWW and East Galveston Bay, rates of shoreline retreat and land loss would likely accelerate. Increased saltwater intrusion would result in decreased plant productivity in fresh and intermediate marshes, reducing soil formation and vertical accretion and leading to submergence and conversion of vegetated marsh to open water. Potential contributions to marsh accretion from mineral sediment supply using dredge material would not be realized. The likelihood of peat burns occurring would increase under this Alternative, with subsequent negative impacts to marsh soils and vertical accretion.

3. Impacts to Hydrology and Water Quality

a. Hydrology

Under Refuge Management Alternative E, the USFWS would discontinue wetland management and restoration activities conducted on the Refuge Complex and aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. These include structural marsh management, rice farming and moist soil management, marsh and prairie wetland restoration, and shoreline protection and restoration. The USFWS would also discontinue coordination with other State and Federal agencies on a large-scale hydrological restoration projects. Under this Alternative, the USFWS would monitor status and trends of wetland habitats on the Refuge Complex.

Implementation of this Alternative would result in three major hydrological impacts - increased saltwater intrusion, additional loss of freshwater inflows, and permanently altered marsh hydroperiods resulting in rapid drainage and drying and/or excessive flooding and inundation. Fresh and intermediate marshes would be converted to more brackish regimes, resulting in a loss of overall biological diversity. Marshes would be more susceptible to the negative impacts of excessive drying and oxidation of soils and water logging, both of which could lead to conversion to open water.

b. Water Quality

Potential sources of contaminants affecting water quality include accidental releases from oil and gas exploration and production activities on and adjacent to the Refuge Complex, including spills and leaks from wells, production facilities, and pipelines. In addition, a high volume of petrochemicals is transported through the Refuge Complex on a daily basis via the GIWW. Municipal development and agricultural practices may also impact water quality in the Refuge Complex. Non-point pollution sources such as storm drain run-off from local cities and towns are major sources of pollutants entering the Galveston Bay estuarine ecosystem (Galveston Bay Estuary Program 1995). Point source pollution from upstream facilities such as landfills is also of concern. Rice cultivation contributes important freshwater inflows to the Galveston Bay and Sabine Lake estuarine ecosystems, but agricultural practices as a whole may also contribute excess nutrients and toxins to surface waters within these coastal watersheds. Herbicide application is used on rice, soybeans, sorghum, and hay throughout the region. Concentrations of

herbicides are greatest during May, June and July, with the lowest concentrations occurring in the fall and winter. Nitrates from nutrient loading are common in agricultural areas where fertilizer application enters into streams, creeks, and bayous during storm events.

Under Refuge Management Alternative E, the USFWS would continue current water quality monitoring efforts described under Alternative A, but would no longer proactively work to address water quality issues affecting Refuge resources. Impacts of point and non-point source pollution sources and accidental spills on water quality, habitats and fish and wildlife resources on the Refuge Complex would likely increase.

4. Impacts to Vegetation and Habitats

a. Impacts from Habitat Management and Restoration Activities

Under Refuge Management Alternative E, the USFWS would curtail most habitat management and restoration activities on the Refuge Complex. Vegetative communities and habitats would be influenced primarily by events such as lightning-ignited fires, herbivory by native wildlife, and tidal and precipitation-related flooding.

(1). Wetland Specific Management and Restoration

(a). Water Management in Coastal Marshes

Under Refuge Management Alternative E, the USFWS would discontinue structural management of approximately 30,000 acres of coastal marshes on the Refuge Complex.

Structurally managed marshes have been shown to provide quality habitat for migratory birds (Chabreck 1960, 1976). Merino *et al.* (2005) found that managed areas, particularly those without complete levees, had more submerged aquatic vegetation than unmanaged areas. Marsh restoration using semi-impoundments in Louisiana reversed the deleterious effects of excessive tidal exchange caused by channelization, allowing both emergent and submergent vegetation to flourish (Hess *et al.* 1989). Monitoring efforts on and around McFaddin NWR indicated that diversity indices for both emergent and submergent plants were higher within structurally managed marshes compared to adjacent unmanaged marshes (USFWS 2006). This was largely due to the presence of plants with lower salinity tolerances, indicating that this marsh management program is at least partially meeting objectives. Chabreck (1994) stresses that careful planning and implementation is required in order for structural marsh management to reverse the negative effects of hydrological alterations and maintain critical wetland functions.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exacerbate flooding, further reducing plant vigor.

Implementation of this Alternative would result in three major hydrological impacts on the Refuge Complex - increased saltwater intrusion, additional loss of freshwater inflows, and permanently altered marsh hydroperiods resulting in rapid drainage and drying and/or excessive flooding and inundation. The historic continuum of fresh, intermediate, brackish and saline marshes would no longer be maintained. Fresh and intermediate marshes would be converted to more brackish regimes, resulting in a loss of overall biological diversity. Marshes would be more susceptible to the negative impacts of excessive drying and oxidation of soils and water logging, both of which could lead to lack of vertical accretion, submergence, and ultimately to conversion to open water.

(b). Marsh Restoration

Under the Refuge Management Alternative E, the USFWS would discontinue coordination efforts with other agencies to implement wetland restoration on the Refuge Complex through the beneficial use of dredge material and hydrological restoration.

Implementation of this Alternative would result in loss of opportunities to restore vegetated emergent marsh in areas which have converted to open water. It would also result in not implementing what may be the most practical alternative available to augment marsh vertical accretion and ensure the viability of the Refuge Complex' coastal wetlands in the face of projected relative sea level rise, i.e., increasing mineral sediment input to marshes through the beneficial use of dredge material.

(c). Moist Soil Management

Under Refuge Management Alternative E, the USFWS would discontinue moist soil management on the Refuge Complex.

Implementation of this Alternative would result in loss of 500 acres of shallow freshwater wetlands and associated moist soil plants which provide important food resources for waterfowl, shorebirds, wading birds and marsh birds. Abandoned moist soil units would be highly susceptible to rapid encroachment by invasive plant species, including Chinese tallow, deep-rooted sedge, Eastern baccharis and common rush. Invasive plant encroachment would displace native vegetation and reduce biological diversity.

(d). Cooperative Rice Farming Program

Under Refuge Management Alternative E, the USFWS would discontinue rice farming on the Refuge Complex.

Implementation of this Alternative would result in loss of 500-700 acres of shallow freshwater wetlands which provide important food resources for migrating and wintering waterfowl and other migratory birds. Fallowed rice fields would be highly susceptible to rapid encroachment by invasive plant species including Chinese tallow, deep-rooted sedge, Eastern baccharis and common rush. Invasive plant encroachment would displace native vegetation and reduce biological diversity.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Under Refuge Management Alternative E, the USFWS would discontinue active native prairie restoration and grassland management activities (burning, grazing, invasive plant control, mowing and haying) on the Refuge Complex. The USFWS would monitor plant community changes in upland prairie habitats.

Implementation of this Alternative would allow plant succession to proceed in the 5,774 acres of upland grassland habitats on the Refuge Complex, including former moist soil units and rice fields. Some reversion to grassland habitat would occur in these newly-fallowed areas, although the diversity of native prairie plants would be less than under current management and restoration programs. Fallowed rice fields and abandoned moist soil units would be highly susceptible to rapid encroachment by invasive plant species including Chinese tallow, deep-rooted sedge, Eastern baccharis and common rush. Invasive plant encroachment would displace native vegetation and reduce biological diversity in all grassland habitats on the Refuge Complex.

(b). Woodlot Restoration and Protection

Under Refuge Management Alternative E, the USFWS would discontinue efforts to protect and enhance coastal woodlots on the Refuge Complex. The USFWS would monitor plant community changes in coastal woodlots.

Overall, implementation of this Alternative would be expected to result in decreased abundance and diversity of native canopy and understory plants, and reduced natural regeneration of native woody species in the 127 acres of woodland habitats on the Refuge Complex. Chinese tallow encroachment would occur and would reduce value of woodlots to many avian species.

(3). General Habitat Management Activities

The USFWS uses fire management, controlled livestock grazing and exotic/invasive species management and mowing/haying to enhance habitats for migratory birds and other native fish and wildlife species. The integrated combination of burning, grazing and water management on the Refuge Complex maintains a diverse mosaic of wetland vegetative communities, both in plant species composition and structural attributes. Shoreline restoration and protection activities are being implemented on the Refuge Complex to counter ongoing coastal land loss caused by relative sea level rise, altered hydrological regimes and loss of coarse sediment supply. These management and restoration activities are used to conserve, enhance and restore both wetland and upland habitats on the Refuge Complex.

(a). Fire Management Wildland Fire Suppression and Prescribed Burning

Under Refuge Management Alternative E, suppression of wildland fires would continue as prescribed in the Refuge Complex Fire Management Plan (USFWS 2001), and the USFWS would discontinue its prescribed burning program on the Refuge Complex. Suppression would involve utilization of “Appropriate Management Response” to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Under this Alternative, whenever feasible, natural fires ignited by lightning would be allowed to burn.

Under Refuge Management Alternative E, the proportion of marsh habitat with early successional plant communities would decrease on the Refuge Complex relative to current conditions as fewer acres would be burned annually. Herbivory by native species such as snow geese and muskrats would also decrease, as burning during fall and early winter provides optimal habitat for these species. In combination, the elimination of prescribed burning and controlled grazing under this Alternative would favor a trend toward higher successional plant communities in intermediate and brackish marshes, primarily marshhay cordgrass. The habitat mosaic created by the current integrated use of burning, grazing and water management in Refuge Complex marshes would become less diverse. Discontinuation of prescribed burning in upland prairie habitats would result in more encroachment by woody species including Chinese tallow and Eastern baccharis. Native prairie plant species dependent upon frequent fire would be negatively impacted. Over time, native prairie plant species diversity and relative abundance would decrease.

(b). Controlled Livestock Grazing

Under Refuge Management Alternative E, the USFWS would discontinue use of controlled grazing in marsh and upland habitats.

Grazing (integrated with fire and water management) in wetland habitats on the Refuge Complex promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Elimination of grazing by cattle and prescribed burning under this Alternative would decrease the abundance of these early successional plants in marsh habitats. Overall, plant succession would

trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards tall, dense and rank stands of vegetation. The habitat mosaic created by the current integrated use of burning, grazing and water management in Refuge Complex marshes would become less diverse. In upland habitats, positive impacts of controlled grazing including increased plant vigor, enhanced nutrient recycling and increased plant diversity would not be realized. Encroachment by woody species would increase.

Under this Alternative, the potential for negative impacts of grazing to habitats and water quality on the Refuge Complex would be eliminated. Potential detrimental affects of grazing result primarily from overgrazing and include excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1995). Warm-season grazing of wetland areas can reduce seed production of annual grasses (Chabreck 1968). Overgrazing in prairie habitats, usually caused by prolonged grazing intensity, can reduce native prairie plant diversity. While prairie ecosystems are adapted to short duration high intensity grazing patterns, extended duration grazing can reduce native grasses and some native forbs, particularly those that are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and spread seed of undesirable plant species by physically carrying them or ingesting them.

(c). Invasive Species Management

Under Refuge Management Alternative E, the USFWS would discontinue invasive species management activities on the Refuge Complex. Field monitoring would be conducted to document occurrence and distribution of invasive species, and any changes in occurrence and distribution.

Under this Alternative, abundance and distribution of the following invasive species would likely increase, with concurrent impacts on native habitats and fish and wildlife:

- Chinese tallow, Eastern baccharis, willow, and deep-rooted sedge in freshwater marshes, prairies, fallowed rice fields and moist soil units, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed and cattail in fresh and intermediate marshes, managed wetland units and in waterways.
- Red rice, coffeebean, barnyard grass, and other grasses in fallowed rice fields and moist soil units.
- Broadleaf weeds and King Ranch bluestem in remnant and restored prairies.

Monocultures of invasive plants reduce natural biological diversity, increase erosion, alter nutrient cycling and displace macro- and micro-fauna that depend on native plants for habitat and food (Sheley and Petroff 1999). Invasive aquatic plant species such as water hyacinth, common reed, and cattail can form dense, monotypic stands which reduce open water habitats on the Refuge Complex.

Under Alternative E, the USFWS would discontinue control of exotic animal species on the Refuge Complex. Feral hog populations would increase, resulting in increased damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging. Additional soil disturbance would enable establishment of Chinese tallow and other undesirable plants. Potential for damage to wetland habitats due to high populations of nutria would increase.

(d). Shoreline Protection and Restoration

Under Refuge Management Alternative E, the USFWS would discontinue participation in current partnership efforts with other federal and state agencies and conservation organizations to implement shoreline protection and restoration to reduce coastal land loss. Under this Alternative, the USFWS would monitor coastal land loss from shoreline erosion.

Although shoreline erosion and retreat along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach/dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs. Shoreline erosion and retreat along the Gulf on these refuges is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Morton *et al.* (1998) found beach erosion between Sabine Pass and High Island to be among the highest in Texas. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline are eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of habitat, loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water (DeLaune *et al.* 1983, Nyman *et al.* 1993).

Under Refuge Management Alternative E, the future effects of relative sea level rise and altered hydrological regimes on coastal habitats will likely be substantial. Without efforts to augment coarse sediment supply along the Gulf and to construct breakwaters along the GIWW and East Galveston Bay, rates of shoreline retreat and land loss would likely accelerate. Increased saltwater intrusion would result in decreased plant productivity in fresh and intermediate marshes, especially on McFaddin and Texas Point NWRs, reducing soil formation and vertical accretion and leading to submergence and conversion of vegetated marsh to open water.

(e). Mowing and Haying

Under the Refuge Management Alternative E, the USFWS would discontinue mowing and haying of upland grassland habitats on the Refuge Complex. Encroachment of Chinese tallow and Eastern baccharis would increase in grassland habitats.

b. Impacts from Public Use Programs

Assuming an overall decrease in visitation to the Refuge Complex under Refuge Management Alternative E, impacts to vegetation and habitats described below would be similar but less extensive than those described for Alternative A.

The greatest potential for impacts to vegetation resources and habitats on the Refuge Complex due to recreational uses likely comes from motorized boating activities. Many Refuge Complex hunt areas and

fishing areas are accessible only or primarily by motorized boat. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submerged aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation can lead to vegetation trampling, and in heavy use areas, cause plant mortality. On the Refuge Complex, the more extreme impacts occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

These impacts would be expected to remain localized and minimal under this Alternative. Regulations, including horsepower restrictions and area closures to motorized boating would remain in effect to protect wetland habitats and public safety. Permanent sanctuary areas would be maintained throughout the Refuge Complex, which do not permit access by the public. Access for other recreational and educational uses would be restricted to established trails, boardwalks, and observation platforms. Fishing piers constructed in many heavily used shoreline fishing areas would reduce trailing impacts. Under this Alternative, the USFWS would generally decrease the scope of public use program management and oversight on the Refuge Complex, including field law enforcement. Consequently, the USFWS' ability to protect public safety, habitats and fish and wildlife resources would decline.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

No direct impacts to vegetation and habitats would occur as a result of continued implementation of the Refuge Complex biological program under Refuge Management Alternative E. Surveys and monitoring and research activities would help track and document impacts of a passive management approach on vegetation and habitats on the Refuge Complex.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative E, oil and gas exploration and development activities on the Refuge Complex would continue to be managed through the issuance of Special Use Permits as under Alternative A. Stipulations in the Special Use Permit include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit also require mitigation for all impacted habitats. Required mitigation activities include restoration and/or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex under this Alternative would be a reduction of impacts to vegetation and habitats from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative E, Refuge staff would no longer coordinate with private landowners on partnership projects to restore and enhance native habitats on private lands. The USFWS would continue to work with Refuge Friends groups, volunteers and other community partners, but at a reduced level. The overall impact would be a reduction in partnership activities aimed at restoring and enhancing native habitats on the Refuge Complex and throughout the project area.

5. Impacts to Fish and Wildlife Resources

Under Refuge Management Alternative E, discontinuation of most habitat management and restoration activities on the Refuge Complex would have impacts to conservation of the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

The USFWS would continue to administer the six priority recreational uses of the National Wildlife Refuge System on the Refuge Complex: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses impact fish and wildlife resources both directly and indirectly.

USFWS management of oil and gas exploration and development would also impact fish and wildlife resources.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Under Refuge Management Alternative E, wintering and migrating waterfowl populations on the Refuge Complex would decline as active habitat management and restoration would be curtailed.

On a year to year basis, overall habitat quality for waterfowl on the Refuge Complex will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers on the Refuge Complex can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative E, structural marsh management and hydrological restoration projects which currently help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl would be curtailed. Habitat values and use by waterfowl would decrease.

On Anahuac NWR, the cooperative rice farming program would be phased out and moist soil management discontinued under this Alternative. This would result in loss of 800-1,000 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and native moist soil plants in these habitats. Elimination of the rice farming and moist soil management programs would result in decreased wintering waterfowl populations on the Refuge Complex.

No additional wetland habitats would be restored through marsh restoration projects under this Alternative.

(b). General Habitat Management and Restoration Activities

Under Refuge Management Alternative E, the USFWS would discontinue use of an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats on the Refuge Complex to promote optimum habitat conditions for wintering waterfowl and many additional migratory bird species. As compared to current conditions, discontinuation of prescribed burning and grazing in marsh habitats under Refuge Management Alternative E would reduce habitat quality for and use by wintering waterfowl on the Refuge Complex. Overall, plant succession in intermediate and brackish marshes would trend toward higher successional plant communities, primarily marshhay cordgrass, and physical structure towards tall, dense and rank stands of vegetation.

Stopping control efforts for invasive vegetation such as common reed, cattail, and California bulrush which form dense homogeneous stands would result in loss of open water habitats under this Alternative. Infestations of invasive floating plants such as water hyacinth, alligatorweed and Salvinia would increase and also negatively impact these habitats. Loss of open water and associated submerged and floating plant communities would decrease habitat quality for wintering waterfowl and other migratory birds.

Under Refuge Management Alternative E, the USFWS would discontinue coordination with other agencies aimed at implementing shoreline protection and restoration projects. Tidal overwash of the eroding beach ridge into inland marshes would continue, and likely increase in frequency and magnitude, on McFaddin and Texas Point NWRs. Resulting salinity spikes in intermediate marshes would kill submerged and floating aquatic plants and invertebrates which provide important food resources waterfowl and other migratory birds.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Under Refuge Management Alternative E, discontinuation of habitat management and restoration activities currently conducted on the Refuge Complex would be expected to have negative impacts on Mottled Ducks.

(a). Wetlands Management and Restoration

Current wetland management and restoration activities on the Refuge Complex provide enhanced habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting.

Under Refuge Management Alternative E, structural marsh management and hydrological restoration projects on the Refuge Complex which currently help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl would be curtailed. Habitat values and use by Mottled Ducks would decrease.

On Anahuac NWR, the cooperative rice farming and moist soil management programs would be discontinued under this Alternative. This would result in loss of 800 -1,100 acres of shallow freshwater wetland habitat, and of the nutritious food sources provided by second growth rice and moist soil plants in these habitats. Rice farming and moist soil management provides reliable shallow freshwater wetland habitat throughout the year, including during the key recruitment periods of nesting and brood rearing.

(b). Uplands Management and Restoration

Under Refuge Management Alternative E, curtailment of native prairie restoration and management activities would decrease the quality of nesting habitat for Mottled Ducks on the Refuge Complex. Brush encroachment by exotic and native woody plants in salty and non-saline prairies would reduce the value of these habitats to Mottled Ducks and other ground-nesting avian species.

(c). General Habitat Management Activities

The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats currently used on the Refuge Complex creates a diverse habitat mosaic which provides ideal habitat conditions for Mottled Ducks and many other migratory bird species. As compared to current conditions, discontinuation of prescribed burning and grazing in marsh habitats under Refuge Management Alternative E would reduce the amount of optimal habitat for Mottled Ducks on the Refuge Complex. Overall under Refuge Management Alternative E, plant succession in marshes would trend toward higher successional plant communities, (primarily marshhay cordgrass in brackish and intermediate marshes), and physical structure towards more tall, dense stands of vegetation.

Salt prairies occur as a broad zone between coastal prairies and marshes, or more commonly on the Refuge Complex, as a ridge between marshes and bays or the Gulf of Mexico. These cordgrass ridges are dominated by Gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). Because of the near total loss of coastal prairie, salt prairie is now the most important Mottled Duck nesting habitat on the Refuge Complex.

Fire is necessary in the management of Mottled Duck nesting habitat in salty and non-saline prairies. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Under Refuge Management Alternative E, occurrence of lightning-ignited natural fires in salty and non-saline prairies would likely be so infrequent that brush encroachment would be widespread in these important nesting habitats.

Lack of control efforts for invasive plants and exotic animals under this Alternative would also reduce habitat quality for Mottled Ducks in wetland and upland habitats.

Marsh habitats being impacted by tidal overwash of the beach ridges on McFaddin and Texas Point NWRs provide important Mottled Duck production and brood rearing habitats. Based on field observations and capture rates during banding efforts, saltwater inundation has reduced Mottled Duck use of affected areas by as much as 50 to 65% over the last 10 years. Refuge Management Alternative E, increased frequency and magnitude of tidal inundation in these intermediate marshes would continue to negatively impact these habitats and Mottled Ducks.

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because of the wide diversity of habitat requirements by this category of birds, current USFWS habitat management and restoration activities on the Refuge Complex which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) is desirable. Discontinuing wetland and upland habitat management and restoration activities under Refuge Management Alternative E would negatively impact many shorebird, wading bird and marsh bird species currently found on the Refuge Complex. Curtailing prescribed burning and grazing under this Alternative would reduce the amount of optimal habitat for species requiring more open habitats, but increase habitat availability for some species requiring more dense stands of vegetation. Discontinuation of the cooperative rice farming and moist soil management programs would eliminate approximately 800-1,100 acres of shallow freshwater wetland habitat of high importance to many shorebird and wading bird species.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative E, structural marsh management and hydrological restoration projects on the Refuge Complex which currently help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl would be curtailed. Habitat values and use by many shorebird, wading bird and marsh and waterbird species would decrease.

Discontinuation of the cooperative rice farming and moist soil management programs would result in loss of 800 to 1,100 acres of important shallow freshwater wetland habitat. Rice farming and moist soil management result in increased abundance of invertebrates and plants that are a preferred food source for many avian species in this group (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002).

(b). Uplands Management and Restoration

Under Refuge Management Alternative E, curtailment of native prairie restoration and management activities would decrease the quality of upland habitats. Brush encroachment by invasive woody plants including Chinese tallow and Eastern baccharis would increase. Habitat quality and use by several species of shorebirds and marsh birds would decline. Impacted species would include three Avian Species of Conservation Concern (USFWS 2005): Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

As compared to current conditions, discontinuing prescribed burning and grazing in marsh habitats under Refuge Management Alternative E would reduce the amount of optimal habitat for shorebirds and wading bird species requiring more open habitats, but may provide additional habitat for some marsh bird species which utilize denser stands of vegetation. Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (*Emberizidae*) and wrens (*Troglodytidae*, Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*) (USFWS unpublished data) increase immediately post-burn. Overall, species requiring denser stands of vegetation in marsh habitats would benefit Refuge Management Alternative E, while the amount of habitat for species requiring more open habitats would decrease.

Stopping control efforts for invasive vegetation such as common reed, cattail, and California bulrush which form dense homogeneous stands would result in loss of open water habitats under this Alternative. Infestations of exotic invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would increase and also negatively impact these habitats. Loss of open water and associated submerged and floating plant communities would decrease habitat quality for many wading bird species.

(4). Impacts to Landbirds

Landbird species found on the Refuge Complex require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf Coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., Red-tailed Hawks and owls). Other landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

(a). Wetlands Management and Restoration

Under Refuge Management Alternative E, discontinuing wetland management and restoration activities including hydrological restoration, structural marsh management and marsh restoration would have negative impacts on several land bird species. This include land birds listed as Avian Species of Conservation Concern, the Seaside Sparrow and Sprague's Pipit (USFWS 2005), which currently benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

(b). Uplands Management and Restoration

Prairie Restoration and Management

Under Refuge Management Alternative E, discontinuing native prairie restoration and management activities would negatively impact habitat quality for several land bird species. Native prairie remnants and other upland grassland habitats on the Refuge Complex currently provide wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow and Nelson's Sharptailed Sparrow, and nesting habitat for species including Dicksissel and Eastern Meadowlark. These are also important nesting habitats for Mottled Ducks. Several species of raptors commonly observed on the Refuge Complex include Red-tailed Hawk, Red-shouldered Hawk, Turkey Vulture, American Kestrel, White-tailed Kite, Northern Harrier, and Short-eared Owl (USFWS, 1997a). Many other raptor species are observed during spring and fall migrations.

Brush encroachment by invasive woody plants including Chinese tallow and Eastern baccharis would increase under this Alternative. Habitat quality and use by several species of land birds would decline. Impacted species include species that are declining in the Coastal Prairies Region of Texas (Texas Parks and Wildlife Department 2000), and/or are among several species recently listed by the USFWS as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005). These include White-tailed Hawk, Loggerhead Shrike, Northern Bobwhite, Short-eared Owl, Sedge Wren, Nelson's Sharptailed Sparrow, Henslow's Sparrow, and LeConte's Sparrow.

Woodlot Restoration and Management

Under Refuge Management Alternative E, the USFWS would discontinue management activities which protect and diversify 60 acres of existing coastal woodlots and riparian woodlands on the Refuge Complex. Encroachment by Chinese tallow would decrease habitat quality for several neotropical migratory birds that require native trees or understory for cover and foraging. Impacted species on the Refuge Complex would include three neotropical migratory birds listed as Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler.

(c). General Habitat Management Activities

Under Refuge Management Alternative E, the USFWS would curtail prescribed burning and grazing on the Refuge Complex. Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested. Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife. In the short-term, decreased burning frequency under Refuge Management Alternative E could positively impact some species and negatively impact others. In the long-term, reduced habitat diversity under this Alternative will have an overall negative impact on land birds.

Under this Alternative, the USFWS would discontinue invasive plant and animal control activities. Rapid encroachment of Chinese tallow would occur and would lead to decreased diversity of native woody plants in the coastal woodlots, as well as decreased forage insects (especially Lepidopteran larvae) for

migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Under Refuge Management Alternative E, the USFWS would curtail several wetland management and restoration activities which currently protect, restore and enhance estuarine wetlands and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The present continuum of fresh to saline aquatic environments on the Refuge Complex supports highly diverse aquatic vertebrate and invertebrate communities. Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Under this Alternative, the USFWS would discontinue structural marsh management. This would have a short-term beneficial impact to certain marine organisms which spend a portion of their lifecycles in estuarine marshes by increasing ingress and egress to these habitats. Structural marsh management using water control structures and levees in managed marsh units can restrict access to managed areas for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Much of the work on fisheries use of flooded marshes has focused on saline marshes with a high component of *Spartina alterniflora* (Zimmerman *et al.* 1990, Baltz *et al.* 1993, Peterson and Turner 1994, Kneib and Wagner 1994, Minello *et al.* 1994, Rozas *et al.* 1998, Zimmerman *et al.* 2000). Brown shrimp, white shrimp, and blue crabs are associated with salt marsh dominated estuaries (Weinstein 1979, Wenner and Beatty 1993). Many of the salt marshes of the western Gulf coast are being impacted by rapid subsidence, sea level rise, saltwater intrusion and conversion to open water. Research has suggested that marsh conversion to open water will reach a point beyond which fisheries will decline due to a reduction of total marsh edge (Browder *et al.* 1989). Further, fisheries habitat gained due to marsh breakup is not sustainable in the long term (Browder *et al.* 1989, Condrey and Fuller 1992). Under this Alternative, the USFWS would discontinue hydrologic restoration, marsh restoration using dredge material, structural marsh management and shoreline restoration and protection, all of which restore and protect wetland habitats and help reduce rates of marsh loss. Ultimately, continued habitat loss and degradation would negatively impact fisheries resources.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring on the Refuge Complex are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth

green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Management Alternative E, protection, restoration and management of coastal wetland habitats on the Refuge Complex which currently benefit the three avian T&E species would be curtailed. Habitat quality and use by T&E species and other declining or sensitive species would decline

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found on the Refuge Complex include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals. Under this Alternative, curtailment of habitat management activities would result in invasion of grassland habitats by woody brush species, which may create more favorable habitat for certain mammals.

Current USFWS management activities on the Refuge Complex which maintain and restore freshwater wetland habitats such hydrological restoration, structural management of marshes, moist soil management and rice farming are particularly beneficial to amphibians and reptiles. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas. Conversion of fresh and intermediate marshes to brackish and loss of freshwater wetland habitat provided by rice farming and moist soil management under this Alternative would negatively impact most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators.

Under Refuge Management Alternative E, the USFWS would curtail prescribed burning. Fire frequency would decrease, but natural fires would burn hotter and likely burn larger acres. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates. Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil-litter stabilize." Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data).

Under Refuge Management Alternative E, the habitat mosaic created by the current integrated use of burning, grazing and water management in Refuge Complex wetland and upland habitats would become less diverse. Overall, this would have negatively impact resident fish and wildlife.

b. Impacts from Public Use Programs

Assuming a decrease in visitation to the Refuge Complex under Refuge Management Alternative E, overall disturbance impacts to fish and wildlife resources would likely decrease from current levels

described under Alternative A. Under this Alternative, the USFWS would generally decrease the scope of public use program management and oversight on the Refuge Complex, including field law enforcement. Consequently, the USFWS' ability to protect public safety, habitats and fish and wildlife resources would decline.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

The most direct effect of hunting on the Refuge Complex is the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually under the USFWS national migratory bird hunting regulation frameworks, and are designed to ensure that viable waterfowl populations are sustained over the long-term, continuation of the waterfowl hunting program on the Refuge Complex under Refuge Management Alternative C will not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichhoff 1976, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton *et al.* 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within Refuge Complex hunt areas would remain the same as under Alternative A and would include motorized boating (primarily in Oyster, Onion and East Bay bayous and East Galveston Bay on Anahuac NWR, in Salt Bayou, Clam Lake and Star Lake and hunt area access ditches on McFaddin NWR, and in Texas Bayou and its tidal tributaries on Texas Point NWR), non-motorized boating, motorized vehicles, and walking. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating. The continued maintenance of sanctuary areas on the Refuge Complex would be required to mitigate for disturbance impacts from hunting activities under Refuge Management Alternative E. Maintaining existing regulations under this Alternative would also be necessary help mitigate the impacts of hunting activity-related disturbance to waterfowl.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation

Under Refuge Management Alternative E, existing visitor facilities on the Refuge Complex would be maintained but no new facilities would be developed. Means of access for these uses and the presence of visitors results in disturbance impacts to waterfowl, as described under Alternative A. Decreased visitation would decrease these impacts.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from "out of vehicle" approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation

platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl is decreased in areas supporting these recreational uses.

(2). Impacts to other Migratory Birds - Shorebirds, Wading Birds, other Marsh and Waterbirds, and Landbirds

(a). Waterfowl Hunting

Although the disturbance impacts of waterfowl hunting under Refuge Management Alternative E on other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and land birds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

Under Refuge Management Alternative E, existing visitor facilities on the Refuge Complex would be maintained but no new facilities would be developed. As described under Alternative A, means of access and the presence of visitors result in disturbance impacts to migratory birds. Under Alternative E, decreased visitation would reduce these impacts.

Disturbance of migratory birds by visitors is likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from "out of vehicle" approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

(3). Impacts to Fisheries

(a). Fishing

The most direct effect of fishing on the Refuge Complex is the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing on the Refuge Complex occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term.

Continuation of fishing and crabbing on the Refuge Complex under Refuge Management Alternative E should not have any measurable effect on overall populations and the long-term viability of these species' populations.

(b). Hunting, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach and other Uses

No impacts to fisheries resources are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative E.

(4). Impacts to Threatened and Endangered Species

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that Bald Eagles, Brown Pelicans and Piping Plovers using Refuge Complex habitats would be subject to the some level of disturbance by public use activities under Alternative E. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three T&E avian species do not nest on the Refuge Complex, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on the Refuge Complex under Refuge Management Alternative E.

(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

As under Refuge Management Alternative A, it is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on the Refuge Complex, under Alternative E. These impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

(b). Commercial Alligator Harvest

Under Refuge Management Alternative E, the commercial adult alligator harvest program would no longer be administered as an economic use on the Refuge Complex. Alligator populations would be monitored. The long-term impact of curtailing harvest on alligator populations on the Refuge Complex is unknown. Initially, it is likely that alligator populations would increase. Alligator populations could reach densities at which migratory bird management objectives are compromised due to high levels of predation on Mottled Ducks and other nesting species. Potential impacts would also include increased damage to water management infrastructure and increased conflicts with the public.

(c). Control of Muskrat Populations

Under Refuge Management Alternative E, no active management of muskrat populations would occur. Muskrat populations would be monitored. Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion or other factors contributing to marsh loss. Under this Alternative, the potential for negative impacts to marsh habitats would increase.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

Under Refuge Management Alternative E, current surveys, monitoring and research activities for migratory birds, resident wildlife, fisheries and T&E species (described under Refuge Management Alternative A) would continue. Surveys and monitoring and research activities would help track and document impacts of a passive management approach on fish and wildlife resources on the Refuge Complex.

d. Impacts from Management of Oil and Gas Exploration and Development

Under Refuge Management Alternative E, the USFWS would continue to manage oil and gas exploration and development activities on the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on the Refuge Complex would be a reduced impact on fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Management Alternative E, Refuge staff would no longer coordinate with private landowners on partnership projects to restore and enhance native habitats on private lands.

The USFWS would continue partnerships with the Friends of Anahuac Refuge and the McFaddin and Texas Point Refuges Alliance, agencies including the Texas Parks and Wildlife Department, Texas General Land Office and Galveston Bay Estuary Program, conservation organizations such as Ducks Unlimited, the Galveston Bay Foundation and local Audubon Society chapters, community organizations and Refuge volunteers. The number and extent of partnership activities and projects would likely be less than current levels, due primarily to the reductions in refuge staff under this Alternative.

It is anticipated that reduced outreach and partnership efforts under Refuge Management Alternative E would result in decreased levels of habitat restoration and enhancement on the Refuge Complex and throughout the project area.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from management activities on the Refuge Complex occur in the regional economy in two different ways. First, there are the direct economic impacts that occur as a result of the economic stimulus of three elements: 1) direct expenditures made by the USFWS to manage operations at the Refuge Complex, 2) value of production from agricultural programs on the Refuge Complex; and 3) expenditures made by recreational visitors to the Refuge Complex. Second, there are indirect and induced economic impacts which are additional economic activity that occur as a result of the re-spending of these direct economic elements. The indirect and induced economic impacts are measured as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the direct economic elements. Total economic impacts (direct, indirect and induced) of for this management alternative were estimated using the data and methods discussed below. The analysis compares the impacts from Refuge Management Alternative E to the "No Action" management alternative, which would continue current activities.

The study area for purposes of estimating economic impacts is all of Jefferson and Chambers Counties along with a small portion of Galveston County, which includes the eastern portion of the Bolivar Peninsula east of Rollover Pass.

a. Direct Economic Impacts

(1). Value of Refuge Operations (Direct Expenditures)¹⁷

Table 4-34 Average Annual Operational Costs for the Refuge Complex – RM Alternative E (Direct Expenditures)			
Cost Category	Annual Average Expenditures		
	Year 1 - 5	Year 5 - 10	Year 10 - 15
Annual Staff Salaries	\$1,614,653	\$1,339,986	\$1,034,801
Utilities	\$35,000	\$35,000	\$35,000
Travel	\$39,123	\$39,123	\$39,123
Water Purchases	\$0	\$0	\$0
Heavy Equip. Rental and Replacement	\$0	\$0	\$0
Annual and Deferred Maintenance	\$28,000	\$28,000	\$28,000
Special Programs	\$0	\$0	\$0
Total Average Expenditures	\$1,716,776	\$1,442,110	\$1,136,924

Based on information about the activities proposed under this management alternative, an estimate of the operational expenditures was prepared. The estimate is broken out into five-year periods because it is expected that the amounts within certain cost categories would change with time under this management alternative. Because projects would occur throughout the study period, project costs will vary by year. In addition, changes in staffing would occur throughout the study period so salary costs vary annually as well. As the USFWS scales back active management at the Refuge Complex, direct expenditures on habitat management, operations and staffing will be reduced. The estimate of the annual average cost, per five-year period, for Refuge Management Alternative E is summarized in Table 4-34.

The estimate of Refuge Operation's direct expenditures under this alternative shows a decrease by more than half by the end of the planning period compared to the \$2,695,184 estimate under the "No Action" alternative.

(2). Value of Production from Refuge Agricultural Programs

(a). Cattle Grazing

Grazing is eliminated in this management scenario along with most other active management strategies. The estimated production value of \$2,103,678 for grazing activities under the "No Action" alternative is reduced to 0. A summary comparing the changes in AUMs and value of production between the "No Action" alternative and Refuge Management Alternative E is contained in Table 4-35.

Table 4-35 Estimated Production Value of Grazing Activities on Refuge Complex - RM Alternative E		
Alternative	Annual Average AUMS	Value of Annual Production
No Action Alternative	23,900	\$2,103,678
Refuge Management Alternative E	0	0

¹⁷ The Value of USFWS Operations Table is essentially done for the No Action Alternative (Alt. A). Under the remaining management alternatives (B through E), the USFWS will change the magnitude and intensity of management activities on the Refuge Complex. These actions will show increases or decreases from the baseline direct expenditures by the USFWS in the local economy as indicated in the Value Table above.

(b). Rice Production

Refuge Management Alternative E will eliminate the cooperative farm program at the beginning of the study period along with the grazing program. Therefore, the estimated annual value for rice production of \$249,867 under the "No Action" alternative would be reduced to 0. A summary comparing the changes in annual average acreage produced and value of production between the "No Action" alternative and Refuge Management Alternative E is contained in Table 4-36.

Table 4-36 Estimated Value of Rice Production on Refuge Complex - RM Alternative E		
Alternative	Annual Average Acreage Produced	Value of Annual Production
No Action Alternative	600	\$249,867
Refuge Management Alternative E	0	0

(3) Value of Refuge Recreational Programs

For each Refuge Management alternative, assumptions were made on how proposed management changes would affect visitation during the study period. These changes are expressed as increases or decreases in the number of non-resident recreational visitors under the "No Action" alternative. The estimated changes in recreational visitors under this alternative are broken out by recreational activity as follows:

<u>Activity</u>	<u>Change</u>
Waterfowl Hunting	10% Decrease
Upland Bird Hunting	No Change
Fishing	No Change
Wildlife Observation	5% Decrease

These changes were then applied to the estimate of annual non-resident visits and the estimate of itemized expenditures by recreational activity which were developed for the "No Action" alternative. Table 4-37 contains a summary of the comparison of the annual direct expenditures associated with recreational visitors to the Refuge Complex between the "No Action" alternative and Refuge Management Alternative E.

Table 4-37 Annual Direct Expenditures Associated with Recreational Visitors on Refuge Complex - RM Alternative E		
Alternative	Annual Non-resident Visitors	Total Recreational Expenditures
No Action Alternative	35,010	\$1,098,923
Refuge Management Alternative E	33,438	\$1,018,007

b. Indirect and Induced Economic Impacts

Indirect and Induced economic impacts are described as the changes in employment, income and indirect business taxes that occur in the regional economy as a result of the economic stimulus of the following three elements: direct expenditures made by the USFWS to manage operations at the Refuge Complex, value of agricultural production on the Refuge Complex, and the direct expenditures made by recreational visitors to the Refuge Complex. These direct expenditures create additional economic activity, the indirect and induced impacts, as re-spending of the direct expenditures occur. The indirect and induced impacts are estimated by using a series of economic multipliers applied to the estimates of the direct economic impacts of USFWS activities. IMPLAN was used to apply economic multipliers to the direct economic elements valued above to arrive at an estimate of the indirect and induced impacts to

employment, income and indirect business taxes in the study area that can be attributable these USFWS activities.

The indirect and induced economic impacts are measured in the four following areas:

Employment: The annual average estimated employment is measured as Full-Time Equivalents (FTEs). Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part time schedules converted to a full-time basis. This includes direct employment at the Refuge Complex (approximately 30 FTEs at this time) as well as the additional employment supported in the surrounding area.

Labor Income: Labor income includes employee compensation and proprietary income. Employee compensation is the total wages and salaries of workers who are paid by employers, as well as the value of benefits such as health care, life insurance, retirement payments, and non-cash compensation. Proprietary income consists of payments received by self-employed individuals as income.

Other Property Type Income: This type of income is payments in the form of rents, royalties, dividends, and includes corporate profits.

Indirect Business Taxes: Indirect business taxes include excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses.

(1). Refuge Operations

The comparison between the indirect and induced economic impacts attributable to Refuge Operations for Refuge Management Alternative E and the "No Action" alternative is summarized in Table 4-38.

Table 4-38. Indirect and Induced Economic Impacts of Operations at Refuge Complex – RM Alternative E			
	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	45	45	45
Refuge Management Alternative E	31	27	22
Labor Income			
No Action Alternative	\$1,066,457	\$1,066,457	\$1,066,457
Refuge Management Alternative E	\$641,785	\$553,290	\$464,795
Other Property Type Income			
No Action Alternative	\$222,664	\$222,664	\$222,664
Refuge Management Alternative E	\$25,065	\$25,065	\$25,065
Indirect Business Taxes			
No Action Alternative	\$493,149	\$493,149	\$493,149
Refuge Management Alternative E	\$439,499	\$377,526	\$315,553

(2). Refuge Agricultural Program

The comparison between the indirect and induced economic impacts attributable to agricultural activities, cattle grazing and rice farming, on the Refuge Complex for Refuge Management Alternative E and the "No Action" alternative is summarized in Table 4-39.

Table 4-39 Indirect and Induced Economic Impacts of Agricultural Activities at Refuge Complex – RM Alternative E			
	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	20	20	20
Refuge Management Alternative E	0	0	0
Labor Income			
No Action Alternative	\$587,382	\$587,382	\$587,382
Refuge Management Alternative E	\$0	\$0	\$0
Other Property Type Income			
No Action Alternative	\$272,759	\$272,759	\$272,759
Refuge Management Alternative E	\$0	\$0	\$0
Indirect Business Taxes			
No Action Alternative	\$87,668	\$87,668	\$87,668
Refuge Management Alternative E	\$0	\$0	\$0

This Table reflects the elimination of both the Grazing Program and the Cooperative Farming Program under Refuge Management Alternative E.

(3). Refuge Recreational Programs

The comparison between the indirect and induced economic impacts attributable to expenditures by recreational visitors at the Refuge Complex for Refuge Management Alternative E and the "No Action" alternative is summarized in Table 4-40.

Table 4-40 Indirect and Induced Economic Impacts of Recreational Activities at Refuge Complex – RM Alternative E			
	Annual Average		
	Year 1 - 5	Year 6- 10	Year 11 - 15
Employment (FTEs)			
No Action Alternative	25	26	26
Refuge Management Alternative E	22	18	14
Labor Income			
No Action Alternative	\$609,908	\$621,374	\$629,040
Refuge Management Alternative E	\$612,891	\$423,679	\$347,310
Other Property Type Income			
No Action Alternative	\$224,963	\$229,144	\$231,939
Refuge Management Alternative E	\$193,175	\$156,187	\$127,938
Indirect Business Taxes			
No Action Alternative	\$136,816	\$139,559	\$141,394
Refuge Management Alternative E	\$117,599	\$95,644	\$78,894

2. Population Impacts

Management actions associated with the Refuge Complex are not expected to have notable impacts on population trends within the study area. Population trends in Jefferson and Chambers counties have shown increases in recent years though these increases are likely not influenced by activities at the Refuge Complex. Any population change that could be associated with implementation of alternatives under consideration in the EIS would likely be linked to employment changes. Under Refuge Management Alternative E, employment associated with the Refuge Complex is expected to fall by nearly half relative to the No Action Alternative. While the decline in employment resulting from this alternative is not expected to have significant impacts to population in the two county study area, there may be noticeable changes to overall employment in some local, largely rural areas which are closest to the Refuge Complex (e.g. Anahuac).

3. Fiscal Impacts on Local Governments

Refuge management has the potential to impact the fiscal conditions of local government entities. This fiscal effect could be on revenues and/or expenditures. The "Economics Impacts" section above has already evaluated impacts from the various current refuge management activities on indirect business taxes. In addition to the increased indirect business taxes, the USFWS makes substantial payments to local governmental entities under the Refuge Revenue Sharing Act.

Changes in demand for government services could vary with changes in population tied to the Refuge Complex and could cause undue strain on infrastructure (e.g. roads, utilities, schools, etc). As discussed above, since notable population changes are not expected, identifiable changes in demand for government services due to changes in population are not expected. Changes in recreation activities could also cause some impacts to local government services through changes in demand though they are not expected to be notable under current management or any of the proposed alternatives.

Management actions can also affect local government services directly. For instance, the USFWS currently purchases water from the Chambers Liberty Counties Navigation District (District) to support its management activities. This provides positive impacts to this local District that has experienced a decrease in water purchases due to a decline in rice production in the area. These water purchases would likely cease under Refuge Management Alternative E with the discontinuation of the cooperative rice farming program.

4. Social Impacts

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, natural resource management actions such as those made by the USFWS on the Refuge Complex. Additionally, Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

a. Impacts to Social Structures and Lifestyles

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them)
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions)
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and/or community cohesiveness and stability)

- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others)

The interactions between USFWS activities and people are already evident in the area. Current direct and indirect interactions between the USFWS and the local and regional population base include visitation to the refuges (e.g., recreation opportunities), participation in USFWS volunteer programs, an awareness of refuge activities (but not direct participation in these activities), or simply driving by the Refuge Complex land holdings. These interactions would basically remain the same for the vast majority of the nearby population under any of the Refuge Management Alternatives being considered in this EIS, and there would be a relatively small magnitude and frequency of “new” impacts since the USFWS has been managing lands within the Refuge Complex for many years.

Additionally, implementation of any of the Refuge Management Alternatives would not lead to substantial new population or changes in the demographic or other characteristics of the existing population. One of the most important causes of potentially significant social effects is a new population that is 1) relatively large in relation to the existing population, and/or 2) demographically or socially different than the existing population. Since there would be little change in population or demographics directly or indirectly from any of the alternatives, this cause/effect relationship is not of concern in this EIS analysis.

Overall, most people’s lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Issues would arise when management activities are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and have localized impacts include water management and prescribed fire activities.

b. Impacts to Relationships between the USFWS and Stakeholder Groups

General categories of stakeholder groups describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A summary of potential future relationships between the USFWS and stakeholder groups follows. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by USFWS management activities on the Refuge Complex:

- Residents and/or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and/or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities and objectives under all the Refuge Management Alternatives may in some cases conflict with some of the goals, beliefs, and objectives of many of the local stakeholders. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and to find a proper balance to its activities. However, socioeconomic issues would continue to exist among the various stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions; many of these issues would remain unresolved in the future as discussed later in this section.

c. Impacts to USFWS Public Outreach Programs and Activities

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and/or desire in regard to the management of the Refuge Complex. Under Refuge Management Alternative E, current USFWS public outreach efforts would continue but likely at reduced levels.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The following is a summary of socioeconomic issues associated with USFWS activities at the Refuge Complex. The proposed USFWS management actions under the Refuge Management Alternatives would have no major effect on the existence or resolution of these current issues. Under any of the Refuge Management Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and/or management of the Refuge Complex.
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions.
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area.
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under Refuge Management Alternatives B through E, management philosophies and priorities would change from current conditions. The USFWS management of the Refuge Complex would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values; however, the philosophy of the primary management approach would differ for each Refuge Management Alternative. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure/lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all Refuge Management Alternatives, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While the Refuge Management Alternatives support different philosophies and priorities, and the differences among Alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the Refuge Complex would generally remain the same as current conditions.

d. Environmental Justice

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex EIS/CCP/LPP is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both adverse and beneficial effects by the continued operation and/or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and/or low-income population components. Overall, the identified minority and/or low-income populations would not be disproportionately affected compared to other segments of the general population in the area.

Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Management Alternatives would be in compliance with EO 12898.

VI. IMPACTS TO CULTURAL RESOURCES FROM REFUGE MANAGEMENT ALTERNATIVES

Impacts on Cultural Resources

Impacts on cultural resources can include inundation, destruction, damage, and/or disruption. Impacts can directly result from ground-disturbing activities or indirectly from human use or land use and management. Potential ground-disturbing activities include facilities construction, road construction, ditch digging, oil and gas activities, and water control projects (such as levee construction, repair, or removal). Human use activities include increased public access and watercraft wakes. Intense wildfires and cattle tromping may indirectly impact cultural sites as well. Natural phenomenon may also impact cultural sites through inundation, wind/water/wave erosion, subsidence, tree bioturbation, and animal burrowing.

Impact Analysis for Refuge Management Alternatives

There is a potential for direct and indirect impacts to cultural sites under all of the Refuge Management alternatives; however, avoidable impacts would not be considered adverse, but rather minor in nature. Unavoidable adverse impacts are anticipated to continue to occur at potentially eligible sites from natural phenomenon.

Natural impacts, including inundation, wind/water/wave erosion, subsidence, tree bioturbation, and animal burrowing, poses the greatest threat to shell middens. Due to the marshy, undeveloped nature of the Refuge Complex and location of the shell middens along shorelines, full protection of the shell middens is not feasible without completely altering the site or removing the material from its context. Inundation of many of the sites has already occurred and the unavoidable adverse impacts are highly likely to continue. The eligible McFaddin beach site is already inundated by the naturally altered coastline and is subject to water erosion and loss of material. Cultural resource management actions are not proposed for the shell midden sites under the Refuge Management alternatives. Existing and proposed shoreline protection projects and water control structures under Refuge Management Alternatives A, B, C, and D would reduce wave fetch and intensity of wave action and shoreline protection projects may indirectly benefit shoreline sites by reducing wave intensity under these Refuge Management alternatives. Discontinuing water management and erosion abatement under Refuge Management Alternative E would reduce the protection of the middens indirectly afforded by these management actions.

Ground disturbing activities, including facilities construction, road construction, ditch digging, oil and gas activities, and water control projects (such as levee construction, repair, or removal), would be subject to a ground survey and consultation requirements with the State Historic Preservation Officer (SHPO) under the NHPA Section 106 regulations. Privately initiated oil and gas activities create ground disturbance in the Refuge Complex with road, pipeline, and well pad construction. Any dredge or fill projects in the Refuge Complex proposed and conducted by the U.S. Army Corps of Engineers under all Refuge Management alternatives, including shoreline and marsh restoration projects, would be subject to the Section 106 process and potential impacts to the NHRP eligible sites. All ground-disturbing activities, whether initiated by the USFWS or other entities, would be subject to restrictions imposed on Refuge Complex lands and consultation with the SHPO under Section 106 regulations. The potential for any ground-disturbing activities to impact known sites or undiscovered sites would be identified and resolved appropriately through the Section 106 process.

Maintenance of existing shoreline protection projects and water control infrastructure as well as additional water management projects under Refuge Management Alternatives A, B, C, and D may result in the identification of additional cultural resources sites and better protection of the sites from wake action. Because water control and facilities construction and improvements occur more frequently under Refuge Management Alternatives C and D, cultural resources may indirectly benefit. Discontinuing water control management under Refuge Management Alternative E may lead to increased erosion of shell middens along shorelines indirectly over time.

The burn intensity of fires may affect archaeological and historical resources. Low-intensity burns are usually associated with lightly burned grasslands during prescribed burns. Low-intensity burns are not anticipated to affect cultural resources, but may cover the resources in soot. High-intensity burns are typically associated with wildfires in dry areas that have abundant litter accumulation due to unnatural fire suppression. High-intensity fires may char or consume cultural resources leading to a potential impact. There is very little likelihood of a high-intensity fire occurring since the Refuge Complex is primarily wet, has high soil moisture content, and was subject to burning by Native Americans, present-day natural resource managers, and lightning-ignited fires. According to the Fire Management Plan (2001), wildland fires on the Refuge Complex are rarely controlled with suppression tactics, firebreaks, or chemical retardants, which are only used sparingly if necessary to protect life and/or property. Natural wildfires are suppressed only when they threaten Refuge Complex facilities, adjacent private property, and/or public health and safety. Rotational prescribed burning considered in Refuge Management Alternatives A, B, C, and D would reduce the potential for damage to cultural resources from intense wildfires. Reliance on natural lightning starts only under Refuge Management Alternative E may lead to more fuel accumulation and higher intensity fires; however, due to the high soil moisture, severe damage is not anticipated and minor charring, at worst, may occur on the surface of cultural sites in the long-term.

Cattle grazing may damage cultural resources by inadvertent tromping. Some of the shell midden sites recorded have already experienced damage by cattle tromp. Cattle on the Refuge Complex typically feed as they disperse in the wet areas and congregate on higher, dry grounds, which typically include manmade 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 tromp is not likely to be exceeded by damage through natural erosion. The potential for inadvertent cattle tromping is likely to occur under Refuge Management Alternatives A, B, C, and D. Inadvertent tromping is not anticipated under Refuge Management Alternative E in which grazing is discontinued.

Refuge visitors and their activities may inadvertently damage cultural sites; however, recreational access to the Refuge Complex is limited by the under-developed character of the area. Recreational activities are limited to Anahuac, McFaddin, and Texas Point NWRs. Bird and wildlife observation, fishing, and hunting would continue under all management alternatives and typically occur in previously disturbed areas. Minor improvements to recreational access, such as trails and boat launches is limited to existing developed areas under Refuge Management Alternatives B, C, and D and would be subject to ground truthing for cultural items before disturbance. Bird and wildlife observation is typically limited to easily accessible areas that comprise a small portion of Refuge Complex lands, where existing shell midden sites are typically not found. Fishing and hunting recreationalists may reach more remote areas by boat. Most of the recreational boat traffic occurs on the interconnected manmade bayous, ditches, and water delivery systems that have already be modified from their original landforms through straightening and dredging. 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 public interpretation and education programs under Refuge Management Alternatives A, B, C, D, and E may indirectly lead to improved public appreciation and awareness of the Refuge Complex lands and resources contained therein. Public appreciation and awareness would be promoted most under Refuge Management Alternative D and least under Refuge Management Alternative E.

VII. IMPACTS COMPARISON TABLE FOR THE REFUGE MANAGEMENT ALTERNATIVES

The impacts discussed in detail in the preceding section, *Part A: Impact Analysis for the Five Refuge Management Alternatives*, are summarized and condensed in the following table. The impacts under the "No Action" Alternative A are the base of comparison for the other four "Action" Refuge Management Alternatives. The table is organized by resource area, the same way the detailed impact analysis in Part A is organized. The table allows for a quick comparison of the impacts in a specific resource area between Alternatives.

NO ACTION ALTERNATIVE	ACTION ALTERNATIVES			
	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
Impacts to Air Quality				
Potential smoke impacts to air quality from USFWS prescribed burns on 12-15,000 acres annually	Potential smoke impacts to air quality increased by expanding prescribed burns to 35,000 acres annually. Decreased potential for smoke impacts from wildfires	Potential smoke impacts to air quality decreased by reducing prescribed burns to 5-6000 acres annually. More potential smoke impacts from wildfires	Same as RM Alternative A.	Prescribed burning discontinued; more potential for smoke impacts to air quality from wildfires
Impacts to Geology and Soils				
Shoreline protection & marsh restoration help reduce coastal land loss. Water management and prescribed burning may contribute to organic soil formation.	Same as RM Alternative A. Additional prescribed burning and structural marsh management may contribute to enhanced organic soil formation	Substantial increase in shoreline protection & restoration using dredge material through expanded interagency coordination.	Same as RM Alternative A. Substantial increase in shoreline protection and marsh restoration using dredge material through expanded interagency coordination. Expanded monitoring and research on factors affecting coastal land loss.	Discontinued shoreline protection & restoration projects resulting in increased coastal land loss and saltwater intrusion.
Impacts to Hydrology and Water Quality				
Extensive water management helps maintain historic continuum of coastal marsh habitats by reducing saltwater intrusion, managing water levels, and providing freshwater inflows. Protects nationally-declining wetland types.	Same as RM Alternative A. Water management enhanced by two new marsh semi-impoundments of 6500 acres.	Expand interagency coordination on watershed-scale hydrologic restoration projects to reduce saltwater intrusion and increase freshwater inflows. Acquire additional water rights.	Same as RM Alternative A. Expand interagency coordination on watershed hydrologic restoration projects, enhance water management, and acquire additional water rights. Expand water quality monitoring.	Active water management & restoration discontinued resulting in saltwater intrusion, loss of freshwater & altered hydroperiods.

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
Impacts to Vegetation/Habitats				
Impacts from Habitat Management and Restoration Activities				
<p>Structural marsh management helps maintain/restore historic continuum of coastal marshes and plant & animal communities that are dependent on these habitats. Moist soil units and cooperative rice farming provide high quality freshwater wetland habitat for migratory birds. Native prairie restored and coastal woodlots protected. Integrated burning, grazing & water management creates and maintains diverse plant communities. Integrated Pest Management (IPM) program helps control exotic and invasive plant & animal species. Shoreline protection & restoration beneficially protects wetland habitats.</p>	<p>Added marsh semi-impoundments, expanded moist soil and cooperative rice farming increase provide additional wetland habitats for migratory birds. Reduced scope of prairie restoration. Expanded burning and grazing programs enhance wetland and upland habitats for waterfowl and other migratory birds. IPM program, shoreline protection same as RM Alternative A.</p>	<p>Hydrologic restoration to restore freshwater inflows. Cooperative rice farming phased-out with expanded restoration to native prairie and wetlands. Native prairie plant associations increased by restoring 4535 acres to native prairie (a Globally Imperiled habitat) & 29 acres to woodlands. Reduced burning and grazing. IPM program expanded to additional areas. Expand interagency coordination efforts to increase shoreline and marsh protection & restoration.</p>	<p>Enhanced structural marsh management same as Alt. A. Expanded moist soil units and same levels of cooperative rice farming. Native prairie plant associations increased by restoring 2223 acres to native prairie & 29 acres to woodlands. Refined burning and grazing to increase benefits to migratory birds and other wildlife. IPM program expanded to additional areas. Expand interagency coordination efforts to increase shoreline protection and marsh restoration. Additional monitoring and research to assess threats to habitats.</p>	<p>Active marsh management ends resulting in saltwater intrusion, loss of freshwater inflows, and altered hydro-periods. Moist soil units and coop rice farming terminate. No active habitat restoration. End of prescribed burning and grazing results in higher successional plant communities. End of IPM program results in increased populations of exotic/invasive plant and animal species. Shoreline protection & restoration discontinued increasing rate of shoreline retreat and coastal land loss, including conversion of vegetated marshes to open water.</p>
Impacts from Public Use Programs				
<p>Some impacts to wetland vegetation, primarily from motorized boating (associated with hunting/fishing) and local impacts to habitats in heavily used areas. Regulations help ensure that Impacts are localized and not substantial</p>	<p>Same as RM Alternative A.</p>	<p>Same as RM Alternative A, except for reduced impacts in wetland habitats due to decrease in hunting use.</p>	<p>Same as RM Alternative A except with potential to increase with overall increase in visitation.</p>	<p>Same as RM Alternative A except less extensive with overall decrease in visitation.</p>

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
Impacts to Vegetation/Habitats				
Impacts from Biological Program, Management of Oil & Gas Exploration/Development, and Community Outreach and Partnerships				
Surveys & monitoring support an adaptive habitat management approach. Oil & gas management minimized impacts to habitats. Outreach and partnerships result in additional habitat restoration/enhancement.	Same as RM Alternative A.	Same as RM Alternative A with more focus on restoration and enhancement of native prairie & coastal woodlot habitats.	Same as RM Alternative A with expanded monitoring and research to guide habitat management and restoration and improve exotic and invasive species management. Expanded outreach and partnerships increase habitat restoration and protection.	Surveys and monitoring only document impacts of passive management. Oil & gas management same as RM Alternative A. Reduced outreach & partnerships results in little habitat restoration or enhancement.
Impacts to Fish and Wildlife Resources				
Impacts from Habitat Management and Restoration Activities				
Management/restoration activities have greatest beneficial impact on wintering, resident and migrating waterfowl. Management activities which result in a mosaic of diverse habitats positively impact other avian species. Activities which maintain/restore productive wetland habitats benefit fisheries in long-term. Management aimed at ensuring biological diversity & ecological integrity benefit T&E and declining species. Most other wildlife species benefit from management activities.	Focus on enhancing waterfowl habitats provide additional benefits for wintering, resident and migrating waterfowl and other wetland-dependent birds. Impacts on fisheries, T&E species and other wildlife species generally same as RM Alternative A.	Emphasis on restoration with less water management reduces benefits to waterfowl and other wetland-dependent migratory birds. Prairie restoration and woodlot protection benefit many declining species. Impacts on fisheries, T&E species and other wildlife generally same as RM Alternative A.	Expanded and enhanced management results in a diverse habitat mosaic which increases benefits to wintering waterfowl, Mottled Ducks, shorebirds, wading birds and other wetland-dependent migratory birds. Prairie restoration and woodlot protection benefit many declining landbird species. Overall, this Alternative provides greatest diversity of habitats benefiting several Avian Species of Conservation Concern. Increased beneficial impacts to fisheries by incorporating fish passage into water management protocols. Impacts to T&E species and other wildlife species same as RM Alternative A.	Discontinued management would decrease habitat values and use by waterfowl and other migratory birds. Habitat values and use by other avian species would also decrease. Curtailed wetland management has short-term benefit for fisheries but habitat loss/degradation of coastal wetlands would have long-term negative impact. Passive management has negative impacts on T&E and other wildlife species.

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
Impacts to Fish and Wildlife Resources				
Impacts from Public Use Programs				
Waterfowl harvest managed through regulations has no impacts on overall populations & long-term viability of these populations. Sanctuary areas mitigate disturbance impacts from hunting. Minimal disturbance impacts to other wildlife species from other wildlife-dependent recreational activities. No impacts to T&E species or fisheries.	Same as RM Alternative A.	Same as RM Alternative A.	Increase in all types of visitation expected to result in minimal, localized increase in impacts to migratory birds and other wildlife. No change in impacts to T&E species or fisheries.	Expected overall decrease in visitation over time would decrease impacts. No impacts to fisheries or T&E species.
Impacts from Biological Program, Management of Oil & Gas Exploration/Development, and Community Outreach and Partnerships				
Surveys and monitoring track & document impacts of management strategies on fish & wildlife supporting adaptive management approach. Oil & gas management reduces impacts on fish & wildlife. Outreach & partnerships result in benefits to fish & wildlife as habitats are restored or enhanced.	Same as RM Alternative A except with more benefits from expanded outreach & partnerships.	Same as RM Alternative A except with more benefits from expanded outreach & partnerships especially in restored prairie woodland habitats.	Expansion of all programs would enhance benefits to fish and wildlife resources. Additional monitoring and research focuses on priority avian and other wildlife species.	Surveys and monitoring would only document impacts from passive management approach. Continued oil & gas management reduces impacts on fish & wildlife. Reduced outreach and partnerships reduce habitat restoration/enhancement and benefits to fish & wildlife.

RM Alternative A	RM Alternative B	RM Alternative C	RM Alternative D	RM Alternative E
Economic Impacts				
<p>Refuge operations contribute \$2.7m* direct to local economy & refuge agriculture programs add \$2.1m* (grazing) and \$.25m* (rice farming). Direct expenditures by recreational visitors contribute another \$1.1m*. Indirect & induced economic impacts from these direct impacts contribute an estimated \$3.3m* more to local economies. *m = million \$</p>	<p>Increased direct contributions from refuge operations by 10%, from grazing by \$.5m*, rice farming by \$.16m*, and recreational visitors by \$.1m*. Corresponding increases in indirect & induced economic impacts from increases in direct impacts.</p>	<p>Increased direct contributions from refuge operations by 25%, but substantial decrease from grazing by \$1.1m* and rice farming by \$.25m*. Very small increase in direct expenditures by recreational visitors. Corresponding increases or decreases in indirect & induced economic impacts dependent on direction of change in direct impacts.</p>	<p>Substantial increase in direct contributions from refuge operations by \$1.0m*. Smaller increases in grazing, \$.3m* & recreational visitors, \$.2m* but rice farming same as Alt. A. Corresponding increases in indirect & induced economic impacts with increases in direct impacts.</p>	<p>Major decreases in direct contributions from refuge operations (by more than half by end of planning period) along with complete elimination of all refuge agricultural programs. Small decrease in direct expenditures by recreational visitors. Corresponding major decreases in indirect & induced economic impacts with decreases in direct impacts.</p>
Impacts on Population, Fiscal Impacts on Local Governments, and Social Impacts				
<p>No environmental justice or population impacts. Payments to local gov't entities under Refuge Revenue Sharing Act. Social conditions remain generally unchanged with unresolved issues.</p>	<p>Same as Refuge Management Alternative A.</p>	<p>Same as Refuge Management Alternative A.</p>	<p>Same as Refuge Management Alternative A.</p>	<p>Same as Refuge management Alternative A except for small localized reduction in employment in a rural area.</p>

PART B: IMPACT ANALYSIS FOR FOUR REFUGE BOUNDARY EXPANSION ALTERNATIVES

Summary of Refuge Boundary Expansion Alternatives

The four Refuge Boundary Expansion Alternatives are graphically depicted on the maps beginning on page 86 of Chapter 2, Part B. The following is a summary describing each of the Refuge Boundary Expansion Alternatives and the focus for each one:

Refuge Boundary Expansion Alternative A (NEPA No Action Alternative) - No Expansion, Current Status

This Alternative assumes no change from the existing refuge boundaries within the Refuge Complex. This is the “No Action” alternative as required under NEPA and is considered the base from which to compare the other Refuge Boundary Expansion Alternatives. There would be no expansion of any of the four refuge boundaries within the Refuge Complex.

Refuge Boundary Expansion Alternative B - 33,590 Acre Expansion

This Alternative continues the four refuges’ historic focus on land acquisition primarily in the coastal marsh and the adjacent agricultural uplands. Acquisition would continue to focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. This Refuge Boundary Expansion Alternative concentrates on high-value wintering waterfowl habitats near the coast that are contiguous to existing refuges. In addition to these high biological value wetland habitats, this Alternative also includes areas adjacent to existing refuges identified as necessary for refuge management. Expansion is proposed for each of the four refuges in the Refuge Complex.

Refuge Boundary Expansion Alternative C (Preferred Alternative) - 64,260 Acre Expansion

Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative B. Similar to Refuge Boundary Expansion Alternative B, this Alternative continues the four refuge’s historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetland portions of this Refuge Boundary Expansion Alternative concentrate on high-value wintering waterfowl habitats near the coast that are contiguous to existing refuges. In addition to these primarily wetland areas, this Alternative includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks, many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. In addition to these two kinds of high biological value habitats, this alternative also includes areas adjacent to existing refuges identified as necessary for refuge management. Expansion is proposed for each of the four refuges in the Refuge Complex.

Refuge Boundary Expansion Alternative D - 104,120 Acre Expansion

Please note that this alternative includes all of the lands in the preceding Refuge Boundary Expansion Alternative C. Similar to Refuge Boundary Expansion Alternative C, this alternative continues the four refuge’s historic focus on land acquisition primarily in the coastal marsh and adjacent agricultural uplands. Much of the acquisition would still focus on habitats of particular value to the waterfowl resource and other wetland-dependent migratory birds. The wetlands portions of this Refuge Boundary Expansion Alternative concentrate on high-value wintering waterfowl habitats near the coast which are contiguous to existing refuges. In addition to these primarily wetland areas, this Alternative includes two areas of important native coastal prairie with high habitat value for resident Mottled Ducks,

many species of grassland-dependent migratory birds, and a wide variety of other native wildlife species. This Alternative also includes an important near-coast bottomland hardwood area, which is an acquisition target new to this Refuge Complex. The primary habitat type in this area is forested wetlands which provide high quality wintering, migrational, and nesting habitats for waterfowl and other wetland-dependent migratory bird species, and important migration stop-over habitats for many neotropical migratory birds making trans- and circum-Gulf migrations. Finally, in addition to these various kinds of high biological value habitats, this Alternative also includes areas adjacent to existing refuges identified as necessary for refuge management.

The estimated acreage for each proposed expansion (Alternative A – D) is summarized for each of the four refuges in the Refuge Complex in Table 4-41.

Refuge	Estimated Acreage			
	Alternative A "No Action"	Alternative B	Alternative C	Alternative D
Moody	0	5,050	7,920	7,920
Anahuac	0	20,500	47,750	64,910
McFaddin	0	7,190	7,190	29,890
Texas Point	0	850	1,400	1,400
Total	0	33,590	64,260	104,120

Assumptions

- **The impacts for the Refuge Boundary Expansion Alternatives are analyzed assuming that all of the lands within an expansion area would be acquired in fee simple within the first year following approval of that proposed boundary expansion. This assumption assures that the maximum possible impacts are addressed even though the proposed "willing seller" acquisition program would obviously not produce this result.**
- **The impacts for the Refuge Boundary Expansion Alternatives are analyzed assuming that the lands within the existing Refuge Complex and those lands acquired in the future would be managed according to the strategies contained in Refuge Management Alternative D, the Preferred Alternative.**

Impacts to Cultural Resources

The impacts to cultural resources on the Complex from the actions proposed in the Refuge Boundary Expansion Alternatives are discussed in a separate section at the end of this part. The impacts for all of the alternatives are grouped together in one discussion because the impacts are very similar and only differ in quantity of acreage proposed for acquisition.

Organization of Impact Analysis

As in Part A of this Chapter, all of the impacts for Refuge Boundary Expansion Alternative A (No Action) will be presented in its own separate section. The impacts occurring under this Alternative become the base for comparison of the impacts from the other "action" alternatives.

Impacts for the other three Refuge Boundary Expansion Alternatives will be presented together in one section. This is done because the impacts from each of the three "action" alternatives are the same and differ only in quantity depending on the size of the expansion proposal. The only exception is the impact to the development potential in Taylors Bayou within Refuge Boundary Expansion Alternative D and this impact is described separately.

I. IMPACT ANALYSIS FOR REFUGE BOUNDARY EXPANSION ALTERNATIVE A (NO ACTION) NO EXPANSION, CURRENT STATUS

Overview

Under Refuge Boundary Expansion Alternative A, the refuge boundaries would not be expanded. Lands within the proposed boundary expansion areas in Refuge Boundary Expansion Alternatives B, C and D would not be acquired by the USFWS, and would likely remain in private ownership. Current land uses within the areas identified in Refuge Boundary Expansion Alternatives B, C, and D are primarily agricultural, and include livestock grazing and rice farming. Many privately-owned agricultural properties in the project area are leased by individuals or commercial guides and outfitters for waterfowl hunting and dove hunting. These uses would likely continue as long as they are economically beneficial to the landowner.

Rice farming, which can provide valuable wildlife habitat when managed for those purposes, is declining in the project area. Much of the acreage in the USDA farm program in Chambers and Jefferson counties is now either fallow or has been converted to improved pasture. Fallow rice fields and improved pasture are now being managed primarily for cattle grazing. Areas not grazed are quickly invaded by exotic plant species, particularly Chinese tallow and deep-rooted sedge. Once infested, these areas provide few benefits for wildlife and require restoration at significant costs to resume rice production or provide suitable pasture for cattle.

Changes in land ownership patterns in the project area may be impacting the extent to which management on private lands specifically includes providing enhanced habitats for fish and wildlife. Many large land holdings formerly owned and managed under single ownership have been divided into multiple ownerships. In many of these cases, land management for wildlife which formerly occurred over large areas is now less likely to occur.

Some land owners in the project area are intensively and very successfully managing properties to enhance wetland habitats for wintering waterfowl, and agricultural practices such as rice farming and cattle grazing can provide substantial benefits to waterfowl and other migratory birds. Overall within the project area, however, economic considerations other than fish and wildlife benefits dictate land uses and land management practices on private lands. This will likely continue to be the case under Refuge Boundary Expansion Alternative A.

Under Refuge Boundary Expansion Alternative A, future land uses would be subject to the discretion of the landowners. Land could remain undeveloped with continued agricultural uses, or be converted to other uses such as residential, recreational or industrial development.

The authorized acquisition boundary for each of the refuges would remain as it is today. The USFWS would continue to manage the lands already acquired and could only acquire the remaining lands, if any, within their existing boundaries.

Summary of Current Land Acquisition Status:

<u>Refuge</u>	<u>Approved Boundary</u>	<u>Acquired Lands</u>	<u>Percent Acquired</u>
Moody NWR	3,516 acres	3,516 acres	100%
Anahuac NWR	34,339 acres	34,339 acres	100%
McFaddin NWR	70,710 acres	58,861 acres	83%
Texas Point NWR	8,952 acres	8,952 acres	100%

A. Natural Resources Section

1. Impacts to Air Quality

The predominant impact to the region's air quality from current land uses is from agricultural burning in support of grazing and rice production. Burning on private lands is conducted mainly to improve forage for livestock and to control brush. Some landowners also burn marshes to enhance habitat for wintering waterfowl. Under Refuge Boundary Expansion Alternative A, private landowners would continue to conduct burning on their lands. Marsh burning generally occurs in September or October. In upland areas, private landowners tend to burn in the late spring for brush control and to create more palatable forage for cattle. Marshes and pastures are typically burned annually. In heavily grazed areas, reduced fuel loads allow only portions of pastures to burn.

The primary source of negative air impacts from burning is from smoke. Regional air quality is affected only when many acres are burned concurrently on the same day. Temporary, localized decreases in air quality occur more frequently, but may be severe at times due to the large quantities of smoke that can be produced in a given area during a short period of time (USFS 1989). Smoke is made up primarily of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organics, nitrogen oxides, and trace minerals. The composition of smoke varies with fuel type. Nitrogen oxides are usually produced at temperatures only reached in piled slash or very intense wildfires; only inconsequential amounts are produced in prescribed fires (USFS 1989). Particulate matter is the major pollutant of concern from wildfire and prescribed fire smoke. Particulate matter is a general term for a mixture of solid particles and liquid droplets found in the air. Particulate matter from smoke tends to be very small (less than one micron in diameter) and, as a result, is more of a health concern than the coarser particles that typically make up road dust. Because of their size range, particulates scatter light effectively and, therefore, reduce visibility easily.

The atmospheric conditions that affect the movement and dispersal of smoke include the following: wind direction, wind speed, mixing height (the elevation in the atmosphere that the smoke mixes and disperses), transport wind speed and direction (the direction and speed of upper level winds responsible for moving the smoke from the immediate area), and Category day/dispersion (a combination of mixing height and transport wind speed to give an over all indicator of smoke dispersion potential). The Category day 1, 2, 3, 4 or 5 equates to poor, fair, good, very good and excellent smoke dispersal (USFWS 2003).

Burning may temporarily expose local residents to low concentrations of drift smoke, which is more of a temporary inconvenience than a health problem. However, high smoke concentrations typically produced from large burns can present health concerns, particularly near homes of people with respiratory illnesses or near health-care facilities (USFS 1989). The human health effects from smoke vary from irritation of the eyes and respiratory tract to more serious disorders including asthma, bronchitis, reduced lung function, and premature death. Particulate matter is the main source of health effects, but carbon dioxide and toxic air pollutants from wildfires can also cause health concerns (Therriault 2001). Additionally, the burning of noxious plants such as poison ivy can affect human respiratory systems, as well as cause severe skin rashes (USFS 1989). Wildlife can also be negatively impacted by smoke, particularly where large areas are ignited in a short period of time.

Burning on private lands in the project area often occurs under conditions of low humidity associated with frontal passages and north winds which typically transport smoke away from communities and other smoke sensitive areas. However, burning activities on private lands also regularly do not adhere to State regulations governing outdoor burning. These include regulations under the Texas Commission on Environmental Quality's Outdoor Burning Rule: 1) sensitive receptors must not be within 300 feet downwind of burning activities; 2) burning must occur no earlier than one hour after sunrise and no later than one hour before sunset; 3) burning must not be permitted when surface winds are less than six mph or more than 23 mph; and 4) burning must not be permitted during periods of persistent (actual or predicted) low level atmospheric temperature inversions (Therriault 2001, USFWS 2003). As such, burning on private lands under conditions which cause smoke impacts to communities in the area is not

uncommon. Burning in areas with heavy fuel accumulations which extends over several days produces the most severe smoke impacts.

2. Impacts to Geology and Soils

Soil erosion is a physical process whereby soils are degraded by the action of water and wind. Other forms of soil degradation including soil compaction, low organic matter, loss of soil structure, poor internal drainage, salinization, and soil acidity problems usually contribute to accelerated soil erosion. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil.

Current agricultural uses on private lands within the project area are impacting soil characteristics. Fertilization, fresh water irrigation that desalinizes soils, and aeration that increases oxidation positively affect soil chemistry and stabilize soils thereby preventing accelerated erosion. Conversely, heavy grazing or intense agricultural uses can destabilize soils and lead to increased soil erosion through excessive removal of vital soil nutrients, soil compaction, removal of vegetation and extensive use of broad spectrum herbicides and pesticides.

The combination of rising sea levels and land subsidence (relative sea level rise) and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water. In addition to ongoing impacts, relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps suggests that current projections of relative sea level rise related to global climate change may be underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Although shoreline retreat and along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has accelerated rates of shoreline retreat along the Gulf shoreline. On the upper Texas Coast, this reduced sand supply has led to loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

The historic barrier beach/dune system has been almost entirely lost on both the Texas Point and McFaddin NWRs and adjacent private lands in Jefferson County. Shoreline erosion and retreat along the Gulf is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. Average annual rates of shoreline retreat on most of Texas Point NWR are greater than 40 feet per year, and significant portions of the McFaddin NWR shoreline is eroding at rates of 10-15 feet per year (Bureau of Economic Geology unpublished data). Coastal habitats affected include wetlands, salty prairie and beaches and dunes. In addition to loss of beach and dune habitat, this loss of elevation along the Gulf shoreline has increased saltwater intrusion from the Gulf, as tidal overwash of the beach ridge is

occurring much more frequently than historically. This increased saltwater intrusion is negatively impacting plant productivity and diversity and many fish and wildlife species in Refuge marshes. Loss of plant productivity may decrease the ability of these marshes to accrete vertically at a rate which keeps up with relative sea level rise, which may lead to submergence and a rapid loss of vegetated marshes as they convert to open water. (On McFaddin NWR, coastal erosion and damage from storm tidal surges have destroyed a portion of Texas State Highway 87, a coastal highway that has been closed since 1989.)

Shoreline erosion and retreat is resulting in loss of coastal habitats on public and private lands throughout the project area. The shore of East Galveston Bay on the Anahuac NWR is eroding at 1.2 meters annually (Carroll 1974). Paine and Morton (1986) determined the East Bay shoreline of Anahuac NWR consistently eroded at a rate of 3 feet/year between 1850 and 1982. Erosion along the GIWW in the project area is occurring at rates between 5 to 10 feet annually. This is resulting in current or pending loss of intermediate and brackish marsh habitats, and further threatening these habitats with saltwater intrusion.

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. It is likely that these impacts have been the most severe in areas subject to both saltwater intrusion and rapid subsidence.

Under Refuge Boundary Expansion Alternative A, it is expected that coastal land loss (as shorelines erode and retreat and emergent marshes convert to open water) would continue at existing or accelerated rates in areas now under private ownership. To date, most shoreline protection projects on private lands in the area have focused on protecting residential and recreational infrastructure. In general, sufficient economic incentives are not in place for private landowners to participate in the types of major conservation-oriented hydrologic restoration and shoreline protection projects which will be required to counter the future effects of relative sea level rise and altered hydrological regimes.

Other land management practices occurring on private lands such as burning are impacting soils and soil formation. Insufficient data exists to adequately address the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood. Burning frequency and timing will likely determine the net effect on vertical accretion. Marsh burning on private lands occurs primarily in support of grazing and hunting operations, and typically marshes are burned annually.

Some landowners in the project area are managing water levels and salinities in coastal marshes, primarily to enhance habitats for wintering waterfowl and to reduce saltwater intrusion which can negatively impact grazing and rice farming operations. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had

significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana. Water management activities on private lands in fresh to brackish coastal marshes which reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying would benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils. Conversely, management which results in increased saltwater intrusion or excessive inundation or "drowning" of emergent marshes may result in lowered plant productivity and reduced soil formation.

In general, it is likely that economic considerations rather than the potential impacts of burning and water management on marsh accretion will continue to dictate the scope, extent and timing of these activities on private lands under Refuge Boundary Expansion Alternative A.

3. Impacts to Hydrology and Water Quality

a. Hydrology

The Chenier Plain region's coastal marshes were historically influenced by high annual precipitation and substantial freshwater riverine inflows, creating a continuum of coastal estuarine marsh types associated with a natural salinity gradient, from fresh to saline. Fresh and intermediate marshes formed a substantial component of this continuum. The natural hydrologic regimes of the coastal marshes throughout the project area have been greatly modified by the construction of the GIWW and numerous smaller canals and ditches, upstream dams and reservoirs, roads, levees and impoundments, and by the deepening and channeling of most natural waterways and other inland drainage improvements. The hydrological consequences of these activities include saltwater intrusion, reduced or restricted freshwater and nutrient/sediment inflows, and altered hydroperiods (wetting and drying cycles). Hydrological changes in turn have impacted natural biological diversity and in some cases contributed to a net loss of estuarine wetlands in the region (Moulton *et al.* 1997).

Conversion of vegetated marshes to open water has occurred throughout the Chenier Plain region in areas where increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels has caused erosional loss of organic marsh soils.

Saltwater intrusion and soil waterlogging has been associated with peat collapse and subsequent conversion of coastal marsh to open water (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Work conducted by Nyman *et al.* (1995b) indicate that marshhay cordgrass has higher root production at lower salinity levels. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993).

Excessive flooding, salt water intrusion, and sulfide stress can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Loss of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

In addition to ongoing impacts, relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps suggests that current projections of relative sea level rise related to global climate change are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Some landowners in the project area are managing water levels and salinities in coastal marshes, primarily to enhance habitats for wintering waterfowl and to reduce saltwater intrusion which can negatively impact grazing and rice farming operations. Management infrastructure comprised of water control structures, levees, and water delivery systems (including pumps, ditches and canals) is used to manage and manipulate water and soil salinities and water levels within structurally-managed marshes. Water management activities on private lands in fresh to brackish coastal marshes which reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying helps maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats support a natural diversity of native plant, fish and animal communities. Such management also helps prevent the conversion of vegetated marsh to open water, promotes plant productivity and contributes to marsh surface elevation gain (accretion). Conversely, management on private lands which results in increased saltwater intrusion, excessive inundation or "drowning" and/or too rapid drainage and excessive drying of emergent marshes is likely resulting in loss and degradation of coastal wetlands.

Changes in land ownership patterns in the project area may be impacting the extent and scope of water management and other land management practices which formerly benefited wildlife and habitat on private lands. Many large land holdings formerly owned and managed under single ownership have been divided into multiple ownerships, making it less likely that management activities such as large-scale hydrologic management or restoration in marshes will take place. In general, it is likely that economic considerations rather than habitat and fish and wildlife conservation objectives will dictate the types and scope of management activities affecting hydrology on private lands under Refuge Boundary Expansion Alternative A.

b. Water Quality

Potential sources of contaminants affecting water quality in the project area include accidental releases from oil and gas exploration and production activities, including spills and leaks from wells, production facilities, and pipelines. Oil and gas exploration and development activities have increased in the project area in recent years. A high volume of petrochemicals is transported through the project area on a daily basis via the GIWW. Municipal development and agricultural practices may also impact water quality in the project area. Non-point pollution sources such as storm drain run-off from local cities and towns are

major sources of pollutants entering the Galveston Bay estuarine ecosystem (Galveston Bay National Estuary Program 1995). Point source pollution from upstream facilities such as landfills is also of concern.

Rice cultivation contributes important freshwater inflows to the Galveston Bay and Sabine Lake estuarine ecosystems, but agricultural practices as a whole may also contribute excess nutrients and toxins to surface waters within these coastal watersheds. Herbicide application is used on rice, soybeans, sorghum, and hay throughout the region. Concentrations of herbicides are greatest during May, June and July, with the lowest concentrations occurring in the fall and winter. Nitrates from nutrient loading are common in agricultural areas where fertilizer application enters into streams, creeks, and bayous during storm events.

In general, it is likely that economic considerations will dictate the types and scope of activities which affect water quality on privately-owned lands under Refuge Boundary Expansion Alternative A.

4. Impacts to Vegetation/Habitats

Land management practices affecting vegetation and habitats on private lands within the project area are undertaken in support of agricultural uses, primarily livestock grazing and rice cultivation. Practices include pasture management (including haying, conversion to “improved” pasture, and control of Chinese tallow), burning, and the soil and water manipulations associated with rice farming. Some landowners implement structural water management in coastal marshes, primarily to enhance habitats for wintering waterfowl and to reduce saltwater intrusion which can negatively impact grazing and rice farming operations. Concurrent with agricultural uses, some private lands are also being managed to provide wildlife benefits, primarily in support of waterfowl hunting. Some rice farming operations are managed so as to provide quality habitat for wintering and migrating waterfowl. A small number of land owners are implementing moist soil management practices to create shallow freshwater wetland habitat, also to enhance habitat values for waterfowl. Most private lands capable of supporting waterfowl and/or dove hunting are leased to individuals or commercial hunting guides and outfitters.

Some land owners in the project area are intensively and very successfully managing properties to enhance habitats for wintering waterfowl, and rice farming and cattle grazing can provide substantial benefits to waterfowl and other migratory birds. Overall in the project area, however, economic considerations other than fish and wildlife benefits dictate land uses and land management practices on private lands. This will continue under Refuge Boundary Expansion Alternative A.

a. Impacts to Vegetation and Habitats from Habitat Management and Restoration Activities

(1). Wetland Specific Management and Restoration

Water management activities (e.g., establishing freshwater inflows, water level management, and restricting saltwater intrusion) impact geology, soils and hydrologic regimes throughout the project area. Such activities also influence vegetation found in wetland habitats.

(a). Water Management in Coastal Marshes

Some landowners in the project area are managing water levels and salinities in coastal marshes to both support agricultural uses and enhance habitats for wintering waterfowl. Controlling saltwater intrusion in support of grazing and rice farming also increases habitat quality for wintering waterfowl. Managed marshes on private lands within project area are under varying degrees of structural control. Some are entirely or almost entirely behind man-made levees and water control structures, and are intensively managed through manipulation of the water control structures. Most are managed less intensively, relying to some degree on natural topography and drainage to control hydrologic regimes. Ditch construction in marshes for drainage and/or access purposes has occurred extensively throughout the region.

Management infrastructure comprised of water control structures, levees, and water delivery systems (including pumps, ditches and canals) is used to manage and manipulate water and soil salinities and water levels within these structurally-managed marshes. On lands being managed for waterfowl, water levels and salinities favorable for producing abundant crops of submerged aquatic vegetation in open water habitats are maintained. Water levels during fall and winter months are maintained to promote utilization by puddle ducks and geese.

Water management activities on private lands in fresh to brackish coastal marshes which reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying are helping to maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats will continue to support a natural diversity of native plant, fish and animal communities. Such management would also help prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain (accretion). Conversely, structural marsh management which results in increased saltwater intrusion or excessive inundation or “drowning” of emergent marshes would result in loss and degradation of coastal wetlands.

On many properties being managed for livestock grazing as the primary economic use, marshes are drained immediately following the hunting season and kept dry as long as possible to increase availability of forage for livestock and increase the amount of dry ground available for calving. Marshes are typically “drawn down” as quickly as possible beginning in late January.

(b). Moist Soil Management

A few private landowners in the project area use moist soil management to enhance wintering waterfowl habitat. Water management and mechanical soil manipulations are timed to promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Water management (drawdowns and flooding) in moist soil units is accomplished with water control structures, levees, and water delivery systems including pumps and canal systems. Conventional farm machinery with discs and roller choppers are used to manipulate soils and vegetation.

Moist soil management contributes to increasing and maintaining the biological diversity of an area. Moist soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Over 80 percent more species have been found to occur in moist-soil impoundments than in adjacent row crops and include invertebrates, herpetofauna (amphibians and reptiles), prairie and marsh passerines, shorebirds, wading birds, waterfowl, gallinaceous birds, raptors, and mammals (Fredrickson and Taylor 1982).

(c). Rice Farming

Rice and livestock production are the predominant agricultural activities in the project area, and rice fields and pastureland are the predominant upland agricultural habitats. Conversion of native habitats to agricultural uses has occurred throughout the project area on most lands that would support these uses.

Rice production requires seasonal flooding, which creates shallow freshwater wetland habitat utilized by many avian and other wildlife species throughout the spring and summer. During fall and winter, flooded rice stubble and rice fallow, plowed fields, water leveled fields, weedy fields, ryegrass fields, and pastureland in the project area provide habitats that historically have supported large concentrations of wintering and migrating waterfowl, shorebirds, and wading birds. Flooding after harvest makes waste grain available to waterfowl. Reservoirs associated with rice production provide permanent, deepwater wetland habitats.

Rice production in the project area has declined significantly in recent years, and only a relatively small amount of base acreage currently in the USDA farm program is being actively farmed. On lands identified under Refuge Boundary Expansion Alternative B, 3,013 acres are currently being subsidized for

rice under the USDA farm program, on which an average of 99 acres per year have been in rice production in recent years. On lands identified under Refuge Boundary Expansion Alternative C, 3,506 acres are currently being subsidized for rice under the USDA program, of which an average of 211 acres per year has been in rice production in recent years. On lands identified under Refuge Boundary Expansion Alternative D, 13,290 acres are currently being subsidized for rice under the USDA program, of which an average of 1,229 acres per year has been in rice production in recent years.

Former rice fields are either left fallow or are being converted to improved pasture. Much of this acreage is supporting livestock operations. Permanently fallowed rice fields which are not grazed are rapidly being invaded by Chinese tallow and deep-rooted sedge. These exotic plant species are so invasive that they quickly replace native plants and provide few benefits for wildlife. The decline in rice production in the project area has significantly reduced the amount of farmed wetland acreage available to waterfowl and other migratory birds. It has undoubtedly contributed to reduced numbers of waterfowl wintering in the area.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Most of the historic native coastal tallgrass prairie in the project area has been converted to agricultural uses, primarily for rice production and pasture for grazing. Some private lands, primarily in Chambers County, contain some of the only remaining large tracts of native prairie on the upper Texas Coast. Land holdings with remnant native prairie stands are utilized and managed primarily to support grazing by cattle.

Increasingly, fallowed rice fields and other privately-owned uplands in the project area are being converted to "improved pasture" in support of cattle grazing operations. This generally involves planting of tame grasses including Jiggs Bermuda, Coastal Bermuda, and Bahia grasses. Improved pastures are typically used as warm season pastures. Winter wheat and rye grass are planted to produce cattle feed for use during the cool season. Improved pastures do not support the plant and animal diversity found in native prairie or rice fields.

(b). Woodlot Restoration and Protection

Coastal woodlots found on private lands in the project area are typically part of the overall land area used for livestock grazing. Woodlots are typically found on higher elevation sites, and cattle will typically congregate on these sites for shade. Grazing typically reduces or eliminates understory shrubs in woodlots, and may preclude natural reproduction of woody plant species.

(3). General Habitat Management Activities

(a). Fire Management - Prescribed Burning

Private landowners in the project area routinely use burning in marsh and upland areas, mainly to improve forage and control brush in support of grazing operations. Some landowners with hunting leases and/or commercial hunting operations also burn marshes to enhance habitat for wintering waterfowl.

Under Refuge Boundary Expansion Alternative A, private landowners would continue to conduct agricultural burning on their lands. Marsh burning generally occurs in September or October. In upland areas, private landowners tend to burn in the late spring for brush control and to create more palatable forage for cattle. Marshes and upland pastures are typically burned annually. In heavily grazed areas, reduced fuel loads often allow only portions of pastures to burn. In areas where fire cannot be applied, private landowners are more dependent on herbicides to control brush.

Although primarily done in support of grazing operations, burning on private lands has the potential to provide the following benefits:

- Hazardous fuels are reduced within immediate proximity to facilities and structures, which ensures protection of life and property. Prescribed burning lessens the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds is restored, maintained, or improved by maintaining early successional plant communities in marsh habitats, by increasing production and nutritional quality of these foods, and enhancing the availability of these foods by creating openings in otherwise dense strands of vegetation. For example, prescribed burning (integrated with grazing and water management) encourages seed producing annual grasses such as sprangletops and millets, and tuber producing plants such as Olney bulrush preferred by waterfowl. Snow geese heavily use recent marsh burns because they can readily access roots, tubers, and young green shoots of the regrowth. Both geese and ducks use burned areas as roosts or loafing areas.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, is suppressed. Without fire disturbance, both marsh and prairie habitats are subject to invasion by such woody plant species, which in turn reduces habitat quality for many grassland-dependent avian species. Burning makes vegetation more desirable to herbivores and will increase grazing pressure. Post-fire herbivory, whether by geese or cattle, prolongs early successional marshes and creates habitat for other wildlife. Post-fire herbivory will slow the recovery of climax vegetation and prolong early serial stages and open marsh conditions favorable to waterfowl (USFWS 1994). Livestock turn the soil through hoof action and further set back succession (Chabreck 1968, Stutzenbaker and Weller 1989).

Interstitial vegetation, often seed producing annuals such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.), increases after a fire, particularly when followed by grazing and suitable hydrology. Burning opens up dense vegetation and allows waterfowl access to seeds and other plant parts (Lynch 1941). Fire can remove plant cover and create open water conditions conducive to Mottled Duck brood-rearing habitat (Stutzenbaker 1988). Generally speaking, burning creates open marsh conditions and sets back succession if timed properly, particularly when followed by herbivory. Burning is an effective tool to manipulate vegetation composition and create a habitat mosaic (Fredrickson and Laubhan 1996).

The impacts of burning in wetland habitats conducted specifically to enhance habitats for waterfowl (in combination with controlled grazing and water level and salinity management) include: 1) increasing plant species diversity, 2) maintaining and enhancing desirable emergent marsh plant communities such as Olney bulrush and leafy three-square bulrush, 3) creating openings in otherwise dense stands of emergent marsh vegetation; and 4) helping to control exotic and/or invasive plants. Burning (integrated with control livestock grazing and water management) in wetland habitats promotes the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). In intermediate and brackish marsh habitats, these include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. The impacts of burning in upland grassland habitats include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control exotic and/or invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased.

While burning can have many positive effects on native habitats, it can also have detrimental impacts ranging from an undesirable change in plant species composition to actual conversion of emergent marshes to open water. Proper timing of burns under appropriate conditions of soil moisture, fuel loads and fuel moisture is essential to minimize negative impacts. For example, burning under excessively dry conditions could result in destruction of desirable vegetation, consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil

moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986). Annual burning over a long period time likely reduces plant species diversity in both wetland and upland habitats.

(b). Livestock Grazing

Livestock grazing is the primary agricultural use on private lands within the project area. Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. The relation of cattle grazing to wildlife varies considerably, depending on stocking rate, seasonality, plant community, and wildlife concerned (Chabreck 1968). Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek *et al.*).

Grazing (especially when integrated with fire and water management) in wetland habitats promotes the germination, growth and reproduction of several "early successional" plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). In intermediate and brackish marsh habitats, these include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Moderate grazing following burns in marshes also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Grazing also helps provide optimal physical structure of vegetation for waterfowl utilization in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds. Private grazing operations involving high stocking rates in marsh habitats often result in improved habitat conditions for waterfowl and increased waterfowl utilization of grazed areas (assuming proper water levels and salinities).

Specifically, the beneficial effects of grazing in wetland habitats include:

- Reduces rank vegetation which enables migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Reduces competing growth of marshhay cordgrass and other dominant climax plant communities, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Creates open water which provide loafing spots for birds and allow them to access aquatic invertebrates.
- Compliments marsh burning by prolonging the time that browse is available for goose use.
- Improves plant vigor, increases plant productivity, speeds nutrient recycling, and prevents excessive build-up of residual plant material.
- Reduces the amount of hazardous fuel loading, reducing the amount and intensity of wildfires.
- Breaks up capped soils through hoof action, which assists in seedling establishment.

- Maintains regrowth of vegetation in recently burned areas in more palatable stages for wintering waterfowl.
- Provides a reliable disturbance tool that is not as dependent on favorable weather and fuel conditions as prescribed fire.

Although grazing operations on private lands in the project area often provide enhanced wetland habitats for waterfowl and other migratory birds, they are not always compatible with maintaining the overall diversity of the region's native plant and animal communities. Typically, marsh pastures used during the cool season on private lands are grazed year after year. Upland pastures are often used year-round. Overall plant species diversity in both wetland and upland habitats will decrease over time in areas which are heavily grazed year after year. On areas used for summer pasture that include fallowed rice, wet prairies or fresh marsh, heavy grazing limits the production of seeds of annual grasses such as the millets and sprangletop. Inhibiting seed production decreases the amount of vital food sources available in these habitats for waterfowl the following fall and winter. Native plant species diversity, productivity and reproduction in remnant native prairie habitats are also reduced by perennial heavy grazing. In areas which are repeatedly overgrazed, potential detrimental impacts include excessive trampling of vegetation, compaction of soils, reduction of percolation rates, increased soil erosion, and reduced water quality from fecal coliform bacteria and excessive nutrients.

(c). Exotic/Invasive Species Management

Many private landowners in the project area actively control exotic/invasive plant species, particularly Chinese tallow, primarily to improve range conditions for livestock. A broad array of pesticides is used in support of rice farming operations to control various agricultural pests including noxious weeds, insects and fungal diseases.

Typically, broad spectrum herbicides and mechanical removal are used for Chinese tallow control on private lands. Aerial application is used for most pesticide applications on rice and for control operations on larger stands of Chinese tallow. While control of Chinese tallow enhances grassland habitats, wide-scale use of broad spectrum herbicides in the project area has contributed to loss of native plant species diversity.

Feral pigs occur in substantial numbers throughout the project area. Rooting and wallowing by feral hogs cause significant habitat and infrastructure damage. These soil disturbances in marsh and upland sites allow invasive plants to establish and reduce the value of the habitats to wildlife. Feral pigs are particularly damaging to water management infrastructure. They wallow and root extensively on levees and within rice fields and moist soil units effecting the management of thousands of acres of habitat. Feral hogs are prolific and are able to exploit wetland and upland habitats. Hunting and trapping of feral hogs would continue to occur on private lands in the project area. Effectiveness in controlling populations and reducing impacts to native vegetation and habitats would depend on the intensity of removal operations.

(d). Shoreline Protection and Restoration

As previously discussed, erosion along the Gulf of Mexico and Galveston Bay shorelines is a major issue in the project area. It is likely that most private landowners in the project area will not engage in significant efforts to restore or protect shorelines due to lack of economic incentives.

(e). Mowing and Haying

Many privately-owned pastures (improved and natural) in the project area are hayed. Haying results in invigorating growth of grasses, while reducing vigor of undesirable herbaceous weeds and woody plants including Chinese tallow and Eastern baccharis.

5. Impacts to Fish and Wildlife Resources

Under Refuge Boundary Expansion Alternative A, land management practices on private lands described in *Impacts on Vegetation and Habitats* would continue to impact the following important fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians
- Invertebrates

Some landowners in the project area are intensively and very successfully managing properties to enhance habitats for wintering waterfowl, and many agricultural practices provide substantial benefits to waterfowl and other migratory birds. In general, however, economic considerations other than fish and wildlife benefits dictate land uses and land management practices on private lands in the project area. This would continue under Refuge Boundary Expansion Alternative A.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on landscape scale increases the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased by urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.¹⁸ Wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Under Refuge Boundary Expansion A, the following land uses and management practices on private lands would have the greatest impacts on waterfowl populations.

¹⁸ During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot, 1996).

(a). Wetlands Management and Restoration

Under Refuge Boundary Expansion Alternative A, some privately-owned marshes would continue to be structurally managed to improve habitat for wintering and migrating waterfowl, utilizing water control structures, levees, and water delivery systems. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. For example, structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

A small number of landowners would continue to use moist soil management to provide habitat for wintering and migrating waterfowl. Moist soil management provides optimal conditions for germination and growth of preferred waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia.

Under Refuge Boundary Expansion A, rice farming operations in the project area which are concurrently managed for waterfowl would continue to provide important freshwater wetland habitat and high quality food resources for wintering and migrating waterfowl. Fall and winter flooding of fallow rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

Rice production in the project area has declined significantly in recent years, and only a relatively small amount of base acreage currently in the USDA farm program is being actively farmed. Former rice fields are either left fallow or are being converted to improved pasture. Much of this acreage is supporting livestock operations. Permanently fallowed rice fields which are not being managed for grazing are rapidly being invaded by Chinese tallow and deep-rooted sedge. These exotic plant species are so invasive that they quickly replace native plants and provide few benefits for wildlife. The decline in rice production in the project area has significantly reduced the amount of farmed wetland acreage available to waterfowl and other migratory birds. It has undoubtedly contributed to reduced numbers of waterfowl wintering in the area. Any future declines in rice production would further exacerbate these impacts.

On properties in the project area being managed for livestock grazing as a primary economic use, marshes and flooded rice fields and moist soil impoundments are usually drained immediately following the hunting season. This is done to increase availability of forage for livestock and increase the amount of dry ground available for calving. These wetland habitats are typically “drawn down” as quickly as possible beginning in late January. This practice reduces wetland habitat available during late winter and spring for migrating waterfowl and other migratory birds.

Utilization of broad spectrum herbicides and pesticides in rice farming and pasture management in the project area may reduce abundance and diversity of invertebrates important as a food sources for waterfowl and other migratory birds.

(b). General Habitat Management and Restoration Activities

The integrated combination of burning, livestock grazing and water management in wetland habitats on private lands being managed specifically for waterfowl in the project area would continue to provide optimum habitat conditions for wintering waterfowl and many additional migratory bird species. Burning and grazing promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing also results in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats on the Refuge Complex include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated

wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields also enhances waterfowl habitat.

On a year to year basis, overall habitat quality for waterfowl in the project area will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers can also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Mottled Ducks are year-round residents of the Chenier Plain region. This species prefers fresh to slightly brackish marshes (Gosselink *et al.* 1979); although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled Ducks in the project area are part of the western Gulf Coast population of Mottled Ducks. Banding studies have indicated that WGC Mottled Ducks do move between Mexico, Texas, Louisiana and Mississippi and Alabama, but no interchange occurs between this population and the Florida population of Mottled Ducks.

Mottled Duck numbers on national wildlife refuges on the Texas Coast have declined precipitously during the last 20 years, as indexed by annual breeding pair surveys and monthly aerial counts conducted September through March (USFWS, Division of Migratory Birds, unpublished reports). Stutzenbaker (1988) reported that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include conversion of native habitats for agricultural and urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988, Morton and Paine 1990), as well as increased pollutants (Cain 1988). Saltwater intrusion into wetlands that range from fresh to moderately brackish probably affects growth and survival of ducklings (Moorman *et al.* 1991). Encroachment of Chinese tallow into nesting habitat probably leads to abandonment of nesting areas (Stutzenbaker 1988). Other potential factors influencing Mottled Duck populations include extended periods of drought, mortality from predation due to increasing populations of alligators and possible increases in mammalian predators, a continued high incidence of lead pellet ingestion, and harvest (USFWS Division of Migratory Birds, unpublished reports).

Under Refuge Boundary Expansion Alternative A, the following would continue to be the primary land management activities on private lands impacting Mottled Ducks in the project area. The landscape level issues described above are likely to control population dynamics of the Western Gulf Coast Mottled Duck population.

(a). Wetlands Management and Restoration

Wetland management activities on private lands in the project area being managed for waterfowl would enhance habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Managing water levels and salinities in managed coastal marsh units would maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. Marsh management also would enhance diversity and productivity of submerged aquatic vegetation which provides important year-round food sources for this species. Rice farming and moist soil management would continue to provide critical shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round.

On properties in the project area being managed for livestock grazing as a primary economic use, marshes and flooded rice fields and moist soil impoundments are usually drained immediately following the hunting season. This is done to increase availability of forage for livestock and increase the amount

of dry ground available for calving. These wetland habitats are typically “drawn down” as quickly as possible beginning in late January. This practice reduces wetland habitat available for Mottled Duck nesting and brood-rearing during late winter, spring and summer.

(b). Uplands Management and Restoration

The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat for Mottled Ducks in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as “sennabean ponds,” as valuable brood rearing habitat. Conversion of most native coastal prairie habitats to agricultural uses in the project area has removed these habitat features.

Some agricultural practices on privately-owned uplands within the project area undertaken to improve forage conditions for cattle may also benefit Mottled Ducks. Controlling brush encroachment in grasslands using burning, livestock grazing, herbicide application and mowing/haying in salty and non-saline prairies (and on levees and along fence lines) would be expected to improve nesting success of Mottled Ducks.

Conversion of fallowed rice fields and other grassland habitats to “improved pasture” and invasion of Chinese tallow and other exotic plants in unmanaged fallowed rice fields would likely have negative impacts on Mottled Ducks by reducing suitable nesting habitat.

(c). General Habitat Management Activities

The integrated combination of burning, livestock grazing and water management in wetland habitats on private lands being managed specifically for waterfowl in the project area which provide optimum habitat conditions for wintering waterfowl also benefit Mottled Ducks during all phases of their life cycle. Burning and grazing promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and grazing also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for Mottled Ducks and other migratory birds. Control of Chinese tallow on private lands in and adjacent to freshwater marshes, moist soil units and rice fields also enhances habitat values for Mottled Ducks.

Agricultural management practices also have the potential to negatively impact Mottled Ducks in the project area. For example, burning may result in the excessive removal of vegetation reducing suitability as Mottled Duck nesting habitat, and burning at the wrong time of year could destroy nests (Baker 1983). Salt prairies occur as a broad zone between coastal prairies and marshes, and commonly as a ridge between marshes and bays or the Gulf of Mexico. Higher, well drained, salt prairie ridges juxtaposed with lower wetland areas have been identified as important Mottled Duck nesting areas in the Chenier Plain region of Louisiana (Baker 1983) and Texas (Stutzenbaker 1988). These cordgrass ridges are dominated by gulf cordgrass with marshhay cordgrass, knotroot bristlegrass (*Setaria parviflora*) and some brush species typically subdominant. Baker (1983) found that salt prairie invaded with *Sesbania* (*Sesbania* spp.) and *Baccharis* (*Baccharis halimifolia*) were avoided by nesting Mottled Ducks. Burned areas appeared to be undesirable for nesting to three years post-fire. Vegetation heights were comparable to unburned areas by the second year post-fire, but residual senesced vegetation remained low. Fire is necessary in the management of Mottled Duck nesting habitat. Fire must be frequent enough to keep brush at low densities, but infrequent enough to maximize years with dense nesting cover for Mottled Ducks. Annual burning of salt prairies would reduce nesting habitat. Overgrazing by cattle may

reduce desirable nesting habitat in marshes and salty prairies, especially after spring burns (Baker 1983, Stutzenbaker 1988).

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover and the Least Tern. Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret and Wood Stork.

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least Sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson's Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster's Tern). Some species are year-round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migrant, including Wood Stork, White Ibis, and Forster's Tern.

(a). Wetlands Management and Restoration

Marsh habitats actively managed for waterfowl on some private lands in the project area (utilizing water control structures, levees, impoundments, etc.) include a wide variety of habitat types used by shorebirds, wading birds and marsh and waterbirds. In general, shorebirds and wading birds would also continue to benefit from rice farming and moist soil management on private lands. Both provide shallow freshwater wetland habitat, which provide invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields would influence the type of and intensity of use by such birds (Huner *et al.* 2002).

On properties in the project area being managed for livestock grazing as a primary economic use, marshes and flooded rice fields and moist soil impoundments are usually drained immediately following the hunting season. This is done to increase availability of forage for livestock and increase the amount of dry ground available for calving. These wetland habitats are typically "drawn down" as quickly as possible beginning in late January. This practice reduces wetland habitat available for migrating shorebirds and other wetland-dependent avian species during spring and summer.

(b) Uplands Management

Some agricultural practices on privately-owned uplands within the project area undertaken to improve forage conditions for cattle may also benefit some shorebirds. For example, heavily grazed wetter prairies are used by Golden Plovers and Black-necked Stilts. Conversion of fallowed rice fields and other grassland habitats to "improved pasture" and invasion by Chinese tallow and other exotic plants in unmanaged fallowed rice fields would likely have negative impacts on shorebirds by reducing suitable nesting, migration and wintering habitat.

(c). General Land Management Activities

The integrated combination of burning, livestock grazing and water management in wetland habitats on private lands being managed specifically for waterfowl in the project area also benefit shorebirds, wading birds and other marsh and waterbirds. Water management activities in coastal marshes which maximize the annual production of submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species. Prescribed burning and controlled livestock grazing help create optimal physical structure of vegetation for shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions also provide excellent habitat for many invertebrate species, another important food source for shorebirds. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for these species

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (*Coturnicops noveboracensis*, Mizell 1998), sparrows (*Emberizidae*) and wrens (*Troglodytidae*) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post-fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (*Gallinago delicata*), (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rails during fire operations on the Texas Mid-Coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. Ignition methods and patterns for agricultural burning in the project area likely are not influenced by issues such as potential wildlife mortality.

Other land uses and land management activities in the project area could negatively impact some species of shorebirds, wading birds, marsh and water birds, dependent on intensity and timing. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979).

Utilization of broad spectrum herbicides and pesticides in pasture management and rice farming in the project area may reduce abundance and diversity of invertebrates, an important food source for shorebirds and wading birds.

(4). Impacts to Landbirds

Landbird species found in the project area require a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other land bird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other wildlife species.

(a). Wetlands Management and Restoration

Water management activities on private lands in the project area aimed at enhancing habitats for wintering waterfowl in coastal marshes would continue to indirectly benefit several landbird species which utilize these habitats.

(b). Uplands Management and Restoration

Some agricultural practices on privately-owned uplands within the project area undertaken to improve forage conditions for cattle may also benefit some landbird species. Controlling brush encroachment to enhance grasslands using burning, livestock grazing, herbicide application and mowing/haying in salty and non-saline prairies (and on levees and along fence lines) would benefit certain species of grassland songbirds.

Conversion of fallowed rice fields and other grassland habitats to “improved pasture” and invasion by Chinese tallow and other exotic plants in unmanaged fallowed rice fields would likely have negative impacts on grassland songbirds by reducing suitable nesting, migration and wintering habitat.

Coastal woodlots and near-coastal bottomland forests support a diverse avian community, which includes several species of neotropical migratory birds. Coastal woodlots and bottomland forests found on private lands in the project area are typically part of the overall land area used for livestock grazing. Coastal woodlots are typically found on higher elevation sites, and cattle will typically congregate on these sites for shade. Grazing typically reduces or eliminates understory shrubs and may preclude natural reproduction of woody plant species. Where this occurs, habitat quality for migrating and resident landbirds is negatively impacted.

(c). General Habitat Management Activities

The integrated combination of burning, grazing and water management occurring on some private lands in the project area to provide optimal habitat conditions for waterfowl also enhances wetland and upland habitats used by many land bird species. Chinese tallow control would also enhance wetland and upland habitats for these species, especially in grassland and coastal woodlot habitats.

Seaside sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding seaside sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson’s Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (1995) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte’s Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife.

Heavy grazing could adversely affect some ground-nesting birds by reducing suitable nesting habitat, trampling and by disturbing nesting pairs (Whyte and Cain 1979). Utilization of broad spectrum herbicides and pesticides in pasture management and rice farming in the project area may reduce abundance and diversity of invertebrates, an important food source for many land bird species.

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Some private landowners in the project area utilize structural marsh management to reduce saltwater intrusion which negatively impacts livestock and rice farming operations and to enhance habitat quality for waterfowl. Burning, grazing, and Chinese tallow control on private lands also enhance estuarine wetlands, and help create wetland habitat diversity and productivity important to a variety of fish and shellfish species.

Managing water levels and salinities (e.g., using water control structures, levees, impoundments, etc.) in managed marsh units may restrict access of some finfish and invertebrate fisheries species to managed areas. Actively managing water levels may impede access for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

(6). Impacts to Threatened and Endangered Species

Three Federally-listed Threatened or Endangered avian species occur in the project area: Bald Eagle, Piping Plover, and Brown Pelican. Water management activities on private lands in the project area aimed at enhancing habitats for wintering waterfowl in coastal marshes would continue to indirectly benefit these avian T&E species.

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found in the project area include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species on the Refuge Complex. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic animals.

In general, land uses and management practices on private lands which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of mammal species.

Land uses on private lands which create or maintain freshwater wetland habitats (structural management of marshes, rice farming, and moist soil management) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibian and reptiles, including frogs,

salamanders, aquatic snakes (e.g., western cottonmouth), turtles, and alligators. Habitat conditions which increase the abundance of insects, crustaceans, and other small prey benefit most species of amphibians and reptiles during at least a portion of their lifecycle. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Many landowners in the project area control coyote populations as a means of reducing losses of domestic livestock. Control of exotic and/or invasive woody species in wetland and upland habitats may decrease habitat quality for certain mammals such as raccoon and striped skunk. Overgrazing by livestock can destroy swamp rabbit and cottontail rabbit habitat (Gosselink *et al.* 1979). Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, reptiles, and invertebrates.

Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying “Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize.” Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data).

B. Socioeconomics Resource Section

The socioeconomic impacts for Refuge Boundary Expansion Alternative A (No Action) are the same as the socioeconomic impacts analyzed for Refuge Management Alternative D, the Preferred Alternative, in Part A. of this Chapter. This is because they both address the present set of conditions at the Refuge Complex and in the project area. The Refuge Complex would remain the same size as present, as no refuge boundary expansion would occur under this Alternative, and the management strategies from Refuge Management Alternative D (Preferred Alternative) would be implemented on the existing refuges. **For socioeconomic impact analysis information, please refer to Refuge Management Alternative D (Preferred Alternative) in the set of Refuge Management Alternatives in Part A of this Chapter. For comparative purposes, socioeconomic impacts under Refuge Boundary Expansion Alternative A (No Action) are compared to those under Refuge Boundary Expansion Alternatives B, C and D in Section II of Part B of this chapter, beginning on the following page.**

II. IMPACT ANALYSIS FOR REFUGE BOUNDARY EXPANSION ALTERNATIVES B, C, AND D

Overview

Refuge Boundary Expansion Alternatives B, C, and D would establish new boundaries for the Moody, Anahuac, McFaddin, and Texas Point NWRs. The USFWS would then be authorized to purchase lands, or interests in lands such as conservation easements, from private landowners within the newly established refuge boundaries. Lands would be acquired from private landowners only on a willing-seller basis and at fair market value, subject to availability of funds. Lands so acquired would become part of the National Wildlife Refuge System, and refuge management programs to be implemented on the existing refuges (as described under Refuge Management Alternative D) would also be implemented on newly acquired lands.

Management of newly acquired lands would be focused specifically on meeting the establishment purpose(s) of the refuges and the mission of the National Wildlife Refuge System. All lands becoming part of the National Wildlife Refuge System would remain undeveloped in perpetuity. Management programs on newly acquired lands would include habitat management and restoration activities in coastal wetlands, prairies and woodlands which emphasize conservation and management of migratory birds, consistent with restoring and maintaining biological integrity and biological diversity. Habitat management activities in wetland habitats would include managing water levels and salinities in coastal marshes and moist soil management to restore shallow freshwater wetlands. Management of uplands would focus on restoration of native coastal prairie and increasing native plant species diversity in coastal woodlots. Economic uses which serve as important management tools in meeting conservation objectives, such as rice farming and livestock grazing, would also be used. A cooperative rice farming program would use fall and winter flooding of second crop rice and first-year fallow fields to provide high quality habitat for migrating and wintering waterfowl, shorebirds and other migratory birds. Grazing would employ techniques such as grazing unit rotations, prescribed stocking levels, and timing and duration of use.

The USFWS would also focus on addressing threats to coastal habitats and fish and wildlife resources on newly acquired lands posed by relative sea level rise, altered hydrological regimes, exotic/invasive plants and animals, and environmental contaminants. Increased coordination with local, State and Federal agencies would be aimed at implementing major coastal habitat restoration projects. An integrated pest management program would be used to manage exotic/invasive plants and animals, with an overall goal of reducing use of chemical herbicides and pesticides over time. Management of oil and gas exploration and development activities would focus on minimizing impacts to habitats and fish and wildlife, including implementing strict pollution controls. Expanded field surveys and scientific monitoring and research would support an adaptive approach for conservation of native habitats and fish and wildlife resources.

Recreational and educational public uses of newly acquired lands would include the National Wildlife Refuge System's six priority wildlife-dependent uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. Development of visitor facilities similar to those found on the Refuge Complex would occur and could include trails, boardwalks and observation decks, fishing piers, boat ramps and photography blinds. The USFWS would also continue and expand outreach efforts and development of community-based partnerships.

Refuge Boundary Expansion Alternative B includes approximately 22,479 acres of coastal wetlands (primarily estuarine marshes) and 9,233 acres of upland habitats. Refuge Boundary Expansion Alternative C includes 29,308 acres of coastal wetlands (primarily estuarine and palustrine marshes) and 32,197 acres of upland habitats, including significant acreage of native coastal prairie. Refuge Boundary Expansion Alternative D includes 40,600 acres of coastal wetlands, including palustrine forested wetlands (bottomland hardwoods), and 55,617 acres of upland habitats.

A. Natural Resources Section

1. Impacts to Air Quality

The USFWS fire management program has the greatest potential of all refuge management activities to impact the region's air quality. Fire management activities on any newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would include both the suppression of unplanned wildland fires and prescribed burning.

Suppression of wildland fires on newly acquired lands would continue as prescribed in the USFWS Texas Chenier Plain Refuge Complex Fire Management Plan (USFWS 2001). Suppression involves utilization of "Appropriate Management Response" to each wildland fire, ranging from direct attack to monitoring. Decisions regarding suppression options and tactics consider firefighter and public safety, protection of private or publicly-owned structures and other infrastructure, and protection of natural and cultural resources. Reducing smoke impacts to surrounding communities is also an important consideration in planning and implementing suppression actions on all wildland fires occurring on Refuge lands.

The USFWS would use prescribed burning on newly acquired lands primarily to maintain and improve habitat for wintering and migrating waterfowl and other migratory birds and to reduce accumulations of hazardous fuels. Most burning would be conducted in emergent marsh habitats from September to late November, in order to maximize the benefits of integrated burning/grazing/water management programs and strictly adhere to management prescriptions. Limited prescribed burning during summer would be conducted if needed to control invasive woody vegetation. Prescribed burning in upland prairie habitats would occur primarily during late winter and early spring, with summer burns conducted as needed to control woody vegetation. Annual burning may occur in newly acquired areas initially if needed to control brush, however, burning frequency on prairies would be reduced over the long-term as grasslands are restored.

Although prescribed burning conducted by the USFWS would continue to be beneficial to habitats and wildlife (as discussed under *Section II.A.4.* and *II.A.5* below); this management action could also negatively impact local air quality, primarily through the production of smoke. Smoke from unplanned wildland fires and from planned prescribed burning could be transported by prevailing winds and affect air quality and transportation safety over a large area which includes the cities of Houston, Beaumont and Port Arthur and numerous smaller local communities. However, because prescribed burning is conducted by the USFWS under strict prescriptions which include implementing smoke management measures, impacts to local and regional air quality will be minimal. Prescription parameters which must be met prior to ignition and for the predicted duration of a prescribed burn include surface and transport wind direction and speed, mixing height, ambient air temperature and humidity, and fuel moisture. Both current and predicted climatic conditions are considered when deciding whether to proceed with a prescribed burn, and these conditions are regularly monitored for the duration of the burn as a further safeguard.

Prescribed burning by the USFWS under these controlled conditions would also reduce the potential for smoke impacts to air quality from unplanned wildland fires by effectively managing vegetative fuels. Most lightning-cause wildland fires on the Refuge Complex occur during the months of June through October, when prevailing winds typically include a southerly component which transports smoke towards communities and other smoke-sensitive areas. Wildland fires are less likely to start in areas with reduced fuel loads because of prescribed burning, and fires that do start burn with less intensity, produce less smoke, and are easier to suppress than in unburned areas with excessive accumulations of hazardous fuels.

2. Impacts to Geology and Soils

The combination of rising sea levels and land subsidence (relative sea level rise), and altered hydrological regimes have impacted coastal habitats in the Chenier Plain region and throughout the

western Gulf Coast ecosystem. These phenomena are impacting the region's soils and geological processes including soil formation. They are resulting in coastal land loss, both from the periphery as Gulf and bay shorelines are eroded and retreat and in interior vegetated marshes which are converting to open water. In addition to ongoing impacts, relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps suggests that current projections of relative sea level rise related to global climate change are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Although shoreline erosion and retreat along the region's Gulf and bay shorelines has occurred over geologic time with fluctuations in sea level and sediment supply, several anthropomorphic factors may be influencing current rates of coastal land loss. Global climate change due to release of greenhouse gases appears to be impacting current rates of sea level rise. Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995). A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has accelerated rates of shoreline retreat along the Gulf shoreline. This reduced sand supply has led to loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges.

Increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels have caused erosional loss of organic marsh soils, also leading to conversion of vegetated marshes to open water. Conversion of vegetated marshes to open water has also occurred throughout the region in areas where rapid land subsidence has resulted in submergence of wetlands. Conversion of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

Under Refuge Expansion Alternatives B, C and D, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss on newly acquired lands. On McFaddin NWR and Texas Point NWRs, these partnerships would continue to focus on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Coordination with other agencies and conservation organizations would be expanded, with a goal of implementing a major project to restore the entire barrier beach/dune system on McFaddin NWR. Major structural erosion abatement projects would also been implemented, including breakwater construction along the GIWW and East Galveston Bay shorelines.

Restoration of the barrier beach/dune system on McFaddin NWR and increased use of dredged material on Texas Point NWR would contribute to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). If successfully implemented, large-scale restoration of the barrier beach/dune system on McFaddin NWR and additional beneficial use of dredge material projects

on Texas Point NWR could substantially reduce current rates of land loss. These projects would also restore historic elevations along the shoreline and protect inland marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring would also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines will reduce land loss and increase sedimentation and vertical accretion within vegetation stands.

Other USFWS management activities on newly acquired lands Refuge Boundary Expansion Alternatives B, C and D would also impact soils and soil formation. Structural marsh management techniques, such as weirs and impoundments, may affect marsh vertical accretion (Nyman *et al.* 1993). In a survey in Louisiana regarding the effects of weir management on marsh loss, Nyman *et al.* (1993) concluded that weirs did not affect marsh loss or accretion, but that weirs may have different effects under different hydrological conditions, and that the effects of herbivore activity (muskrats) were important. Bryant and Chabreck (1998) found three structurally managed marshes in the Chenier Plain of Louisiana had significantly lower accretion than adjacent unmanaged marshes, while the fourth managed marsh had higher accretion than the adjacent unmanaged marsh. The managed marsh with higher accretion rates remained permanently flooded, while the three managed marshes with lower accretion underwent frequent drainage. It was hypothesized that structurally managed marshes are hydrologically isolated from tidal sediment subsidies and that frequent forced drying oxidized organic material in the soil. Gabrey and Afton (2001) found that belowground biomass was higher in unimpounded than impounded marshes. Perez and Cahoon (2005) did not find any difference in marsh accretion between structurally managed marshes on McFaddin NWR and adjacent unmanaged marsh.

Conversion of coastal marshes to open water is often associated with plant stresses such as salt water intrusion and soil waterlogging (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993, DeLaune and Pezeshki 2003). Excessive flooding and salt water intrusion can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Marsh accretion in the Chenier Plain region's fresher marshes is very dependent on the accumulation of organic matter, as opposed to mineral sediment deposition which is very important in the deltaic marshes of southeastern Louisiana. USFWS water management activities in fresh to brackish coastal marshes on newly acquired lands would reduce saltwater intrusion and prevent excessive and artificially-prolonged inundation or excessive drainage and drying. These management activities therefore would benefit soil formation and vertical accretion by increasing plant productivity and preventing oxidation of marsh soils.

Prescribed burning on newly acquired lands could also affect soils and vertical accretion in marshes. Insufficient data exists to adequately address the effects of fire on marsh accretion. Evidence exists suggesting root mass is a significant contributor to vertical accretion via peat formation (DeLaune *et al.* 1983, Nyman *et al.* 1993). In a study on the McFaddin NWR, both root volume and sediment elevation recovered faster in a burned area relative to an unburned area after salt water flooding (M. Ford and D. Cahoon, unpubl. data). Gabrey and Afton (2001) found that unburned and cover-burned Chenier plain marshes showed no differences in belowground biomass. Fire has been shown to increase primary productivity in some Gulf coast marshes (Hackney and Cruz 1981, Gabrey and Afton 2001). While these studies examined the effects of cover burns (burns conducted when sufficient water is present in the marsh to restrict biomass consumption to aerial plant material), root and peat burns can have a profound impact on marsh accretion. Root fires consume the litter layer and shallow root systems, while peat fires burn deeper into the soil consuming available organic matter (Lynch 1941). In most situations, root and peat fires are avoided by carefully monitoring water levels and soil moisture. Nyman and Chabreck (1995) concluded that fire should be used with caution until its effects on marsh accretion is better understood.

The USFWS would also coordinate and support expanded monitoring and scientific research to determine impacts of shoreline and marsh restoration efforts and the effects of habitat management activities such as structural marsh management and prescribed burning on marsh soils and vertical accretion. This would lead to a greater understanding of how to reduce the impacts of ongoing and future

relative sea level rise and altered hydrological regimes. For example, monitoring and research would help ensure that structural marsh management and prescribed burning programs are being conducted in a way to maximize marsh accretion while meeting short-term habitat objectives.

3. Impacts to Hydrology and Water Quality

a. Hydrology

The Chenier Plain region's coastal marshes were historically influenced by high annual precipitation and substantial freshwater riverine inflows, creating a continuum of coastal estuarine marsh types associated with a natural salinity gradient, from fresh to saline. Fresh and intermediate marshes formed a substantial component of this continuum. The natural hydrologic regimes of the coastal marshes in the region, and on the Refuge Complex, have been greatly modified by the construction of the GIWW and numerous smaller canals and ditches, upstream dams and reservoirs, roads, levees and impoundments, and by the deepening and channeling of most natural waterways and other inland drainage improvements. The hydrological consequences of these activities include saltwater intrusion, reduced or restricted freshwater and nutrient/sediment inflows, and altered hydroperiods (wetting and drying cycles). Hydrological changes in turn have impacted natural biological diversity and in some cases contributed to a net loss of estuarine wetlands (Moulton *et al.* 1997).

Conversion of vegetated marshes to open water has occurred throughout the Chenier Plain region in areas where increased saltwater intrusion and introduction of tidal energies to historically non-tidal or micro-tidal freshwater marshes through the construction of navigation channels has caused erosional loss of organic marsh soils.

As discussed in *Section 4.B.2* above, salt water intrusion and soil waterlogging has been associated with peat collapse and subsequent conversion of coastal marsh to open water (DeLaune *et al.* 1994). Naidoo *et al.* (1992) found marshhay cordgrass, a common intermediate and brackish marsh species, suffered from low root production and leaf elongation rates under waterlogged soils. Work conducted by Nyman *et al.* (1995b) indicate that marshhay cordgrass has higher root production at lower salinity levels. Root production may partially contribute to vertical accretion via peat accumulation (DeLaune *et al.* 1983, Nyman *et al.* 1993). Excessive flooding, salt water intrusion, and sulfide stress can lead to poor plant vigor and root production which in turn can reduce vertical accretion and exasperate flooding, further reducing plant vigor. Loss of emergent marsh to open water has been blamed on the synergistic effects of rapid land subsidence as well as salt water intrusion and soil waterlogging (Nyman *et al.* 1993). In some areas, rapid land subsidence caused by underground fluid withdrawals has resulted in submergence of wetlands, also leading to conversion of vegetated marshes to open water (White and Tremblay 1995). Land subsidence occurs naturally as geologic sediments compact, but also as a result of subsurface fluid withdrawal (groundwater and oil and gas) which has occurred extensively throughout the region (White and Tremblay 1995, Morton *et al.* 2001). It is likely that conversion of vegetated marshes to open water have been greatest in areas subject to both saltwater intrusion and rapid subsidence.

In addition to ongoing impacts, relative sea level rise and altered hydrological regimes pose a significant future threat to the region's coastal habitats. The mean sea level trend for Sabine Pass, Texas is a rise of 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps suggests that current projections of relative sea level rise related to global climate change are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise. Increased saltwater intrusion and loss of freshwater and sediment/nutrient inflows may limit the ability of the marshes in the Chenier Plain region to accrete vertically by reducing plant productivity. Below-ground plant productivity is perhaps the primary soil building mechanism in the region's fresh and intermediate marshes (Nyman *et al.* 1993).

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would conduct wetland management and restoration activities on newly acquired lands aimed at minimizing or mitigating impacts of altered hydrological regimes on plant, fish and wildlife resources. These would include structural marsh management, moist soil management, a cooperative rice farming program, and restoration of coastal wetlands. Water management activities in marsh habitats would include water level and salinity management and establishment of freshwater inflows using management infrastructure comprised of water control structures, levees, and water delivery systems (including pumps, ditches and canals). Water levels which mimic natural marsh hydroperiods (wetting and drying cycles) as closely as possible would be maintained. Specifically, management of water levels would be aimed at preventing too rapid drainage and excessive drying or artificially high water levels and/or prolonged periods of inundation. Similar water management infrastructure would be used to intensively manage moist soil units and rice fields. Marsh hydrology would also be restored by removing abandoned roads, levees, and well pads remaining from past oil and gas development.

The wetland management and hydrologic restoration activities implemented by the USFWS on newly acquired lands would help maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes. In turn, these habitats would support a natural diversity of native plant, fish and animal communities. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater and nutrient/sediment inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes would also help to prevent the conversion of vegetated marsh to open water, promote plant productivity and contribute to marsh surface elevation gain.

b. Water Quality

Potential sources of contaminants affecting water quality in the project area include accidental releases from oil and gas exploration and production activities, including spills and leaks from wells, production facilities, and pipelines. Oil and gas exploration and development activities have increased in the project area in recent years. A high volume of petrochemicals is transported through the project area on a daily basis via the GIWW. Municipal development and agricultural practices may also impact water quality in the Refuge Complex. Non-point pollution sources, such as storm drain run-off from local cities and towns, are a major source of pollution entering the Galveston Bay estuarine ecosystem (Galveston Bay Estuary Program 1995). Point source pollution from upstream facilities such as landfills is also of concern.

Rice cultivation contributes important freshwater inflows to the Galveston Bay and Sabine Lake estuarine ecosystems, but agricultural practices as a whole may also contribute excess nutrients and toxins to surface waters within these coastal watersheds. Herbicide application is used on rice, soybeans, sorghum, and hay throughout the region. Concentrations of herbicides are greatest during May, June and July, with the lowest concentrations occurring in the fall and winter. Nitrates from nutrient loading are common in agricultural areas where fertilizer application enters into streams, creeks, and bayous during storm events. Some studies have indicated that rice tail waters entering the Galveston Bay system are relatively free of pollutants.

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would periodically monitor water quality on newly acquired lands through its Environmental Contaminants program, and would work with local, state and federal agencies to address water quality issues. Oil and gas exploration and production activities would be managed, including enforcing conditions of Special Use Permits aimed at preventing pollution from accidental releases. The USFWS would continue to coordinate with State and Federal spill response agencies to maintain a high level of preparedness and to effectively respond to accidental spills affecting water quality (and fish, wildlife and habitats). Overall, these activities would reduce the impacts of point and non-point source pollution sources and accidental spills to water quality and fish, wildlife and plant resources.

4. Impacts to Vegetation/Habitats

USFWS management activities affecting vegetation and habitats on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would include the following habitat management and restoration activities in wetland and upland habitats: 1) structural water management in coastal marshes, 2) wetland restoration, 3) prairie grassland management and restoration, and 4) coastal woodlot and near-coastal bottomland forest restoration and protection. Other habitat management and restoration activities with impacts to vegetation and habitats would include prescribed burning, controlled grazing, exotic/invasive plant and animal control, shoreline restoration and protection, and mowing/haying.

The USFWS would administer public uses on newly acquired lands, including the six priority wildlife-dependent uses of the National Wildlife Refuge System: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These uses would have direct and indirect impacts to vegetation and habitats.

Systematic monitoring of vegetation and habitats under the USFWS Refuge Biological Program would be conducted, allowing for ongoing assessment and refinement of management activities.

The USFWS would manage oil and gas activities on newly acquired lands through issuance of Special Use Permits. Stipulations in the SUPs would serve to minimize and mitigate for impacts of these activities on habitats and fish and wildlife resources.

a. Impacts to Vegetation and Habitats from Habitat Management/Restoration Activities

(1). Wetland Specific Management and Restoration

Wetlands management and restoration activities on the Refuge Complex impact hydrologic regimes. Such activities also strongly influence the vegetative communities found in Refuge Complex coastal marshes and prairie wetlands habitats.

(a). Water Management in Coastal Marshes

Coastal marshes provide important food resources and cover to a diversity of wetland-dependent resident and migratory fish and wildlife species. These marshes also provide buffering of tidal storm surge, reduce flooding, and filter excessive nutrients and other contaminants.

Threats to the Chenier Plain region's coastal marshes include altered hydrology resulting in increased saltwater intrusion and loss of freshwater and sediment inflows, and rising sea levels and land subsidence. These processes are resulting in coastal land loss as shorelines are eroded and recede and as inland vegetated wetlands convert to open water, which in turn is decreasing habitat quantity and quality for native fish and wildlife.

The USFWS would use structural water management on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D to control salinities and water levels within marsh habitats. Managed marsh units within the project area are under varying degrees of structural control, and may best be described as marsh semi-impoundments. Some units are entirely or almost entirely behind man-made levees and water control structures, and are intensively managed through manipulation of the water control structures and water delivery systems including ditches and canals. Most are managed less intensively, relying to some degree on natural topography and drainage to control hydrologic regimes. Most existing water control structures on private lands in the project area are designed to actively control the amount of saltwater or freshwater entering or leaving the managed unit.

The typical water management regime for managed marshes on newly acquired lands would involve maintaining salinities within the range of the particular marsh type being targeted by controlling the volume and timing of inputs of freshwater and saltwater. In general, salinity management promotes the establishment of the aquatic plant communities associated with brackish, intermediate and fresh

marshes. Saltwater inputs would sometimes be increased to higher than target levels if required to control certain aquatic invasive species such as cattail. Water levels would be maintained at target elevations to maintain plant productivity and diversity and to provide optimal wildlife habitat. The general water level management regime across most managed marsh habitats would involve maintaining pre-determined water levels which provide favorable conditions for dabbling ducks and geese during fall and winter. Following the wintering migratory bird season, managed marsh units would be drawn down gradually to create soil conditions favorable for the germination of a variety of seed producing annual plants in emergent marshes and water levels conducive to the germination and establishment of submerged and floating aquatic plants in ponds and other open water habitats. Summer water levels and salinities would be maintained to promote the growth of these plant species and subsequent seed and tuber production. Overall, water levels which mimic natural marsh hydroperiods (wetting and drying cycles) as closely as possible would be maintained. Specifically, management of water levels would be aimed at preventing too rapid drainage and excessive drying or artificially high water levels and/or prolonged periods of inundation.

The above notwithstanding, periodic climatic events such as flooding during periods of high rainfall or due to tidal storm surge and prolonged drought would continue to influence and sometimes be the dominant factor controlling hydrologic regimes and the response of vegetative communities in these coastal marshes.

This management activity would help maintain or restore the historic continuum of fresh, intermediate, brackish and saline marshes and the native plant, fish and animal communities that depend on these habitats. This would include the establishment of diverse and productive submerged and floating aquatic plant communities in open water habitats. Restoring historic hydrological conditions by reducing saltwater intrusion, reducing tidal energies in formerly non-tidal or micro-tidal marshes, establishing freshwater and sediment inflows and managing water levels to mimic historic hydroperiods (wetting and drying cycles) in coastal marshes on newly acquired lands would also help to prevent the conversion of vegetated marsh to open water. By promoting plant productivity, this management activity may also contribute to marsh soil formation and surface elevation gain (marsh accretion).

(b). Marsh Restoration

Under Refuge Boundary Expansion Alternatives B, C, and D the USFWS would expand the level and scope of wetland restoration activities on newly acquired lands. Coordination with the U.S. Army Corps of Engineers and other state and federal agencies would be expanded to develop additional projects which beneficially use dredge material to restore coastal marshes.

Impacts of marsh restoration efforts would be to increase the amount of vegetated marsh in areas which have converted to open water, in turn providing more productive habitats for native fish and wildlife.

(c). Moist Soil Management

Freshwater prairie wetlands on the Gulf Coast have been reduced mainly through development and agriculture (Moulton *et al.* 1997). Like coastal marshes, shallow freshwater prairie wetlands provide important food resources and cover to a diversity of wetland-dependent resident and migratory birds and wildlife. Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would implement moist soil management on newly acquired lands to provide and enhance shallow freshwater wetland habitat for migratory birds and other wetland-dependent wildlife.

Water management and mechanical soil manipulations on new moist soil units would be timed to promote conditions for germination and growth of waterfowl food plants, including annual grasses such as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia. Some units would be flooded throughout the summer to provide brood rearing habitat for Mottled Ducks and whistling ducks. This management regime favors the establishment of perennial wetland plants, including several species of floating and submerged aquatic plants, including arrow head, white water lily, and lotus.

Moist soil management increases wetland productivity and waterfowl use on migrating and wintering grounds (Fredrickson and Taylor 1982). Moist soil management is the process of exposing soils by lowering water levels or mechanically manipulating vegetation or soils to create a seedbed for native wetland plants to germinate, grow and reproduce. Flooding provides foraging habitat and cover for diverse communities of migrating and wintering waterfowl and other waterbirds (Fredrickson and Taylor 1982). The seeds, tubers, rhizomes and vegetative portions of moist soil plants provide important foods for waterfowl and other migratory birds.

Moist soil management contributes to increasing and maintaining the biological diversity of an area. Moist-soil impoundments more closely resemble natural wetland habitats and provide required habitat parameters for a larger variety of game and nongame wildlife species than monotypic agricultural row crops (Fredrickson and Taylor 1982). Over 80 percent more species have been found to occur in moist-soil impoundments than in adjacent row crops and include invertebrates, herpetofauna (amphibians and reptiles), prairie and marsh passerines (small- to medium-sized perching birds), shorebirds, wading birds, waterfowl, gallinaceous birds (e.g., pheasants, wild turkeys), raptors, and mammals (Fredrickson and Taylor 1982).

(d). Cooperative Rice Farming Program

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would implement a cooperative rice farming program on newly acquired lands where feasible. Primary objectives of the program would be to provide shallow freshwater wetland habitat with high value food resources for wintering and migrating waterfowl, shorebirds, wading birds and other migratory birds. The program would use Cooperative agreements with local farmers. Preference would be given to those farmers proposing to grow rice organically in order to reduce overall use of chemical herbicides and pesticides on Refuge lands.

Cooperative rice farming on newly acquired lands would provide shallow freshwater wetland habitat and serve several outcomes for migratory bird management: 1) providing habitat and nutritious forage for migrating and wintering waterfowl, 2) creating habitat for migrating shorebirds, and 3) providing fresh water habitat for during spring and summer for breeding and brood rearing Mottled Ducks and fulvous and black-bellied whistling ducks. Flooding after harvest makes existing waste grain available to waterfowl and often produces a second crop of rice, which is also available to wildlife. Fall and winter flooding allows migratory waterfowl to exploit waste rice and other weeds found in the fields. During migration and wintering periods, waterfowl and waterbirds extensively use post-harvest ricefields that were cultivated and at least partially flooded (Czech and Parsons 2002). Managed rice fields would provide wintering and migrational habitat for Blue-winged Teal, Northern Pintail, Green-winged Teal and Snow Geese, several shorebirds species including Long-billed Dowitchers and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted sandpipers, and for several wading bird species. Mottled Ducks also heavily use habitats adjacent to rice fields for nesting (Stutzenbaker 1988). Rice farming would also help to offset waterfowl consumption of crops on adjacent privately-owned croplands.

(e). General Habitat Management Activities

The USFWS would also utilize fire management, controlled livestock grazing, and exotic/invasive species control as integrated management tools in wetland habitats. The impacts of these activities on vegetation and habitats are discussed below under *General Habitat Management Activities*.

(2). Upland Specific Management and Restoration Activities

(a). Native Prairie Restoration and Management

Over 9 million acres of native tallgrass prairie once occurred along the western Gulf Coast in Texas and Louisiana (Smeins *et al.* 1991). Based on remnant stands of native grasslands, prairies on the upper Texas coast were characterized by little bluestem, brownseed paspalum, and Indiangrass or eastern

gammagrass and switchgrass associations, depending on hydrology (Diamond and Smeins 1984). It is now estimated that 99.8% and 99.6% of little bluestem and eastern gamma grass/switchgrass prairies, respectfully, have been lost in Texas (McFarland 1995). The little bluestem-brownseed paspalum community has been identified as a threatened natural community and the eastern gammagrass-switchgrass community has been identified as an endangered natural community by the Texas Organization for Endangered Species (Diamond *et al.* 1992). Both communities are assigned a Global conservation status rank of “Critically Imperiled” (G1) by The Nature Conservancy (2002).

Coastal prairie habitats are important for prairie-dependent avian and wildlife. Currently, nine of the 13 avian species listed as Rare and Declining within the Coastal Prairies Region in Texas are present in coastal prairie grasslands on the Refuge Complex. The USFWS has listed seven avian species occurring in prairie habitats on the Refuge Complex as Avian Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS 2005).

Refuge Boundary Expansion Alternatives C and D include the largest contiguous native coastal prairie remnants on the upper Texas Coast. Under Refuge Boundary Expansion Alternatives B, C and D, the following prairie habitat restoration and management activities would be used on newly acquired lands: 1) protect and manage existing native prairies and restore prairie on suitable upland sites; 2) restore shallow depressional “prairie wetlands”; 3) conduct a rotational prescribed burning program on existing and restored prairies; 4) conduct a rotational livestock grazing program; 5) utilize an integrated pest management program, consisting of herbicide application, mechanical removal, prescribed burning and controlled livestock grazing to manage exotic/invasive plant species such as Chinese tallow and deep-rooted sedge which are negatively impacting prairie habitats; and 6) mow or hay to control weed and woody species infestations.

Overall, prairie restoration and management activities on newly acquired lands would increase the abundance of native prairie grasses and forbs, including the increasingly rare little bluestem/brownseed paspalum and eastern gamma grass/switchgrass prairie plant communities. The USFWS would use integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing/haying to restore the historic mosaic of prairie plant communities and the different structural characteristics of these habitats. Brush encroachment by exotic and native plant species would be reduced. Previously-drained shallow depressional “prairie wetlands” within extant stands of native prairie would be restored. Additional native prairie and freshwater wetlands would be restored on adjacent fallowed agricultural fields. Management and restoration of native prairie habitats on newly acquired lands would help conserve an important and increasingly rare component of the western Gulf Coast ecosystem. The long-term protection and management of the remaining largest contiguous tracts of native prairie on the Upper Texas Coast will provide functional habitats to support many declining native plant and wildlife species, including plant associations classified as Globally Imperiled and many Avian Species of Conservation Concern.

Seed viability in prairie plants is believed to be reduced in highly fragmented prairie landscapes due to loss of genetic variability as remnant stands become smaller and more isolated. Prairie plants on the upper Texas Coast evolved under relatively unique climatic conditions of high annual rainfall and hydric soils. Conservation of existing coastal prairie remnants in the project area under Refuge Boundary Expansion Alternatives B, C and D would protect important reservoirs of genetic material and extremely valuable sources of viable local seed and plant materials. Future restoration of native coastal prairie in the region would greatly benefit by the protection of these existing viable local seed and plant material sources.

(b). Woodlot Restoration and Protection

Although comprising a small percentage of the upland habitats in the project area, coastal woodlots help support a diverse avian community which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in woodland habitats in the project area. Migratory birds depend on coastal woodlots for cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier Plain prior to or

immediately after crossing the Gulf of Mexico (Barrow *et al.* 2000). Trans-Gulf or circum-Gulf migratory songbirds use Texas Coastal woodlots as stopover habitat (Mueller 1981), which is critical at a time when the birds are depleted of water and energy reserves (Leberg *et al.* 1996).

A primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially *Lepidopteron* larvae. Chinese tallow woodlots may thus be an “ecological trap” that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001).

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would protect and manage coastal woodlots and near-coastal forests on newly acquired lands by: 1) native tree and shrub plantings; 2) exotic/invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts. Under Refuge Boundary Expansion Alternative D, an important near-coastal bottomland hardwood forest (Taylors Bayou bottomlands) would be protected.

Overall, implementation of the USFWS management actions discussed above on newly acquired lands would improve coastal woodlot and bottomland forest habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced woodland habitats would provide quality habitat for neotropical migratory birds and other wildlife that require native trees or understory for cover and foraging.

(3). General Habitat Management Activities

Under Refuge Boundary Expansion Alternatives B, C, and D, the USFWS would use fire management, controlled livestock grazing, exotic/invasive species management, and mowing/haying on newly acquired lands to enhance habitats for migratory birds and other native fish and wildlife. Shoreline restoration and protection activities would be implemented to counter ongoing coastal land loss caused by relative sea level rise, altered hydrological regimes and loss of coarse sediment supply. These management and restoration activities would be used to conserve, enhance and restore both wetland and upland habitats on newly acquired lands.

(a). Fire Management - Prescribed Burning/Wildland Fire Suppression

Natural fire and herbivory by native species likely occur less frequently or at reduced levels than historically in the Chenier Plain region, primarily due to human influences on this coastal ecosystem. This has reduced diversity and productivity of native wetland and upland habitats. For example, in brackish and intermediate marsh habitats, reduced disturbance generally allows marshhay cordgrass, considered a climax plant community, to become the dominant emergent plant. Dense, homogeneous stands of marshhay cordgrass are less biologically diverse and productive than marsh habitats in which burning and herbivory create a mosaic of plant communities with greater plant species composition and greater structural diversity (attributes such as stem densities, height, and erect vs. decumbent growth habits). In upland coastal prairie habitats, encroachment by native and exotic woody species, such as Eastern baccharis and Chinese tallow, occurs in areas where fire is excluded, also resulting in loss of native habitat diversity and productivity.

Fire has long had a role in the ecology of the Texas Chenier Plain marshes. Pre-European settlement, fire frequency for these marshes is estimated to be 1-3 years (Frost 1995). Lightning caused wildfires were common in coastal marshes (Hoffpauer 1968, Frost 1995). Additionally, Native Americans used fire to facilitate hunting and travel (O’Neil 1949, Givens 1962). In the past, fires in the Gulf coast prairies and marshes probably varied greatly in spatial extent. Natural firebreaks existed in many forms. Bayous, tidal creeks, fault lines, animal trails, and areas previously disturbed by fire or animal herbivory all may limit the spread of wildfires. Weather, fuel conditions, and water levels influence the effectiveness of the natural firebreaks and ultimately the size of the fire. Anecdotal data suggest that prior to human caused changes

in historic isohaline lines and hydroperiods, much of the vegetation that dominated these fresher marshes (i.e. Sawgrass (*Cladium mariscus* subsp. *jamaicense*), maidencain (*Panicum hemitomon*), giant cutgrass (*Zizaniopsis miliacea*), and bullwhip (*Schoenoplectus californicus*)) were less pyrogenic than common vegetation found today, such as marshhay cordgrass. This may have reduced the frequency and size of historical fires in the region's marshes compared to current vegetative conditions. Conversely, natural fire starts in the region have undoubtedly been significantly reduced because of the landscape-level conversion of upland prairie habitats to agricultural uses. Navigation canals, ditches, levees and roads constructed throughout upland and wetland habitats effectively serve as firebreaks and have greatly affected fire spread and the ultimate size of present-day natural fires.

Generally, three types of fires in coastal marshes are recognized: cover, root, and peat burns (Lynch 1941). Soil moisture and organic content, as well as surface water at the time of the fire, determine the type of burn that occurs. Water levels and soil conditions must be considered carefully to meet management objectives of prescribed burns (Bacchus 1995, Hungerford *et al.* 1995). The USFWS would carefully consider these parameters in implementing its fire management program on newly acquired lands.

The most common and widely used fire in coastal marshes is the cover burn (Hoffpauer 1968). This type of fire, taking place when water levels are at or near the marsh surface, removes the aerial portions of the vegetation. Recommended water levels for a cover burn range from marsh surface to five inches (Lynch 1941, O'Neil 1949, Hoffpauer 1968). Cover burns temporarily remove dense emergent vegetation and attract wildlife and cattle to the new growth (Lynch 1941, Hoffpauer 1968). Marshes recover quickly after winter cover burns. Soil moisture or surface water protects the subterranean plant parts from damage. Gabrey and Afton (2001) found in the Chenier Plain of Louisiana that the total above ground biomass was reduced for two years while dead above ground biomass was reduced for three years post fire compared to unburned control plots. In addition, they found that plant species composition in burned plots was the same as unburned plots, with a slight increase in richness during the first growing season post-fire.

Root burns occur in marshes under dryer conditions. The roots of plants may move into the litter layer in marshes that have not burned in several years (Lynch 1941). If the litter layer is dry enough to support combustion, a root burn may occur. Root fires burn away the litter layer and destroy shallow root systems. This type of burn can create significant changes in the plant community. Climax species such as maidencane and marshhay cordgrass are often set back, allowing subclimax species to increase. Because the fire is in the litter layer and soil is not consumed, this type of burn would also be classified as a surface fire by most fire researchers, though the results of the fire would be very different.

The last type of marsh fire is the peat burn. This takes place under the driest soil conditions. In a peat burn, the fire removes the organic subsurface fuels and in some instances will burn down to the underlying clay pan. This type of fire typically removes existing vegetation and creates open water conditions that may last for decades (Lay and O'Neil 1942, O'Neil 1949, Hoffpauer 1968). Peat burns can create quality waterfowl habitat by burning holes into the marsh that later become open water (Lynch 1941, Uhler 1944, Baldassare and Bolen 1994). Despite this, peat burns are not a management goal in most instances. The prolonged smoldering involved in peat burns would likely cause smoke management problems in surrounding communities. With the alarming loss of coastal wetlands to sea-level rise and subsidence, these types of burns cannot be justified in most situations (Nyman and Chabreck 1995). The general fire management community would classify peat burns as a ground fire.

Once a burn has been completed, many factors can affect post-fire conditions. If excessive rainfall causes water to cover the vegetation stubble for prolonged periods of time, the vegetation can die off (Hoffpauer 1968). Soils are particularly susceptible to erosion until the vegetation recovers. Excessive high tides, particularly storm driven tides, can push salt water over the burn area and cause plant mortality.

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would use its fire management program on newly acquired lands to manage prescribed burning and to suppress wildfires in a manner beneficial to native plant and animal communities and ecological functions, while providing for public and

employee safety and minimizing negative impacts to the surrounding communities (USFWS 2001). In wetland habitats, prescribed burning would be implemented in combination with controlled livestock grazing and water level and salinity management with of primary goal of providing diverse high-quality wintering habitats for waterfowl, shorebirds and other marsh and water birds. In upland habitats, prescribed burning and controlled grazing would be used to control encroachment by woody species and to enhance germination and growth of native prairie grasses and forbs, benefiting many grassland avian species.

Prescribed burning would generally occur on a three-year rotation; however, the actual condition of vegetation and fuel loading would dictate the need for a burn (USWS 2001). The majority of the prescribed burning in marsh habitat would be conducted from September to late November. Prescribed burning of upland grassland habitat would occur primarily in late winter and early spring to stimulate native warm season grasses. Summer burning would occur in wetland and upland habitats when necessary to control invasive woody vegetation.

The USFWS fire management program would be conducted on newly acquired lands to achieve the following benefits:

- Hazardous fuels reduction within immediate proximity to USFWS and private facilities and structures (to protect life and property). Prescribed burning lessens the potential of uncontrollable wildfires by reducing the accumulation of rank vegetation and litter.
- Habitat for waterfowl and other migratory birds is restored, maintained, or improved by maintaining early successional plant communities in marsh habitats, by increasing production and nutritional quality of these foods, and enhancing the availability of these foods by creating openings in otherwise dense stands of vegetation. For example, prescribed burning encourages tuber producing plants such as Olney and leafy three-square bulrush preferred by waterfowl. Snow geese heavily use recent marsh burns because they can readily access roots, tubers, and young green shoots of these plant species. Both geese and ducks use burned areas as roosts or loafing areas.
- Encroachment of undesirable woody shrubs, including Chinese tallow, bigleaf sumpweed, and Eastern baccharis, is suppressed. Without fire disturbance, both marsh and prairie habitats in the project area are subject to invasion by such woody shrubs, which in turn reduces habitat quality for many grassland-dependent avian species and other wildlife. Management of exotic and invasive species such as Chinese tallow, deep-rooted sedge and Eastern baccharis using an integrated pest management approach enhances germination, growth and reproduction of native prairie grasses and forbs. The mechanical removal of undesirable woody and weed plant species reduces competition with native plant species, and enhances germination, growth and reproduction of native prairie grasses and forbs.

Burning makes vegetation more desirable to herbivores and will increase grazing pressure. Post-fire herbivory, whether by geese or cattle, prolongs early successional marshes and creates habitat for other wildlife. Post-fire herbivory will slow the recovery of climax vegetation and prolong early serial stages and open marsh conditions favorable to waterfowl (USFWS 1994). Livestock turn the soil through hoof action and further set back succession (Chabreck 1968, Stutzenbaker and Weller 1989).

Interstitial vegetation, often seed producing annual grasses such as sprangletops (*Leptochloa* spp.) and millets (*Echinochloa* spp.), increases after a fire, particularly when followed by grazing and suitable hydrology. Burning opens up dense vegetation and allows waterfowl access to seeds and other plant parts (Lynch 1941). Fire can remove plant cover and create open water conditions conducive to Mottled Duck brood-rearing habitat (Stutzenbaker 1988). Generally speaking, burning creates open marsh conditions and sets back succession if timed properly, particularly when followed by herbivory. Burning is an effective tool to manipulate vegetation composition and create a habitat mosaic (Fredrickson and Laubhan 1996).

USFWS fire management practices in non-saline coastal prairies on newly acquired lands would include prescribed burning in late winter prior to green-up of the warm season grasses. This is the most common type of prescribed burn currently conducted on remnant native prairies and restored coastal prairie sites on the Refuge Complex, and it is used to promote the growth of these native grasses. Burning would be conducted on upland non-saline grasslands when target warm-season grass species have less than 10cm of green foliage, prior to the grasses' growth points becoming elevated. This strategy of prescribed burning is considered a restoration phase in the management of non-saline uplands on the Refuge Complex.

One of the primary objectives of burning non-saline upland grasslands on newly acquired lands would be the control of Chinese tallow. Tallow is generally non-flammable and in heavily infested situations suppresses herbaceous plants and fine fuel loading, limiting the potential for fire (Grace *et al.* 2001). Thus, the invasion of Chinese tallow converts a fire-adapted grassland site to a non-flammable, near monotypic woodland. Work has been conducted on Brazoria NWR in the Texas Mid-Coast region on the relationship between fire and Chinese tallow. Preliminary results indicate that while total control was not realized with one treatment, some mortality was achieved (Grace 1998). Further, sites with fuel characteristics more typical of coastal prairies (high fuel loading, species composition, and continuity of fuels) achieved better control of Chinese tallow using fire than did abandoned agricultural fields.

The impacts of prescribed burning in wetland habitats (in combination with controlled grazing and water level and salinity management) would include: 1) increasing plant species diversity; 2) maintaining and enhancing desirable emergent marsh plant communities such as Olney bulrush and leafy three-square bulrush; 3) creating openings in otherwise dense stands of emergent marsh vegetation; and 4) helping to control exotic and/or invasive plants. Prescribed burning (integrated with control livestock grazing and water management) in wetland habitats would promote the germination, growth and reproduction of several "early successional" target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato.

The impacts of prescribed burning in upland grassland habitats would include: 1) maintaining and enhancing native prairie plant communities, including several native grasses and forbs, by enhancing conditions which encourage reproduction and growth of these species; and 2) helping to control exotic and/or invasive plants, most notably Chinese tallow and Eastern baccharis, which often outcompete and replace native grasses in areas where fire has been excluded or its frequency decreased.

While this valuable habitat management tool has many positive effects, prescribed burning can have detrimental impacts ranging from an undesirable change in vegetative species composition to actual conversion of emergent marshes to open water when fires occur at the wrong time. Proper timing of burns under appropriate conditions of soil moisture, fuel loads and fuel moisture is essential to minimize negative impacts. For example, burning under excessively dry conditions could result in destruction of desirable vegetation, consume organic matter and decrease marsh soil elevation, which in turn could result in permanent conversion to open water. Hot fires may result in root burns, which can cause mortality of desirable marsh plant species. Fire increases the soil erosion potential until regrowth occurs. Recently burned areas are especially susceptible to erosion during storm surges from tropical storms and hurricanes. Hot fires occurring without adequate soil moisture can also cause a temporary reduction in microflora and microfauna in wetland soils. Burning cannot restore lost marsh or counter the effects of excessive flooding or salinity (Chabreck 1994). Burning is not as beneficial in more saline marshes, because the resulting subclimax plant community is not as diverse (Spicer *et al.* 1986). Under Refuge Expansion Alternatives B, C and D, the USFWS prescribed burning program on newly acquired land would consider factors including soil and vegetative fuel moisture, seasonality and timing, ignition patterns, habitat type and previous burn history to ensure maintenance of diverse and productive at wetland and upland habitats. In addition, the USFWS would use short and long-term ecological fire effects monitoring on newly acquired lands to guide an adaptive approach to implementing its fire management program. Additional research studies to determine fire effects on marsh soils and vertical

accretion, vegetation, and wildlife would be conducted through new and expanded partnerships with the U.S. Geological Survey and academic institutions.

(b). Controlled Livestock Grazing

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would use controlled grazing on newly acquired lands (integrated with fire management and water management) to maintain and increase diversity (plant species composition and structural attributes) and productivity in wetland and upland habitats.

Grazing strategies would include variations in stocking rates, timing (cool vs. warm season) and duration. Smaller grazing units would be grazed on a rotational basis, providing “rest” as needed to maintain plant diversity and productivity. Stocking rates and rotations would be determined annually according to management objectives for the various grazing units and the quantity and condition of forage and availability of fresh water in those units. Cool season and summer cattle grazing on various marsh and upland units would be used. The USFWS would expand the use of high intensity, short duration grazing on upland prairie habitats to mimic historic patterns of herbivory.

Controlled grazing can be an effective and inexpensive tool in wetland and grassland management providing habitat components that benefit waterfowl and other wildlife species. Research indicates that dual use of grasslands by wildlife and livestock is often compatible when livestock grazing is carefully managed and wildlife needs are considered (Holechek 1982).

Grazing (integrated with fire and water management) in wetland habitats on newly acquired lands would be managed to promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Moderate grazing following burns in marshes would result in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Grazing would also help provide optimal physical structure of vegetation for waterfowl utilization in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining plant communities such as seashore paspalum which grow low to the ground. When shallowly flooded, stands of low-growing seashore paspalum and seashore saltgrass interspersed with ponds provide ideal habitat conditions for many waterfowl, shorebird and wading bird species. These conditions would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Specifically, the beneficial effects of the USFWS controlled grazing program in wetland habitats would include:

- Reduction of rank vegetation which enables migratory birds access to roots and tubers of mature plants and shoots of new plants.
- Reduction of competing growth of marshhay cordgrass and other dominant climax plant communities, allowing for the growth of subdominant plant species, many of which are preferred foods of ducks and geese.
- Creation of open water which provides loafing spots for birds and allows them to access aquatic invertebrates.
- Complimenting marsh burning by prolonging the time that browse is available for goose use.

- Increased plant vigor, increased plant productivity, enhanced nutrient recycling, and prevention of excessive build-up of residual plant material.
- Reduction of hazardous fuel loading, reducing the amount and intensity of wildfires.
- Breaking up of capped soils through hoof action, which assists in seedling establishment.
- Maintenance of regrowth of vegetation in recently burned areas in more palatable stages for wintering waterfowl.
- Provides a reliable disturbance tool that is not as dependent on favorable weather and fuel conditions as prescribed fire.

Carefully managed grazing (and prescribed burning) in coastal prairie habitats increases vigor of many native prairie grasses, and increases overall plant species and structural diversity.

Potential detrimental affects of grazing includes the risk of overgrazing, excessive trampling of vegetation, compaction of soils reducing percolation rates, and increased soil erosion. The deposition of excess nutrients in the form of feces in areas where livestock concentrate (USFWS 1994) may negatively impact surface water quality. Fecal coliform from geese and livestock are the main pollutants contaminating the shellfish waters of East Galveston Bay (Galveston Bay Estuary Program 1995). Overgrazing in prairie habitats reduces native prairie plant diversity, as native grasses and some native forbs are more palatable and are preferentially selected by livestock. Soil disturbance by excessive hoof action can provide conditions favorable for establishment of exotic and invasive plant species such as Chinese tallow, and cattle can spread seed of undesirable plant species by physically carrying them or ingesting them. The USFWS would continue to monitor grazing programs and adjust grazing strategies so as to avoid detrimental impacts.

(c). Exotic/Invasive Species Management

Under Refuge Boundary Expansion Alternatives B, C, and D, the USFWS would expand the scope of exotic and invasive species management activities on newly acquired lands. An Integrated Pest Management (IPM) program would be implemented to control the following exotic and invasive plant species:

- Chinese tallow, Eastern baccharis, willow, deep-rooted sedge and King Ranch bluestem in freshwater marshes, prairies, woodlots and on levees and roadsides.
- Water hyacinth, alligatorweed, Salvinia, common reed, and cattail in waterways and managed wetland units.
- Red rice, coffeebean, barnyard grass, and other grasses in rice fields.
- Invasive broadleaf weeds and King Ranch bluestem in restored prairies.

Integrated pest management would be implemented using a combination of treatments including herbicide application, mechanical control, approved and permitted biological controls, prescribed burning, controlled grazing and water level and salinity management. The overall goal of the USFWS IPM program would be to achieve results while decreasing dependence on and use of chemical herbicides to control and manage invasive plant species. Spot treatments using target-specific herbicides would be used in wetland and upland habitats when target stands are small enough to treat by hand. In wetland habitats, this would include treatment of invasive plant species including cattail, common reed, and California bulrush where these plants have formed dense, homogeneous stands which result in pond closure and loss of open water. Control of exotic floating aquatic plants such as water hyacinth, alligatorweed and Salvinia also restores open water habitats. Aerial herbicide application would be

required to initiate control on large mature stands of Chinese tallow. Mowing/haying and burning would be used on upland grassland habitats, and burning, controlled grazing and salinity management would be primary tools used in marsh habitats. Discing or roller chopping would be used in rice fields and moist soil units.

The USFWS would also expand monitoring programs for exotic/invasive species on newly acquired lands using GIS and GPS technologies to document and track infestations and evaluate the effectiveness of treatments. Additional research would also be supported through new and expanded partnerships with the U.S. Geological Survey and academic institutions.

Control of invasive emergent and floating plants in ponds would promote the growth of native floating and submerged aquatic plant species important to native fish and wildlife.

The control of Chinese tallow and deep-rooted sedge in prairie and woodlots would result in increased diversity of native plants. In woodlots, reduction of Chinese tallow and increasing native tree and shrub abundance would likely increase abundance of forage insects for migrating birds (especially Lepidopteran larvae) (Barrow and Renne 2001).

The USFWS would also continue to control exotic animal species to conserve biological diversity and to maintain habitat quality for migratory birds and other native wildlife. Feral pigs are the primary species currently impacting habitats in the project area. Rooting and wallowing by feral pigs causes significant habitat and infrastructure damage. These soil disturbances in marsh and upland sites allow invasive plants to establish and reduce the value of the habitats to wildlife. Feral pigs are particularly damaging to water management infrastructure. They wallow and root extensively on levees and within rice fields and moist soil units affecting the management of thousands of acres habitat. Feral hogs are prolific and are able to exploit wetland and upland habitats. Control of feral hogs would decrease damage to wetland, prairie and woodlot habitats and levees and roads from rooting and foraging, and reduce the creation of disturbed areas that enable establishment of Chinese tallow and other undesirable plants.

Although nutria have not reached population levels capable of damaging habitats in recent years in the project area, this exotic animal has been highly destructive in coastal wetlands in neighboring Louisiana and other coastal states. Control activities for nutria which could be implemented as necessary on newly acquired lands.

(d). Shoreline Protection and Restoration

As discussed under Part B in *Section II.A.2. Impacts to Geology and Soils*, altered hydrological regimes and relative sea level rise resulting in erosion and land loss along the Gulf and Bay shorelines are major threats to wetland and upland habitats on the Refuge Complex. Barrier beach and dunes along the Gulf of Mexico provide habitat for a variety of plant and animal species, protect and stabilize the coastline and help protect landward wetland habitats. Shoreline erosion threatens Gulf of Mexico beach and dune habitats throughout the Chenier Plain region. Although shoreline erosion during storms is a natural process, a severe sediment deficit in the Gulf's littoral system resulting from construction of navigation channels, jetties and upstream dams on rivers has greatly accelerated rates of shoreline retreat. Rising sea levels and land subsidence are also causative factors in the accelerated loss of coastal habitats.

Under Refuge Expansion Alternatives B, C and D, the USFWS would continue involvement in several partnership efforts with other federal and state agencies and conservation organizations to address threats which are resulting in ongoing coastal land loss on newly acquired lands. On McFaddin NWR and Texas Point NWRs, these partnerships would continue to focus on augmenting coarse sediment supply along the Gulf shoreline through dune restoration and beneficial use of dredge material, respectively. Coordination with other agencies and conservation organizations would be expanded, with a goal of implementing a major project to restore the entire barrier beach/dune system on McFaddin NWR. Structural erosion abatement projects would also be implemented, including breakwater construction along the GIWW and East Galveston Bay shorelines.

Restoration of the barrier beach/dune system on McFaddin NWR and increased use of dredged material on Texas Point NWR would contribute to increasing coarse sediment supply and reduced net erosion along shorelines (Chabreck 1976, 1994). If successfully implemented, large-scale restoration of the barrier beach/dune system on McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR could substantially reduce current rates of land loss. These projects would also restore historic elevations along the shoreline and protect inland marshes, and plant productivity therein, by reducing saltwater intrusion. Offshore rock breakwaters and shoreline armoring would also reduce the erosion of shoreline. Restoring emergent marsh by planting smooth cordgrass along shorelines will reduce land loss and increase sedimentation and vertical accretion within vegetation stands.

Shoreline protection and restoration activities on newly acquired lands would continue to positively impact vegetation resources and habitats by restoring upland and protecting existing wetland habitats. Restoration of barrier dunes along the Gulf of Mexico would protect interior intermediate marshes and their plant communities from excessive inundation with saltwater during high tidal events, as well as restoring an upland native habitat type which has been almost completely lost in the project area. Use of dredged material along existing shorelines would protect existing marshes by reducing shoreline retreat and direct loss of these habitats, provide a substrate for reestablishment of marsh vegetation and restoration, and increase net sediment supply to marshes which provides nutrients and increases plant productivity (Chabreck 1976, 1994). Breakwaters would enhance marine habitat by functioning as an artificial reef, providing opportunities for oyster spat, barnacles, algae, baitfish, and predator fish utilization. Restoring emergent marsh by planting smooth cordgrass between the breakwaters and existing shorelines would restore vegetated wetlands that have converted to open water. The stands of smooth cordgrass would also provide habitat for snails, shrimp, crabs, insects, and numerous benthic organisms.

(e). Mowing and Haying

Under Refuge Boundary Alternatives B, C and D, the USFWS would continue to utilize mowing and haying in upland grassland habitats on newly acquired lands. Mowing and haying would invigorate growth of many native grasses, while reducing vigor of undesirable herbaceous weeds and woody plants. Reduction of herbaceous and woody cover often results in the “release” of native prairie plants. Mowing and haying would be used where the vegetation to be controlled is undesirable to livestock, or where the terrain or soil conditions are difficult to graze without excessive environmental damage. Mowing and haying facilitates more control over the amount and locations of vegetation management, however, costs per acre are much higher than for controlled grazing or prescribed burning. Mowing and haying would also reduce use of chemical herbicides.

b. Impacts from Public Use Programs

The greatest potential for impacts to vegetation resources and habitats on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would likely be from motorized boating activities. Motor boats, vehicles and walking would be the primary means of access to areas opened to the public for wildlife-dependent recreational uses including hunting, fishing, wildlife observation and photography and environmental education and interpretation. Wetland vegetation, especially submerged aquatic vegetation, can be impacted by motorboat activity. For example, propeller scarring has been shown to detrimentally impact seagrass beds in the Laguna Madre in South Texas (Pulich *et al.* 1997, Dunton *et al.* 1998) and in Florida (Madley *et al.* 2004). Propeller scarring leaving permanent channels in shallow pond and waterway bottoms on the Refuge Complex has also raised concerns about the potential for increased saltwater intrusion, with concurrent negative impacts on emergent and submergent aquatic vegetation.

Foot traffic in areas open to hunting, fishing, wildlife observation and photography, environmental education and interpretation could lead to vegetation trampling, and in heavy use areas, cause plant mortality. The more extreme impacts would occur in areas heavily used for shoreline fishing. Some vegetation trampling and trailing from hunter foot traffic occurs in marsh habitats in Refuge Complex hunt areas, although these impacts tend to be short-term.

These impacts would be expected to be localized and minimal. Regulations, including horsepower restrictions and area closures to motorized boating would be used to protect wetland habitats and public safety. Access for other recreational and educational uses would be restricted to established roads. The USFWS would also construct trails, boardwalks, and observation platforms and fishing piers on newly acquired lands to support recreational uses while reducing trailing impacts.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

No direct impacts to vegetation and habitats would occur as a result of implementation of the USFWS Biological Program on newly acquired lands. Habitat and vegetation monitoring activities and research studies would support an adaptive management approach by providing information which helps refine and improve existing management practices.

d. Impacts from Management of Oil and Gas Exploration and Development

Lands acquired under Refuge Boundary Expansion Alternatives B, C and D would be acquired subject to exploration and development of reserved and outstanding mineral interests. The USFWS would manage oil and gas exploration and development activities on newly acquired lands through the issuance of Special Use Permits. Stipulations in the Special Use Permit would include those aimed at minimizing impacts to vegetation and habitats, including required use of specialized equipment, location and size of facilities, and required pollution controls. As per federal regulations (50 CFR 29.21), the USFWS would ensure that impacted sites are restored as closely as possible to pre-project conditions upon cessation of activities. Conditions of the Special Use Permit would also require mitigation for all impacted habitats. Required mitigation activities include restoration and/or enhancement of habitats on the Refuge Complex which are similar to those impacted by oil and gas activities.

The net effect of USFWS management of oil and gas exploration and development on newly acquired lands would be to reduce impacts on vegetation and habitats from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife Program and other private lands initiatives such as the Texas Prairie Wetlands Project. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands. It is anticipated that continuation of outreach and partnership efforts would result in additional habitat restoration and enhancement.

5. Impacts to Fish and Wildlife Resources

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS habitat management and restoration and biological program activities on newly acquired lands would be focused on conservation of the following fish and wildlife resources:

- Waterfowl - Wintering and Migrating
- Waterfowl – Resident (Mottled Ducks)
- Shorebirds, Wading Birds, and Other Marsh and Waterbirds
- Landbirds (passerines, raptors, and non-passerines)
- Fisheries
- Threatened and Endangered Species
- Mammals
- Reptiles and Amphibians

- Invertebrates

The USFWS would manage the six priority wildlife-dependent uses on newly acquired lands. These uses would have impacts to fish and wildlife. Impacts would be mitigated by on-refuge habitat management activities, refuge-specific regulations governing public uses, and law enforcement for protection of natural resources and public safety.

USFWS management of oil and gas exploration and development and community outreach and partnership programs would also impact these resources.

a. Impacts from Habitat Management and Restoration Activities

(1). Impacts to Migrating and Wintering Waterfowl

Coastal habitats in Texas are part of the southern terminus in the U.S. for most of the ducks and geese in the Central Flyway. The 2004 mid-winter waterfowl survey indicated that 7,901,489 waterfowl used the Central Flyway. Of those birds, 5,110,022 waterfowl (65%) wintered in Texas. Available wintering waterfowl habitat in Texas is shrinking due to changes in agricultural uses, industrial and urban development, increased pollutants (Cain 1988), land subsidence, rising sea levels, and man-made hydrological changes such as canals resulting in saltwater intrusion (Michot 1996). Loss or degradation of habitat on landscape scale increases the importance of public and private lands managed specifically for supporting wintering and migrating waterfowl.

Since the mid-1950s to the early 1990s, approximately 211,000 acres of wetlands were lost on the Texas Gulf Coast, to both natural and man-made causes (Moulton *et al.* 1997), with most of the palustrine wetland lost to agriculture (in recent years agricultural lands have decreased due to urban development). Palustrine emergent marshes showed the largest decline, primarily by conversion to upland agriculture and other uses; and most estuarine wetlands loss was due to land subsidence. Tacha *et al.* (1992) concluded that between 1976 and 1991 the total ducks in the Chenier Plain of Texas declined by 89%, and these decreases were highly correlated with losses and degradation of wetland habitat.¹⁹ Wintering and migrating waterfowl along the Texas Coast tend to prefer freshwater coastal marshes and freshwater prairie wetlands. Rice agriculture provided an especially valuable habitat for wintering waterfowl.

Under Refuge Boundary Expansion Alternatives B, C and D, the following USFWS management activities would have the greatest impacts on wintering and migrating waterfowl populations in the project area.

(a). Wetlands Management and Restoration

Under Refuge Boundary Expansion Alternatives B, C and D, marsh habitats on newly acquired lands would be structurally managed to enhance habitat for wintering waterfowl and other migratory birds. This management activity would utilize existing water control structures, levees, and water delivery systems. Marsh management would help maintain the full continuum of marsh types, from fresh to saline, and native emergent, submergent and floating plant communities which provide food for wintering waterfowl. For example, structural management of brackish and intermediate marshes may directly increase the abundance of preferred plant species, such as Olney bulrush and widgeongrass, which provide food resources for wintering and migrating waterfowl (Chabreck 1976, Broome *et al.* 1995). Management of water levels would also provide optimal conditions for foraging and resting waterfowl.

The USFWS would use moist soil management on newly acquired lands to provide shallow freshwater wetland habitat for wintering and migrating waterfowl. Existing rice farming infrastructure on permanently fallowed fields would be adapted to provide this capability. Moist soil management provides optimal conditions for germination and growth of preferred waterfowl food plants, including annual grasses such

¹⁹ During the 1969 through 1994 period, the Louisiana coastline experienced major wetland losses, similar to the Texas coast. However, there appears to have been no declines in duck populations of coastal Louisiana marshes between 1969 and 1994 (Michot 1996).

as millets and sprangletops and several forbs including smartweeds, Delta duck potato, and purple ammenia.

The USFWS would use a cooperative rice farming program on newly acquired lands, also to provide shallow freshwater wetlands with high quality forage for wintering and migrating waterfowl. Management of first year fallowed rice fields would also provide weeds and seed that are heavily utilized by waterfowl.

The USFWS would implement marsh and wetland restoration activities on newly acquired lands. Restoration would create additional emergent marsh and open water habitats and provide additional habitat for wintering and migrating waterfowl.

Wetland management and restoration implemented by the USFWS on newly acquired lands would likely increase use by wintering and migrating waterfowl. Management and restoration of newly acquired lands would benefit three wintering waterfowl species listed by the USFWS as Game Birds Below Desired Condition: Northern Pintail, Lesser Scaup and Ring-necked Duck. On a year-to-year basis, overall habitat quality for waterfowl on Refuge lands and in the project area as a whole will continue to be influenced by climatic events and trends, most specifically by extreme periods of drought or high rainfall and/or the occurrence of tropical storms and hurricanes and associated tidal surges. Annual fluctuations in waterfowl numbers in the project area would also be expected based on a variety of factors including trends in continental waterfowl populations, habitat conditions affecting wintering distribution along migration routes and in wintering areas (as affected by climatic conditions), regional and local changes in agricultural land uses and practices, and variability in regional and local hunting pressure. Recent decreases in rice production have reduced available habitat and subsequently wintering waterfowl numbers in the project area, and any future declines in rice production would further exacerbate these impacts.

(b). General Habitat Management and Restoration Activities

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would use an integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats to create optimal habitat conditions for wintering waterfowl and other migratory bird species. Prescribed burning and controlled grazing would promote the germination, growth and reproduction of several “early successional” target plant communities which are especially beneficial to migratory birds as food sources (Allen 1950, Gosselink *et al.* 1979). Burning and moderate grazing would also result in the growth of new grass shoots, a valuable food for snow geese (Gosselink *et al.* 1979). Target plant communities in intermediate and brackish marsh habitats would include Olney bulrush, saltmarsh bulrush, seashore paspalum, seashore saltgrass and annual grasses including millets and sprangletops, several sedges, and several annual forbs such as purple ammenia and Delta duck potato. Burning and grazing would also help provide optimal physical structure of vegetation for waterfowl utilization of emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining plant communities with low growth habits such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions would also provide excellent habitat for many invertebrate species, another important food source for waterfowl and other migratory birds.

Waterfowl habitat on newly acquired lands would be enhanced through the control of undesirable invasive vegetation such as common reed, cattail, and California bulrush in areas where these plants have formed dense homogeneous stands and resulted in loss open water habitats. Infestations of exotic and invasive floating plants such as water hyacinth, alligatorweed and *Salvinia* would also be controlled to restore and maintain open water habitats. Maintaining an interspersed of open water and vegetated emergent wetlands would provide the habitat diversity needed to support wintering waterfowl and other migratory birds. Restoring open water habitats would increase the production of submerged and floating aquatic plants, an important food source. Control of Chinese tallow and deep-rooted sedge in and adjacent to freshwater marshes, moist soil units and rice fields would also enhance waterfowl habitat.

The USFWS would implement shoreline protection and restoration activities on newly acquired lands, which would enhance wintering waterfowl habitat by decreasing saltwater intrusion into inland marshes and reducing threats of additional saltwater intrusion. 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 could substantially enhance wetland habitats for wintering waterfowl on these refuges. Offshore rock breakwaters and shoreline armoring on East Galveston Bay and the GIWW would protect habitats of high importance to wintering waterfowl.

(2). Impacts to Resident Waterfowl - Mottled Ducks

Mottled Ducks are year-round residents of the Chenier Plain region. This species prefers fresh to slightly brackish marshes (Gosselink *et al.* 1979), although a variety of marsh habitats, prairie, and agricultural wetlands (rice fields) are also utilized. Mottled Ducks in the project area are part of the western Gulf Coast (WGC) population of Mottled Ducks. Banding studies have indicated that WGC Mottled Ducks do move between Mexico, Texas, Louisiana and Mississippi and Alabama, but no interchange occurs between this population and the Florida population of Mottled Ducks.

Mottled Duck numbers on the Refuge Complex (and other national wildlife refuges on the Texas Coast) have declined precipitously during the last 20 years, as indexed by annual breeding pair surveys and monthly aerial counts conducted September through March (USFWS, Division of Migratory Birds, unpublished reports). Stutzenbaker (1988) reported that the most serious threat facing Mottled Ducks is degradation and loss of habitat. In Texas, factors contributing to loss of habitat include conversion of native habitats for agricultural and urbanization, drainage, marsh subsidence, saltwater intrusion, spread of introduced species (Stutzenbaker 1988, Morton and Paine 1990), as well as increased pollutants (Cain 1988). Saltwater intrusion into wetlands that range from fresh to moderately brackish probably affects growth and survival of ducklings (Moorman *et al.* 1991). Encroachment of Chinese tallow into nesting habitat probably leads to abandonment of nesting areas (Stutzenbaker 1988). Other potential factors influencing Mottled Duck populations include extended periods of drought, mortality from predation due to increasing populations of alligators and possible increases in mammalian predators, a continued high incidence of lead pellet ingestion, and harvest (USFWS Division of Migratory Birds, unpublished reports).

Under Refuge Expansion Alternatives B, C and D, the following habitat management and restoration activities would continue to be the primary management activities impacting Mottled Ducks on newly acquired lands. All would be expected to have positive impacts on this species, although the landscape level issues described above are likely to control population dynamics of the WGC Mottled Duck population.

(a). Wetlands Management and Restoration

Wetland management and restoration activities on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would provide and enhance habitats used by Mottled Ducks for foraging, resting, pair establishment, brooding and molting. Managing water levels and salinities in managed coastal marsh units would maintain fresh, intermediate and brackish marsh habitats, all of which are important to Mottled Ducks. Marsh management also would enhance diversity and productivity of submerged aquatic vegetation which provides important year-round food sources for Mottled Ducks. Moist soil management and the cooperative rice farming program would provide critical shallow freshwater habitat and nutritious food resources for use by Mottled Ducks year-round. The USFWS would manage selected moist soil units each year specifically to provide brood-rearing habitat for Mottled Ducks during summer.

(b). Uplands Management and Restoration

The historical prairie-wetland continuum of the upper Texas Coast provided nesting cover and brood habitat for Mottled Ducks in close proximity. In a study of Mottled Duck nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton 2003). The dense nesting cover and

mima mounds that are characteristic of native coastal prairie probably provided excellent nesting habitat for resident Mottled Ducks. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as “sennabean ponds,” as valuable brood rearing habitat.

Under Refuge Boundary Expansion Alternatives B, C and D, native prairie restoration and management activities on newly acquired lands would benefit Mottled Ducks primarily by protecting, restoring and enhancing nesting and brood-rearing habitats.

The native coastal prairie habitats within the proposed refuge boundary expansion areas under Refuge Boundary Expansion Alternatives C and D have great potential to provide high quality nesting and brood-rearing habitat for this species. USFWS management activities in native prairie habitats and adjacent fallowed agricultural lands would be aimed at increasing native plant species diversity and productivity. The USFWS would use integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing/haying to restore the historic mosaic of prairie plant communities and the different structural characteristics of these habitats. Brush encroachment by exotic and native plant species would be reduced. Previously-drained shallow depressional “prairie wetlands” within extant stands of native prairie would be restored. Additional native prairie and freshwater wetlands (using moist soil management) would be restored on adjacent fallowed agricultural fields. Restored and enhanced prairie habitats and prairie wetland habitats would likely increase overall reproductive success of Mottled Ducks in the project area.

(c). General Habitat Management Activities

Under Refuge Expansion Alternatives B, C and D, the USFWS would use prescribed burning, grazing, and exotic/invasive species management, and shoreline protection and restoration activities on newly acquired lands. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats would enhance wetland and upland habitats used by Mottled Ducks during all life history phases: pair formation, breeding, nesting, brood rearing, molting and wintering. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for Mottled Ducks, as would shoreline protection and restoration activities. If successfully implemented, large-scale restoration of the barrier beach/dune system on newly acquired lands within McFaddin NWR and additional beneficial use of dredge material projects on Texas Point NWR would enhance wetland habitats for Mottled Ducks on these refuges. Offshore rock breakwaters and shoreline armoring on East Galveston Bay and the GIWW would protect habitats of high importance to Mottled Ducks.

(3). Impacts to Shorebirds, Wading Birds, and other Marsh and Waterbirds

Because the category of shorebirds, wading birds, and other marsh and waterbirds consists of a wide variety of species, individual species use microhabitats (e.g., vegetative cover and water depth) differently than other species in the same category (Gosselink *et al.* 1979, Skagen *et al.* 1999). For example, bare to sparse vegetative cover for foraging is preferred by species such as Piping Plover (Federally listed Threatened) and the Least Tern (State-listed Endangered). Denser vegetation is preferred by other species, for example Little Blue Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Least Bittern, American Bittern, King Rail, and Clapper Rail. Other species have broad vegetation density requirements, and can utilize areas ranging from relatively bare of vegetation to dense vegetation, for example Reddish Egret (State-listed Threatened) and Wood Stork (State-listed Threatened).

This category of avian species also varies greatly in the amount of soil moisture and water depths they prefer, usually for feeding activities. These requirements range from relatively dry or shallow water (a few centimeters deep), such as the Piping Plover, to slightly deeper (but still relatively shallow) water, such as the Western Sandpiper and Least Sandpiper, to waters about 8-12 cm deep, such as the Black-bellied Plover and Willet. Other species prefer deeper waters, often within wading depth for long legged birds, such as the White-faced Ibis (State-listed Threatened) and the Least Tern. Some species can utilize deep waters as well as shallower waters (Wilson’s Phalarope, Red-necked Phalarope, Olivaceous Cormorant, Double-breasted Cormorant, Laughing Gull, and Forster’s Tern). Some species are year-

round residents, such as Brown Pelican (Federally listed Endangered), Double-breasted Cormorant, Great Blue Heron, Little Blue heron, Great Egret, and Black Skimmer. Other species are mostly migrant, including Wood Stork, White Ibis, and Forster's Tern.

Because of the wide diversity of habitat requirements by this category of birds, USFWS habitat management and restoration activities on newly acquired lands which result in a mosaic of diverse habitat types (plant species composition, structural characteristics, water levels and salinities) would positively impact shorebird, wading bird, marsh and waterbird species found in the project area.

(a). Wetlands Management and Restoration

The USFWS would manage water levels and salinities (by utilizing water control structures, levees, impoundments, etc.) in structurally managed marshes on newly acquired lands, which would protect and enhance habitats used by many avian species in this group. In general, shorebirds and wading birds would benefit from moist soil management and rice farming activities on newly acquired lands that would result in increased abundance of invertebrates and plants that are a preferred food source (Chabreck 1976, Broome *et al.* 1995). Management of agricultural crops such as rice can increase nesting habitat as well as provide foraging opportunities for some bird species in this category (Czech and Parsons 2002). The timing and depth of flooding on managed agricultural fields would influence the type of and intensity of use by such birds (Huner *et al.* 2002).

The USFWS would manage some moist soil units on newly acquired lands specifically to provide wetland and mudflat habitat for shorebirds during spring and fall migrations. Targeted shorebird species would include several species identified as Avian Species of Conservation Concern and/or as needing conservation action under the U.S. Shorebird Conservation Plan, Gulf Coast Joint Venture All-bird Conservation Initiative and North American Waterbird Conservation Plan: Long-billed Dowitcher, Semi-palmated Plover, Black-bellied Plover, Black-necked Stilt, Whimbrel, American Avocet, Long-billed Curlew, Hudsonian and Marbled Godwits, and Semi-palmated, Western, Least, White-rumped, Baird's, Pectoral, Stilt and Buff-breasted Sandpipers. Wading and marsh bird species using moist soil habitats would include American Bittern, Great Blue Heron, Great Egret, Snowy Egret, Little Blue Heron, Tricolored Heron, Black-crowned and Yellow-crowned Night Herons, White Ibis, White-faced Ibis, and Roseate Spoonbill.

(b). Uplands Management and Restoration

Under Refuge Boundary Expansion Alternatives B, C and D, restoration and enhancement of native prairie habitats on newly acquired lands would benefit some avian species in this category, primarily by providing improved habitat for migrating and wintering birds. Three Avian Species of Conservation Concern (USFWS 2005) (also listed as needing conservation action under the U.S. Shorebird Conservation and North American Waterbird Conservation plans) would benefit from these activities: Yellow Rail, Black Rail, and Buff-breasted Sandpiper.

(c). General Habitat Management Activities

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would conduct prescribed burning, controlled grazing, and exotic/invasive species management, and shoreline protection and restoration activities on newly acquired lands. The integrated combination of water level and salinity management, fire management and controlled livestock grazing in wetland habitats would enhance wetland and upland habitats used by many shorebird, wading bird and marsh bird species. Water management activities in coastal marshes which maximize the annual production of desirable submerged aquatic plant species provide improved habitat for invertebrates and small vertebrates, which are the primary prey items for many shorebird, wading bird and marsh bird species. Prescribed burning and controlled livestock grazing would help create optimal physical structure of vegetation for shorebirds and wading birds in emergent marshes and other vegetated wetlands (flooded moist soil and rice fields) by creating openings in otherwise dense stands of vegetation and maintaining short plant communities such as seashore paspalum which when shallowly flooded provide ideal habitat conditions. These conditions

also provide excellent habitat for many invertebrate species, another important food source for shorebirds. Exotic and invasive plant and animal control activities would also enhance wetland and upland habitats for these species. The removal of invasive vegetation that forms dense, homogeneous stands resulting in pond closure, such as common reed, cattail, and California bulrush, would improve habitat conditions for wading bird and marsh and waterbird species that utilize open water habitats. Shoreline restoration activities including dune restoration and creation of emergent marsh and mudflats in intertidal zones behind breakwaters would benefit many shorebird and wading bird species.

Short-term studies show that the lack of vegetative cover in the months immediately following a burn has a negative effect on King and Clapper Rails (Sikes 1984), Yellow Rails (Mizell 1998), sparrows (*Emberizidae*) and wrens (*Troglodytidae*) (Gabrey *et al.* 1999). In some situations, leaving unburned patches of vegetation for cover for Yellow Rails (Mizell 1998), sparrows, and wrens (Gabrey *et al.* 1999) can partially mitigate this negative effect. Fires in coastal wetlands are considered stand-replacing fires (Wade *et al.* 2000). Not surprisingly, these secretive marshland bird species decline in the first year post fire. Other bird species such as Icterids (Gabrey *et al.* 2001) and Wilson's Snipe (USFWS unpublished data) increase immediately post-burn.

The susceptibility of wildlife to mortality during fire events seems to be dependent on weather, fuel characteristics (moisture, loading and continuity), fire characteristics (as influenced by ignition strategies), and the capability and behavior of the species in question. Black rail mortality has been observed where large areas are burned with little unburned escape cover available, while mortality was not observed in a burn containing a mosaic of unburned escape cover (Legare *et al.* 1998). No fire induced mortality was observed for three species of rail during fire operations on the Texas mid-coast, though data were insufficient to draw strong conclusions (Grace *et al.* 2005). Burns conducted under fuel and weather conditions that allow for patches of unburned habitat within the unit may minimize wildlife mortality. Burns ignited in a way that maximizes escape options, primarily through the use of backing and widely spaced strip flanking fires, probably minimizes wildlife mortality while maintaining fire-dependent habitat. The USFWS would use these techniques in prescribed burning operations on newly acquired lands.

Some USFWS management activities on newly acquired lands could negatively impact some species of shorebirds, wading birds, and marsh and waterbirds. For example, some species in this group have a relatively narrow range of optimal water depth for feeding and other activities, ranging from almost dry sediment to relatively deeper water (Skagen *et al.* 1999). Management activities that increase water depth may negatively impact those species that prefer shallow or no water, and those that prefer deeper water are negatively impacted when management activities lower water levels. Similar impacts could occur with management of vegetative cover, as some species prefer areas devoid of vegetation, while others prefer heavy vegetative cover. However, most avian species in this group (especially migrants) have evolved with unpredictable available resources, and are able to find suitable microhabitats in an adequately diversified landscape that contains a mosaic of microhabitats, both spatially and temporally. The USFWS strategy of management to maintain a mosaic of available habitats and resources should provide an adequate range of habitats for this group of avian species.

Other habitat management activities could negatively impact some species of shorebirds, wading birds, marsh and waterbirds, especially if improperly implemented or timed. Grazing could negatively impact some ground-nesting species such as Black-necked Stilts by trampling nests and grazing on emergent pond vegetation used by those birds, and may also disturb nesting pairs (Whyte and Cain 1979).

(d). Management of Oil and Gas Exploration and Development

Lands acquired under Refuge Boundary Expansion Alternatives B, C and D would be acquired subject to exploration and development of reserved and outstanding mineral interests. Under Refuge Boundary Expansion Alternatives B, C, D, the USFWS would continue to manage oil and gas exploration and development activities on newly acquired lands through the issuance of Special Use Permits. Stipulations in the Special Use Permit include those aimed at minimizing impacts to shorebirds, wading birds, marsh and other waterbirds, including timing of activities to avoid major periods of utilization, offsets

to avoid nests and concentrations of birds, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development would be to reduce impacts on fish and wildlife resources, including avian species in this group, from these activities.

(4). Impacts to Landbirds

Landbird species found in the project area use a wide variety of habitats. Many passerines are trans- and circum-Gulf migrants, and require coastal wooded areas as stopover habitat (food, cover, and water) as they make first landfall during spring on the Texas Gulf Coast (Mueller 1981, Barrow *et al.* 2000). Some raptor species prefer intermingled field and forested areas (e.g., red-tailed hawks and owls). Other land bird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted by the USFWS on newly acquired lands under Refuge Boundary Expansion Alternatives B, C and D would benefit avian species in this group. Although comprising a relatively small portion of the overall habitats within the project area, restoration, management and protection of native prairies, coastal woodlots and near-coastal forested wetlands (bottomland hardwoods) are of particular significance because of the importance of these habitats to many passerine species, including many neotropical migratory birds.

(a). Wetlands Management and Restoration

The USFWS would implement wetland management and restoration activities on newly acquired lands. Managing water levels and salinities in coastal marshes, marsh restoration, moist soil management, and the cooperative rice farming program would benefit resident and migratory landbirds which depend on wetland habitats. Several landbird species listed as Avian Species of Conservation Concern (USFWS 2005), including the Seaside Sparrow, Nelson's Sharptailed Sparrow and Sprague's Pipit, would benefit from protection, restoration and enhancement of coastal marsh habitats on the Refuge Complex.

(b). Uplands Management and Restoration

Prairie Restoration and Management

Many animal species typical of northern prairies, such as Henslow's Sparrows, smooth green snakes, and prairie voles, were all found year-round in the Gulf coastal prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf coastal prairies as wintering and/or migratory habitat. Many of the landbirds that would benefit from protection and management of native coastal prairie habitats under Refuge Boundary Expansion Alternatives B, C and D are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as "Avian Species of Conservation Concern" in the Gulf Prairies Bird Conservation Region (USFWS 2005). For example, White-tailed Hawk, Northern Bobwhite, Yellow and Black Rail, Buff-breasted Sandpiper, Short-eared Owl, Sedge Wren, and LeConte's Sparrow are all Avian Species of Conservation Concern that would benefit from conservation of prairie habitats on the Refuge Complex.

The native coastal prairie habitats within the proposed refuge boundary expansion areas under Refuge Boundary Expansion Alternatives C and D have great potential to provide high quality wintering and nesting habitat for several grassland songbird species. The USFWS would manage and restore native prairie habitats and adjacent fallowed agricultural lands on newly acquired lands to increase native plant species diversity and productivity. The USFWS would use integrated application of prescribed burning, controlled livestock grazing, herbicide application, and mowing/haying to restore the historic mosaic of prairie plant communities and the different structural characteristics of these habitats. This habitat

diversity would in turn support many species of grassland songbirds. Native prairie and other upland grassland habitats on newly acquired lands would provide enhanced wintering and migrational habitat for several grassland songbird species including LeConte's Sparrow and Nelson's Sharp-tailed Sparrow, and nesting habitat for species including Dicksissel and Eastern Meadowlark. Landbirds listed as Avian Species of Conservation Concern utilizing prairie habitats and which would benefit from conservation and management of native coastal prairie in the project area include LeConte's Sparrow, Henslow's Sparrow, Sedge Wren, Loggerhead Shrike, and White-tailed Hawk.

Woodlot Restoration and Management

Although comprising a small percentage of the upland habitats in the project area, coastal woodlots help support a diverse avian community, which includes several sensitive songbird species. Six of the seven avian species listed as Rare and Declining within the coastal prairies region in Texas are present in the project area's coastal woodlots. Migratory birds also depend on coastal woodlots for cover and food. At least 63 species of migratory birds regularly use the wooded habitats of the Chenier Plain region prior to or immediately after crossing the Gulf of Mexico (Barrow *et al.* 2000). Trans-gulf or circum-gulf migratory songbirds use Texas coastal woodlots as stopover habitat (Mueller 1981), which is critical at a time when the birds are depleted of water and energy reserves (Leberg *et al.* 1996).

A primary threat to coastal woodlots is encroachment by the Chinese tallow tree, which provides poor habitat for migratory songbirds. Although the Chinese tallow trees attract birds as frequently as other trees, they provide poorer forage because of sparse insect populations. Specifically, they harbor fewer insects and spiders, especially *Lepidopteron* larvae. Chinese tallow woodlots may thus be an "ecological trap" that provide cover but little food for migrants when they are energy-depleted after migration (Barrow and Renne 2001). Rooting by feral hogs can also damage understory vegetation and soils, and may also cause a shift in plant succession. Such activities can also create disturbed areas that enable easier establishment of invasive plant species. Feral hogs may also directly compete with several species of native wildlife for certain foods.

Under Refuge Boundary Expansion Alternatives B, C and D the following USFWS management actions on newly acquired lands would have beneficial impacts on coastal woodlots: 1) native tree and shrub plantings; 2) exotic/invasive species management (primarily to reduce Chinese tallow and feral hog populations), and 3) fencing of selected woodlots to protect them from grazing impacts.

Under Alternative D, the USFWS would protect bottomland hardwoods along Taylors Bayou in Jefferson County, an important near-coastal forest that is heavily utilized by neotropical migratory birds, especially during spring migration. Radar studies have identified this area as an important annual "fall-out" area, where large numbers of songbirds stop to rest and renew energy reserves following their trans-Gulf migration (Dr. Sidney Gauthreaux, Clemson University, personal communication).

Overall, implementation of the USFWS management activities on newly acquired lands would improve coastal woodlot habitat by increasing native plant abundance and diversity, creating additional understory, and allowing natural regeneration of native woody species. Restored and enhanced coastal woodlots would provide quality habitat for neotropical migratory birds and resident songbirds that require native trees or understory for cover and foraging. Protecting a riparian bottomland hardwood forest under Refuge Boundary Expansion Alternative D would ensure conservation of a near-coastal forest which is especially valuable to neotropical migratory birds. Species to benefit would include three neotropical migratory birds considered to be Avian Species of Conservation Concern: Swainson's Warbler, Prothonotary Warbler, and Kentucky Warbler. Since acreage of woodland habitat in the project area is small relative to its importance to migrating neotropical migratory birds and resident landbirds, such positive impacts for each acre protected are proportionately significant.

(c). General Habitat Management Activities

The USFWS would use prescribed burning, controlled grazing, exotic/invasive species management, and shoreline protection and restoration on newly acquired lands. The integrated combination of water level

and salinity management, fire management and controlled livestock grazing would enhance wetland and upland habitats used by many 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. For example, control of Chinese tallow would lead to increased diversity of native woody plants in the coastal woodlots, as well as increased forage insects (especially Lepidopteran larvae) for migrating passerines and other birds. Chinese tallow stands have an ecological trap effect for migrant songbirds that are drawn to the cover of the woodlots, but then find insufficient food resources to replenish depleted energy reserves (Barrow and Renne 2001).

Seaside Sparrow habitat use is influenced by fire. Whitbeck (2002) found densities of singing males 2.8 (2.2-3.2) times higher the second breeding season following fire than the first, third or fourth season. Gabrey *et al.* (2001) reported that breeding Seaside Sparrows in Louisiana declined in the first year post-fire, increased in the second, and dropped to levels similar to the first year post-fire by the third. It is possible that second year post-fire habitat offers the greatest interspersed nesting and foraging habitat, though this theory has yet to be tested.

Gabrey *et al.* (1999) found that Seaside Sparrows, Nelson's Sharp-tailed Sparrows, Marsh Wrens, and Sedge Wrens declined in the first winter following a burn, but returned in the second winter. In some situations, leaving unburned patches of suitable habitat can partially mitigate this negative effect. Baldwin (2005) studied over-wintering passerines in coastal prairie on the Texas Mid-Coast. This study found that Savannah Sparrows were highly associated with prairies the first year post-burn, LeConte's Sparrow were most common in prairies burned within the past two years, and Sedge Wrens were most likely to be found in prairies three years post fire. These data indicate that a burn regime varied temporally and spatially is the key to providing habitat for native wildlife and that an inactive burn program can be detrimental to grassland dependent wildlife.

The USFWS fire management program on newly acquired lands would incorporate known habitat needs of the diverse avian communities found on the refuges.

(5). Impacts to Fisheries Resources

(a). Wetlands Management and Restoration

Estuarine coastal marsh habitats support over 95 percent of the Gulf of Mexico's commercial and recreational fisheries species during some portion of their life cycles. Tidal marshes serve primarily as nursery areas for many transient estuarine species that return to larger water bodies upon maturing. Densities of most organisms are highest within 3 m of the water's edge, indicating the importance of marshes to a diversity of species (Peterson *et al.* 1994). The flooded interior marsh was found to be more important for resident species. White and brown shrimp show a strong preference for marsh edges and limit use of flooded marshes to edges (Peterson *et al.* 1994). Blue crabs utilized the entire estuary with juveniles showing strong preferences for flooded marshes (Zimmerman & Minello 1984, Hettler 1989, Thomas *et al.* 1990, Kneib 1991, Rozas 1995).

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would continue to structurally manage marshes, restore coastal wetlands, and conduct vegetative management activities including prescribed burning, controlled livestock grazing, exotic plant and animal control, and shoreline restoration and protection. These management activities would protect, restore and enhance estuarine wetlands, and ensure wetland habitat diversity and productivity important to a variety of fish and shellfish species. The continuum of fresh to saline aquatic environments in the project area support highly diverse aquatic vertebrate and invertebrate communities.

Managing water levels and salinities (using water control structures, levees, impoundments, etc.) in managed marsh units may restrict access of some finfish and invertebrate fisheries species to managed areas. Actively managing water levels may impede access for some aquatic organisms, such as fish and crustaceans (Rogers *et al.* 1992, Kuhn *et al.* 1999). A well vegetated marsh that is not regularly inundated and not accessible to fisheries and invertebrates may not be as productive for fisheries as a

natural stable or deteriorating deltaic marsh (Peterson *et al.* 1994). Densities of resident fisheries in structurally managed marshes can be either higher or lower than unmanaged marshes, depending on implementation of spring drawdown (Rozas and Minello 1999). In contrast to resident species, this study found transient species to be lower in structurally managed marshes regardless of drawdown.

Impacts of structural marsh management to fisheries resources would be reduced by the USFWS on newly acquired lands by incorporating design features into existing water control structures such as vertical slots which allow passage of estuarine organisms, managing structures to facilitate ingress and egress by opening gates during key movement periods, and utilizing rock weirs to counter erosion and enlargement of tidal waterways (as opposed to traditional fixed crest weirs). Ingress/egress slots allow more marine organism passage than fixed crest weirs, with larger openings allowing greater fisheries access (Herke *et al.* 1992). These slots provide a means of allowing movement of estuarine organisms in and out of structurally managed marshes, but assist in maintaining the fresher end of the coastal marsh continuum.

Periods of peak ingress and egress movements are associated with water level fluctuations and tidal cycles. Highest peak fisheries resource movements are often related to periods of combined lunar cycles and major tidal movements. Manipulating water control structures during the full moon and new moon of the lunar cycle allows opportunity for the maximum ingress potential of fisheries resources. Holding slight levels of excess water for several days prior to these cycles and releasing during peak ingress periods greatly increases access to the unit from fisheries species dependent on coastal estuaries. Many species will move towards fresher water during incoming tides (Guillory 1996). The USFWS would also use these techniques on newly acquired lands to enhance fisheries utilization of managed marsh units.

Structural marsh management is employed on portions of the Refuge Complex to reduce impacts of saltwater intrusion and subsequent marsh loss as well as to maintain the historic salinity gradient that characterized coastal marshes of the Chenier Plain. Target salinity ranges typical of structurally managed marshes range from fresh to the low end of brackish, being primarily intermediate (0.5-5.0ppt). While these salinity ranges are used by estuarine species, a study of fisheries use along a salinity gradient in Galveston Bay (Zimmerman *et al.* 1990) found estuarine fisheries were not greatly attracted to intermediate (oligohaline) marshes of the Trinity River delta. This study concluded that the oligohaline environment was not favorable for development of preferred foods, primarily epiphytic algae and peracarid crustaceans. Further, while transient species such as juvenile shrimp, crabs, and fishes had ready access to oligohaline marshes in this area, they did not use them extensively. These data indicate that while water control structures may limit ingress/egress of estuarine organisms, the habitat within may not be optimum for these organisms compared to brackish and saline marshes available on the Refuge Complex.

(6). Impacts to Threatened and Endangered Species

Three avian species occurring in the project area are Federally-listed as Threatened or Endangered: Bald Eagle, Piping Plover, and Brown Pelican.

The Texas Parks and Wildlife Department lists six avian species and three species of reptiles which occur or potentially occur on the Refuge Complex as Threatened or Endangered: Arctic Peregrine Falcon, Reddish Egret, Wood Stork, White-Faced Ibis, Interior Least Tern, American Swallow-tailed Kite, smooth green snake, alligator snapping turtle and the Texas horned lizard. Several additional species of reptiles and amphibians are listed in the Texas Natural Heritage Database, now maintained by the Texas Nature Conservancy's Texas Conservation Data Center.

Under Refuge Boundary Expansion Alternatives B, C and D, protection, restoration and management of coastal wetland habitats on the Refuge Complex would benefit the three avian T&E species. Bald eagles observed on the Refuge Complex are usually associated with large concentrations of wintering waterfowl. Brown pelicans utilize shorelines and tidal saline ponds for resting and foraging. Shoreline restoration and protection activities would provide improved habitat for Piping Plover and Brown Pelican. Conservation and management of both wetland and upland habitats aimed at ensuring biological integrity

and biological diversity under Refuge Boundary Expansion Alternatives B, C, and D would benefit Threatened and Endangered species and many other sensitive or declining native fish and wildlife species, including several State-listed T&E species.

(7). Impacts to other Fish and Wildlife Species – Mammals, Reptiles and Amphibians, and Invertebrates

Mammals typically found in the project area include muskrats, coyotes, raccoons, bobcats and river otters. Vegetation and other habitat requirements vary greatly among the different mammal species. Muskrat habitat includes brackish and intermediate marshes where they can build burrows or lodges from vegetation or underground. Coyotes and bobcats are found in a wide variety of habitats (but prefer early successional stages of vegetation), and are also highly opportunistic omnivores, adapting to a wide variety of food sources. Raccoons utilize canal levees, bayou edges, mud banks and beaches, marshes, and upland habitats, feeding largely on fish and crayfish, but also many plant species. River otters use various wetland habit types, including open waters, feeding mainly on various aquatic and semi-aquatic fish, shellfish and small animals.

In general, USFWS habitat management and restoration activities on newly acquired lands under Refuge Expansion Alternatives B, C and D which maintain naturally diverse and productive wetland and upland habitats would benefit a broad array of wildlife species.

USFWS management activities under which maintain and restore freshwater wetland habitats (structural management of marshes, moist soil management, rice farming) are particularly beneficial to amphibians and reptiles. Reliable freshwater habitat is critical for most amphibians and reptiles found on the Refuge Complex, including frogs, salamanders, aquatic snakes, turtles, and alligators. Habitat conditions which increase the abundance of insects, crustaceans, and other small prey benefit most species of amphibians and reptiles during at least a portion of their lifecycle. Surveys conducted on and around McFaddin NWR found that anurans have a strong preference for structurally managed marshes compared to adjacent unmanaged areas (USFWS 2006). This indicates that lower salinities provided through structural marsh management is preferable over higher salinities found in unmanaged areas.

Control of exotic and/or invasive woody species in wetland and upland habitats on newly acquired lands may decrease habitat quality for certain mammals such as raccoon and striped skunk. Large, intense and fast-moving fires may result in direct mortality of less mobile species such as small mammals, amphibians, and some reptiles, and invertebrates.

Fire has been shown to alter invertebrate communities in marshes and prairies. A study conducted in brackish marshes (*Distichlis spicata* being the dominant plant species) found that many dominant macro- and microinvertebrates were at higher densities in burned areas than unburned controls (de Szalay and Resh 1997). A notable exception was lower densities of copepods in burned areas. A review of literature available on the effects of fire on invertebrates (Higgins *et al.* 1989) summarizes by saying "Fire causes an immediate decrease in insect populations (except ants and other underground species), followed by a gradual increase in numbers as the vegetation recovers. The insects eventually reach a population level higher than adjacent areas, then decline to near preburn levels as vegetation and soil litter stabilize." Research conducted in coastal prairie in Galveston County, Texas found that arthropod diversity increased with frequent burning (Hartley, unpublished data). It appears that fire management practices that favor desired vegetation conditions seem to be compatible with maximizing arthropod diversity as long as a mosaic of burned and unburned habitats is maintained.

b. Impacts from Public Use Programs

The USFWS would administer priority wildlife-dependent uses, including hunting, fishing, wildlife observation and photography and environmental education and photography on newly acquired lands identified under Refuge Boundary Expansion Alternatives B, C and D. This would make new recreational and educational opportunities available to the general public.

The USFWS would open specific areas within newly acquired lands to the public for these uses. Facilities similar to those currently found on the Refuge Complex including trails, boardwalks, observation decks, boat ramps and fishing piers would be developed over time to support these uses. Regulations similar to those currently governing public uses on the Refuge Complex would be in place to protect natural resources and public safety. The USFWS would maintain closed areas on portions of newly acquired lands to provide undisturbed habitats for migratory birds and other wildlife.

(1). Impacts to Waterfowl

(a). Waterfowl Hunting

The most direct effect of hunting on newly acquired lands would be the mortality of harvested waterfowl species resulting from the hunting activities. However, because regulations governing harvest in the Central and Mississippi Flyways are developed annually under the USFWS' national migratory bird hunting regulation frameworks and are designed to ensure that viable waterfowl populations are sustained over the long-term, waterfowl hunting on newly acquired Refuge lands will not have any measurable effect on overall populations and the long-term viability of these populations.

Many studies have documented the effects of hunting on intensity on the number of birds utilizing an area (Reichholz 1976, Madsen *et al.* 1992 as cited by Fox and Madsen 1997, Wolder 1993). These studies have shown that relatively light hunting pressure can reduce waterfowl abundance in hunted areas. Distribution and habitat use, feeding patterns, and the nutritional status of waterfowl have also been shown to be affected by hunting activities. Hunting activity can cause birds to alter habitat use, change feeding locations (Madsen 1995), feed more at night (Morton *et al.* 1989) and reduce the amount of time spent feeding (Korschgen *et al.* 1985, Madsen 1995). Collectively, these changes in behavior have the potential to adversely impact the nutritional status of waterfowl (Belanger and Bedard 1995).

Means of access to and within new hunt areas would include motorized boating, non-motorized boating, motorized vehicles, and walking and bicycling. Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use, but these impacts are likely less than those caused by motorized boating.

Monthly aerial surveys of wintering waterfowl on the Refuge Complex have documented the disproportionate use of established sanctuary areas by waterfowl, as compared to the areas open to hunting. This further supports the above studies and indicates that hunting affects the overall distribution of wintering waterfowl on the Refuge Complex. The size, location and habitat quality of sanctuary areas on the Refuge Complex remains critically important to ensure that migrating and wintering populations of waterfowl maintain sound nutritional and physiological status.

The USFWS would establish sanctuary areas on newly acquired lands to ensure that wintering populations of waterfowl maintain sound nutritional and physiological status in advance of migration and nesting. Providing waterfowl with predictable undisturbed sanctuary areas likely increases the ability of birds to meet the obligations of their annual cycle. Waterfowl undergo considerable physiological demands during winter. Heitmeyer (1988) estimated that prebasic molt in female mallards required and additional three grams per day of protein over base metabolic rates. These demands approach the estimated five grams per day associated with reproduction. Pair formation for most North American waterfowl takes place away from the breeding grounds. Waterfowl must accumulate endogenous energy reserves to meet the demands of courtship (Baldassarre and Bolen 1994). Baldassarre and Bolen (1994) proposed that birds that do not accumulate energy reserves may have less time and energy at their disposal to initiate courtship and/or may be unable to maintain previously established pair bonds. Clearly, birds must meet high energy demands to successfully fulfill critical wintering components of their annual cycle. Further, Heitmeyer and Fredrickson (1981) build a scenario where endogenous reserves established on wintering grounds return mallards to breeding areas in better condition to begin nesting, leading to larger clutch sized and earlier nests, which tend to be more successful. Providing sanctuary

areas of adequate size, encompassing and/or adjacent to quality feeding areas, may contribute to the ability of birds to meet the physiological demands required during winter and possibly the subsequent nesting cycle.

It has been shown that sanctuary areas on the wintering grounds are effective in maintaining local waterfowl populations in a landscape subject to hunting pressure (Bellrose 1954, Madsen 1998). Heitmeyer and Raveling (1988) found that waterfowl used sanctuaries during the day and local rice fields at night. Similarly, Fleskes *et al.* (2005) found Northern Pintail used areas closed to hunting during the day and dispersed throughout the area at night. These data indicate that while sanctuaries are effective in maintaining local waterfowl populations through the hunting season, birds must disperse at night to feed.

Refuge-specific hunting regulations for new hunt areas on newly acquired lands would help mitigate the impacts of hunting activity-related disturbance to waterfowl. Waterfowl hunting in hunt areas would be allowed three days per week, and all hunting activity would be curtailed each day at noon. The non-hunted days and afternoon and evening closures would provide undisturbed periods within the hunt areas, facilitating waterfowl utilization of hunt area habitats for foraging and resting. Regulations would also govern means of access to hunt areas, including boat motor and horsepower restrictions, prohibition of airboat and all-terrain vehicle use, and establishment of areas in which only non-motorized boat access is allowed. While these regulations would be in place primarily to protect habitats and public safety, they would also reduce overall disturbance impacts to waterfowl and other migratory birds

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation

Primary means of access to areas on newly acquired lands for fishing and wildlife observation and photography would include motorized and non-motorized boating and motorized vehicles on roads open to the public. Motorized vehicles and walking would be used to access areas used for environmental education and interpretation. The USFWS would develop trails, boardwalks, observation platforms and fishing piers and boat ramps on newly acquired lands.

Motorized boating has been shown to affect the abundance, distribution and habitat use of waterfowl and other birds (Skagen 1990, Bauer *et al.* 1992, Dahlgren and Korshgen 1992). Non-motorized boats, vehicles on roads, and walking also have potential to disturb waterfowl and influence distribution and habitat use.

Disturbance of waterfowl by visitors would likely be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993). In wetland habitats, disturbance from “out of vehicle” approaches can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). While some species of waterfowl appear to acclimate to vehicular traffic, and even presence of visitors on trails, boardwalks, and observation platforms, other species are less tolerant of disturbance. Overall it is likely that species composition and abundance of waterfowl would be decreased in areas supporting these recreational uses.

(2). Impacts to other Migratory Birds - Shorebirds, Wading Birds, other Marsh and Waterbirds and Landbirds

(a). Waterfowl Hunting

Although the impacts of waterfowl hunting on newly acquired lands to other wetland-dependent migratory and resident birds which are not hunted is likely less than for waterfowl, studies have demonstrated that hunting (including accessing hunt areas) does affect abundance and distribution of these other avian species. The noise associated with shooting likely reduces habitat utilization by shorebirds, wading birds, other marsh and waterbirds, and landbirds using wetland habitats within hunt areas, at least while hunting is occurring. Motorized boating disturbs and displaces many waterbird species (Dahlgren and Korschgen 1992, Knight and Cole 1995), as will non-motorized boats, vehicles and walking through the marsh.

(b). Fishing, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach, and other Uses

Primary means of access to areas on newly acquired lands opened for fishing, wildlife observation and photography would be motorized and non-motorized boating and motorized vehicles on roads open to the public. The USFWS may also develop walking trails, boardwalks and observation platforms, boat ramps and fishing piers to support access for these uses on newly acquired lands. Motorized vehicles and walking would be used to access areas used for environmental education and interpretation.

Disturbance of migratory birds by visitors would likely to be greatest in concentrated areas of use, including along trails, boardwalks, observation platforms and along roads (Klein 1993) and shoreline areas regularly used for fishing. Along roads through wetland habitats, disturbance from “out of vehicle” approaches for observation and photography can reduce the time spent foraging by some waterbirds, or even cause avoidance of areas that are highly disturbed (Klein 1993). Walking on trails tends to displace birds and can cause declines in species richness and abundance (Riffell *et al.* 1996). Some generalist avian species such as house finches tend to increase near trails, while specialist species such as solitary vireo move away from trails. The zone of influence around trails appears to be approximately 75m for woodland areas adjacent to grasslands (Miller *et al.* 1998).

Disturbance impacts to birds from visitation are often magnified during the breeding season. Color of clothing worn can attract or repel different passerine species based on breeding plumages of those species (Gutzwiller and Marcum 1997). Primary song occurrence and consistency of certain passerines can be impacted by a single visitor (Gutzwiller *et al.* 1994), which could limit the number of breeding pairs and production by those species in disturbed areas (Reijnen and Foppen 1994). Predation on songbird, raptors, colonial nesting species, and waterfowl nests tends to increase near more frequently visited areas (Glinski 1976, Buckley and Buckley 1978, Boyle and Samson 1985, Miller *et al.* 1998).

(3). Impacts to Fisheries

(a). Fishing

The most direct effect of fishing on areas opened for this use on newly acquired lands would be the mortality of harvested freshwater and saltwater fish, blue crabs, and several fish and shellfish species caught for use as bait. Fishing and crabbing would occur under regulations promulgated by the Texas Parks and Wildlife Department. These regulations are designed to ensure that viable fish and shellfish populations are sustained over the long-term. Fishing and crabbing should not have any measurable effect on overall populations and the long-term viability of these species' populations.

b). Waterfowl Hunting, Wildlife Observation and Photography, Environmental Education and Interpretation, Beach and other Uses

No impacts to fisheries resources are expected to occur as a result of administration of these public uses on newly acquired lands opened for these uses.

(4). Impacts to Threatened and Endangered Species

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

It is likely that Bald Eagles, Brown Pelicans and Piping Plovers using newly acquired lands would be subject to the some level of disturbance by public use activities. These impacts are expected to be negligible. Bald Eagles are usually associated with large concentrations of wintering waterfowl that occur in refuge sanctuary areas which are not open to the public. Piping Plovers utilize beach, shoreline and intertidal mudflat habitats primarily during fall and winter, when use of these habitats by the public is lightest. Brown Pelicans readily forage and roost adjacent to human activity and infrastructure. The three

T&E avian species do not nest within areas identified under Refuge Boundary Expansion Alternatives B, C or D, their presence is transient in nature, and they are highly mobile and able to move to undisturbed areas. Overall, no impacts to Federally-listed or State-listed Threatened and Endangered species are expected to occur as a result of continued administration of these public uses on lands newly acquired under Refuge Boundary Expansion Alternatives B, C or D.

(5). Impacts to other Fish and Wildlife Species – Mammals, Amphibians, Reptiles, and Invertebrates

(a). Waterfowl Hunting, Fishing, Wildlife Observation and Photography, and Environmental Education and Interpretation

It is likely that mammals and amphibians and reptiles would be subject to some level of disturbance from public use activities occurring on newly acquired lands, but these impacts are expected to be negligible. Vehicles would occasionally strike and kill mammals such as Virginia opossum, armadillo, raccoon and striped skunk, and reptiles and amphibians including alligators, snakes and frogs.

(b). Commercial Alligator Harvest

The USFWS may administer an adult alligator harvest program as an economic use on newly acquired lands. This program would be administered under regulations promulgated by the Texas Parks and Wildlife Department. State regulations are designed to ensure that viable alligator populations are sustained over the long-term. In addition, the USFWS would regulate the alligator harvest program through issuance of a Special Use Permit which contains stipulations also designed to conserve alligator populations. For example, special regulations would be in place to restrict harvest of reproductive-aged alligators and maintain a natural age structure in the alligator population. Expanding the commercial alligator harvest program currently being administered by the USFWS on the Refuge Complex to newly acquired lands would not have any measurable effect on the long-term viability of alligator populations.

(c). Control of Muskrat Populations

Herbivory in areas of high density muskrat populations can cause or exacerbate conditions resulting in permanent conversion of vegetated marsh to open water. This is likely to most prevalent in areas affected by saltwater intrusion, land subsidence or other factors contributing to marsh loss. The USFWS would control muskrat populations on newly acquired lands in specific locations as deemed necessary to protect wetland habitats through issuance of Special Use Permits for trapping and removal by qualified individuals. Trapping and removal of muskrats under this program would have negligible if any impacts on overall muskrat populations and the long-term viability of these populations.

c. Impacts from Biological Program – Surveys, Monitoring, and Research

The USFWS would implement a variety of field surveys and new and expanded scientific monitoring and research on newly acquired lands.

Surveys, monitoring and research activities for waterfowl would include: 1) monthly aerial surveys of waterfowl (September through March); 2) annual Mottled Duck breeding pair surveys; 3) national, regional and local banding studies of waterfowl, including ongoing banding studies of Mottled Ducks and Snow Geese; 4) data collection from harvested waterfowl at check stations including body condition indices and lead shot ingestion rates; 5) participation in the annual Audubon Society Christmas Bird Count; and 6) coordination of research studies on Mottled Ducks and other priority waterfowl species through partnerships with the USFWS Division of Migratory Birds, universities and the U.S. Geological Survey Biological Resources Division.

Surveys, monitoring and research for shorebirds, wading birds and other marsh and waterbirds would include: 1) an annual nesting survey for colonial nesting waterbirds on Gulf shoreline of Texas Point NWR; 2) periodic spring and fall shorebird surveys in various representative wetland habitats;

3) participation in the annual Audubon Society Christmas Bird Count; and 4) research studies on priority species through partnerships with the U.S. Geological Survey Biological Resources Division and academic institutions.

Surveys, monitoring and research activities for resident and migratory land birds would include:

1) periodic surveys of selected land birds in marsh, prairie and woodland habitats; 2) participation in the annual Audubon Society Christmas Bird Count; and 3) coordination of research studies on priority species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Surveys and monitoring activities for fisheries resources to continue under Refuge Management Alternative A would include: 1) coordination with the USFWS Fisheries Program for periodic fisheries monitoring in representative wetland habitats; and 2) coordination with USFWS Division of Ecological Services and other State and Federal agencies to conduct periodic monitoring and studies of contaminant impacts to fisheries.

Surveys and monitoring activities indirectly benefiting T&E species would include: 1) participation in the annual coast-wide wintering Piping Plover survey; and 2) coordination of research studies on sensitive and/or declining species through partnerships with universities and the U.S. Geological Survey Biological Resources Division.

Aerial basking surveys and nighttime spotlight surveys to monitor alligator population trends would be expanded to include newly acquired lands. Data collection from harvested alligators and coordination and information sharing with the Texas Parks and Wildlife Department on alligator harvest management, population monitoring, and research would occur.

Information on species composition and relative abundance of invertebrates would be collected through "BioBlitz" events and other surveys conducted in partnership with universities, the U.S. Geological Survey Biological Resources Division, and volunteer naturalists. The North American Butterfly Association's Fourth of July Butterfly Counts would be expanded. These monitoring activities would provide baseline information on invertebrate populations.

Surveys and monitoring/research activities are useful for tracking and documenting the impacts of various management strategies on fish and wildlife populations, distribution, movements and habitat utilization. This information would facilitate implementation of an adaptive management approach which allows continual refinement and improvement of management activities.

d. Impacts from Management of Oil and Gas Exploration and Development

Lands acquired under Refuge Boundary Expansion Alternatives B, C and D would be acquired subject to exploration and development of reserved and outstanding mineral interests. The USFWS would manage oil and gas exploration and development activities on newly acquired lands within the Refuge Complex through the issuance of Special Use Permits. Stipulations in the Special Use Permit would include those aimed at minimizing impacts to fish and wildlife resources, including timing of activities to avoid major periods of utilization, required use of specialized equipment, location and size of facilities, and required pollution controls.

The net effect of USFWS management of oil and gas exploration and development on newly acquired lands would be reduced impacts to fish and wildlife resources from these activities.

e. Impacts from Community Outreach and Partnership Efforts

Under Refuge Boundary Expansion Alternatives B, C and D, the USFWS would continue to develop partnerships with private land owners to restore and enhance wetland and upland habitats on private lands in the project area by: 1) providing technical assistance on habitat restoration and management activities; and 2) facilitating development of partnerships under the USFWS Partners for Fish and Wildlife

Program and other private lands initiatives such as the Texas Prairie Wetlands Project. To date, projects developed through these efforts have resulted primarily in improved water management in coastal marsh habitats (including reducing negative impacts of saltwater intrusion) and restoration of shallow freshwater wetlands.

It is anticipated that continuation of outreach and partnership efforts would result in benefits to fish and wildlife resources as important habitats are restored and enhanced on private lands. Projects such as those implemented to date would enhance wetland habitats for wintering waterfowl, Mottled Ducks and other wetland-dependent migratory birds, and for resident wildlife including several species of reptiles and amphibians which depend on freshwater habitat.

B. Socioeconomic Resources Section

1. Economic Impacts

Economic impacts from Refuge Boundary Expansion Alternatives B, C and D can be associated with changes in land use which would occur with the transfer of land from private to federal ownership. The changes in land use would occur in the following segments of the local economy:

- Rice farming on acreage within the USDA farm program
- Cattle grazing
- Commercial hunting operations
- Reduction in potential development for areas near Taylors Bayou.

a. Rice Farming - Reduction in Agricultural Support Programs

A large number of acres in the proposed refuge boundary expansion areas within Chambers and Jefferson counties are in the USDA farm program as base acreage for rice. However, a large percentage of this acreage is no longer used for rice production and is either being converted to improved pasture or is fallow. The USFWS would expand its cooperative farming program on acquired acreage that is currently in rice production due to the habitat benefits rice provides for migratory birds and other wildlife. However, the USFWS would generally not attempt to convert fallowed areas to rice production due to the cost associated with restoring water delivery infrastructure and removal of exotic plant species (e.g. Chinese tallow). The USFWS will manage some formerly cropped areas as native prairie or moist soil units and use grazing to help achieve wildlife habitat objectives. The success of this cooperative farming program will largely depend on the availability of farmers willing to work within the guidelines of the program including: 1) limits on harvest of the second ratoon crop of rice; 2) restrictions on herbicide and pesticide use; and 3) prohibition of some rotational crops. Overall, market conditions affecting rice production throughout the project area will likely be the primary factor affecting the USFWS' ability to expand the cooperative rice farming program on any newly acquired lands.

The USFWS currently manages a cooperative farming program with approximately 1,700 base acres registered with the USDA Farm Service Agency (FSA). Rice producers in the cooperative farming program are eligible for farm support programs. As discussed earlier, the USFWS would try to extend the cooperative farming program for additional acquired acreage that is currently in rice production so that it would also be eligible for farm support programs through the FSA. However, base acreage that is not currently in rice production would be converted to native prairies or moist soil units and thus would not be eligible for support payments. Although private landowners are able to collect payments even if acreage is not currently in rice production, the same is not true for federal acreage within the Refuge Complex. For these areas, cooperative farmers, contracted by USFWS, must actually be producing rice or conducting approved maintenance on the allotted base acreage to receive payments. Thus, it is likely that economic impacts could occur within the study area from a reduction in farm support due to a change in land ownership.

To help ensure viable and strong rice production in the United States, the Farm Security and Rural Investment Act of 2002 provides direct payments and counter-cyclical payments to producers for rice

crops. Eligibility for direct and counter-cyclical payments requires producers to sign an agreement with the Farm Service Agency (FSA), which administers this USDA farm program. Producers must also report annually all crop acreage and comply with conservation and planting requirements to establish eligible base acreage payments.

(1). Direct Economic Impacts from Reduction in Agricultural Support Programs

(a). Loss of "Direct Payments"

Direct payments are similar to production flexibility contract payments as they help absorb market shocks that affect production and prices. **The direct payment for rice is calculated as follows:**²⁰

$$\text{Direct Payment Rate} \times 0.85[\text{Base Acreage}] \times [\text{Direct Payment Yield}]$$

The direct payment rate for rice within the years 2002-2007 is set at \$2.35 per hundredweight (cwt). Producers are limited to direct payments not exceeding \$40,000 per crop year and payments are decoupled from both current production and prices on eligible acres.

This information was used to estimate the average direct payment rate per acre for eligible farms in Jefferson and Chambers counties. For Texas, 591,649 acres of rice acreage are enrolled in the program.²¹ Of this amount, 85 percent (502,900 acres) are eligible to receive direct payments. The specific yield per acre for Texas as estimated by FSA is 4.947 hundredweight (cwt). Multiplying the direct payment yield by the number of base acres eligible for the program and the direct payment rate of \$2.35 per cwt resulted in total direct payments to producers in Texas of \$58.4 million. Dividing the total direct payments in Texas by the number of eligible acres resulted in an average payment per base acre of \$116 per acre.

An estimate of the base acreage within the Refuge Boundary Expansion Alternatives was made with information from the FSA. FSA provided maps and acreage figures for cropland, base acreage and production acreage within the acquisition boundaries. Using this data and GIS software, base acreage and acreage in current production was estimated by alternative and is summarized in Table 4-42. There are only a relative few rice producers left in the acquisition area. This finding is expected, as the majority of rice production is located in northern parts of Jefferson and Chambers counties.

Acreage Type	Refuge Boundary Expansion Alternative			
	No Action	Alternative B	Alternative C	Alternative D
Crop Acreage	0	5,965	13,730	30,874
Eligible Base Acreage	0	3,026	3,506	13,290
Average Annual Production Acreage (2000 – 2004)	0	197	421	2,457

20 U.S. Farm Service Agency Online, Fact Sheet Electronic Edition, Rice Summary of 2002-2007 Program, April 2003, <http://www.fsa.usda.gov/pas/publications/facts/html/rice03.htm>

21 Personal communication with Nathan Childs of the U.S. Department of Agriculture, (202)-694-5292.

Using the average direct payment per acre and the estimated base acreage, the total annual direct payments received by producers for rice acreage within the acquisition boundary was estimated for each alternative as summarized in Table 4-43.

Refuge	Refuge Boundary Expansion Alternative			
	No Action	Alternative B	Alternative C	Alternative D
Moody	\$0	\$0	\$0	\$0
Anahuac	\$0	\$315,647	\$371,435	\$1,171,163
McFaddin	\$0	\$36,161	\$36,161	\$374,133
Texas Point	\$0	\$0	\$0	\$0
Total	\$0	\$351,808	\$407,596	\$1,545,295

The direct payments summarized in Table 4-43 represent an upper bound estimate of the possible losses in direct payments if the USFWS were to acquire all historically cropped acreage within the boundary expansion area. It is likely that losses would not approach these upper end estimates because 7 to 20 percent of the base acreage is currently in production and would remain in production under USFWS ownership, and thus eligible for payments. Additionally, it is likely that current landowners would retain a certain percentage of the base acreage when farms are reconfigured after a portion of the farm is sold and included in the Refuge Complex.

(b). Loss of Counter Cyclical Payments

Counter-cyclical payments also are decoupled from current production. However, they are negatively correlated to current prices as the payments increase when market prices decline. **For rice, the counter-cyclical payment is calculated as follows.**²²

$$\text{Counter-Cyclical Payment Rate} \times 0.85[\text{Base Acreage}] \times [\text{Counter-Cyclical Payment Yield}]$$

Counter-cyclical payments for rice are made when the target price for rice is above the effective price. The effective price is formulated from the direct payment price (\$2.35) plus the higher of either the seasonal average farm price or the national loan rate²³. For years 2002-2003 the rice crop target price is \$10.50 per cwt and the rice loan rate is \$6.50 per cwt. The counter-cyclical payment rate for 2003 was calculated by the FSA as follows because the seasonal average farm price (\$3.85 per cwt) was below the loan rate.²⁴

$$\$10.50 - [2.35 + 6.50] = \$10.35 - \$8.85 = \$1.65$$

Producers are limited to counter-cyclical payments not exceeding \$65,000 per crop year. If the effective price is below the target price then producers receive counter-cyclical payments in addition to direct payments.

The information presented above was used to estimate a counter-cyclical payment that may occur on rice acreage in the areas under Refuge Boundary Expansion Alternatives B, C and D. The maximum payment would occur when farm prices are below the established rice loan rate of \$6.50. If rice prices are above this rate, producers receive a smaller counter-cyclical payment. Therefore, a conservative

22 U.S. Farm Service Agency Online, Fact Sheet Electronic Edition, Rice Summary of 2002-2007 Program, April 2003, <http://www.fsa.usda.gov/pas/publications/facts/html/rice03.htm>.

23 The National Agricultural Statistics Service determines the season average farm price.

24 U.S. Farm Service Agency Online, Fact Sheet Electronic Edition, Rice Summary of 2002-2007 Program, April 2003, <http://www.fsa.usda.gov/pas/publications/facts/html/rice03.htm>.

estimate was used for this analysis and assumed that producers would receive the maximum counter-cyclical payment of \$1.65 cwt produced on eligible acreage within acquisition boundaries.

The counter-cyclical payments were estimated by multiplying the counter-cyclical rate by the number base acres and the counter-cyclical payment yield (4.947 cwt). An estimate of the counter-cyclical payments that could be eliminated if USFWS were to acquire all rice acreage within the boundaries is summarized in Table 4-44.

Refuge	Refuge Boundary Expansion Alternative			
	No Action	Alternative B	Alternative C	Alternative D
Moody	\$0	\$0	\$0	\$0
Anahuac	\$0	\$224,052	\$263,652	\$831,314
McFaddin	\$0	\$25,668	\$25,668	\$265,566
Texas Point	\$0	\$0	\$0	\$0
Total	\$0	\$249,720	\$289,319	\$1,096,880

This is an upper bound estimate of the losses of counter-cyclical payments that could occur. However, like the direct payments discussed earlier, it is likely that only a percentage of these payments would be lost because some acreage would remain in production under the USFWS cooperative farming program and some of the base acreage would be retained by current landowners as farms are reconfigured.

(2). Indirect and Induced Economic Impacts of Reduction in Agricultural Support Programs

Farm support programs, such as direct payments and counter cyclical payments, have additional benefits beyond those realized by the individual producer. These programs provide income to producers that generate additional economic activity in the area, as this income is re-spent. IMPLAN was used to estimate the additional economic activity associated with the farm support programs for rice that could be lost if USFWS were to acquire all lands within the acquisition boundaries.

Additional economic activity that is generated by these particular programs will depend on how the additional income earned by producers is re-spent in the local economy. Because direct payments and counter-cyclical payments are decoupled from actual production, eligible producers are free to spend this additional income as they see fit. Therefore it was assumed that producers would re-spend this additional income in a similar fashion to other forms of income. To estimate economic impacts of this re-spending, total direct payments for the study area were run through the household income models in IMPLAN that correspond to Jefferson and Chambers counties.

Table 4-45 summarizes the additional economic activity that is estimated to occur due to the farm support programs associated with eligible acreage within the acquisition boundaries. The impacts to employment and income presented in this table represent upper bound estimates of losses in farm support programs if the USFWS were to acquire all acreage within the acquisition boundary. However, impacts are not likely to approach this upper bound due to a number of factors. First, this analysis uses the maximum payment available for the counter-cyclical program and thus represents the greatest impact if these payments were eliminated. If average prices received were to exceed the loan rate in future years, the payment would not be as great and thus the impact would not be as large as presented in this table. In addition, the direct payments are tied to farms instead of actual rice acreage. Therefore, it is possible for base acres to remain eligible after a farm is reconfigured upon the sale of certain acreage. Finally, a percentage of the base acreage would remain in rice production under the cooperative farm program and would be eligible for these farm programs.

Table 4-45

Indirect and Induced Economic Impacts of the Reduction in Farm Support Programs by Alternative

	Refuge Boundary Expansion Alternative			
	Alternative A	Alternative B	Alternative C	Alternative D
Labor Income	\$0	\$151,661	\$175,710	\$ 666,160
Employment	0	6	7	25

There may be additional economic impacts if the USFWS were to acquire croplands within the boundary expansion area. This is due to the fact that rice production may decline with a change in ownership. While the USFWS plans on continuing their cooperative farming program in areas that are historically important for rice production, the program's success is dependent on individuals' willingness to meet the requirements of the program. It is possible that some acreage could be taken out of production with a change in land ownership if producers lack interest in the USFWS cooperative farming program.

However, declines to the rice industry are likely to continue in the study area following recent trends with or without the USFWS Refuge boundary expansion and subsequent land acquisition program due to several factors including:²⁵

- Texas producers have higher cost of production than other states
- unfavorable climatic conditions (e.g. high average temperature and late season hurricanes),
- difficulty in growing rotational crops in south Texas
- impacts from waterfowl migration
- problems with red rice
- development encroachment

All these factors will continue to affect the viability of the rice industry in Texas and will have a substantially larger impact than those expected to occur due to the refuge boundary expansion proposed by the USFWS.

b. Cattle Grazing Operations

Changes in land ownership may also cause impacts to grazing operations within the study area. While USFWS will continue to use controlled grazing for habitat management, it is likely that grazing operations on acreage managed by the USFWS will differ from those on private lands. Differences between grazing practices on USFWS lands and on private lands result from differing land use objectives. Grazing on the refuges is used as a tool to enhance wetland and upland habitats for wildlife, while economic objectives generally dictate grazing programs on private lands. In general, stocking rates and duration of use will be less on refuge lands than private lands. The difference in management techniques will affect the productivity of the acreage for cattle production. In addition, it is anticipated that grazing activities on lands managed by the USFWS will be more costly due to more frequent rotations. Although changes in grazing operations under USFWS management in upland prairie areas are expected to be notable; changes in marsh areas are expected to be relatively minor. Therefore, it is not expected that expansion of refuge boundaries and subsequent land acquisition will cause significant changes in the cattle industry in the study area though some local impacts may occur.

c. Commercial Hunting Operations

(1). Commercial Hunting Operators

Waterfowl and dove hunting are widely available, usually through a lease, on private lands in the study area. Several commercial guiding outfitters operate in the study area with services for waterfowl hunting,

²⁵ Personal communication with Nathan Childs of the U.S. Department of Agriculture, 202-694-5292.

charter fishing, alligator harvest, and birding. The project area is probably best known in the community for waterfowl hunting, which also provides a source of revenue in the local community for two weeks during the September teal season and from November to January for waterfowl. Approximately six outfitter-guiding services and three landowners who leased their property to outfitters or hunt clubs were identified within the areas identified under the Refuge Boundary Expansion Alternatives. In addition, many rice farmers are currently transitioning from rice to cattle, hunting or a combination of these activities. In general, most outfitters that were contacted operate near current refuge boundaries.

Pricing and packages for guide services vary by outfitter. However, on average waterfowl hunting varies between \$50 a day to \$150 a day. Many outfitters also provide meals and lodging, which may average around \$35 a night for lodging and \$50 a day for meals. Outfitters noted that many clients also visit the local establishments while they are in town.

Most outfitters have operated in the area for decades and are either from the local community or are seasonal residents from in-state metropolitan areas. Outfitters contacted during this study employ an average of 13 guides seasonally from the local communities and average between 700 to 2,500 clients annually. The client base mostly includes people from outside the project area. According to the interviews, guided hunting is not a high priority for most local residents, with only a few interested in outfitter services from the Beaumont area. Depending on the marketing of the hunting outfitter, most clientele are from either out-of-state or metropolitan areas within Texas (such as Houston, Dallas, or San Antonio). Some international clientele was also noted. Many clients are repeat customers.

Some outfitters noted that they have a good relationship with the USFWS and that the proximity of the refuges benefits their hunting business. In addition, many outfitters believe that USFWS programs provide support in making habitat improvements that increases hunting profitability. Private lands used for hunting are generally well maintained, including wetland projects, which provides high quality neighboring habitat to the refuges. Some outfitters noted that converting land from private to public ownership has already adversely affected their businesses and more land acquisition would further impair their business or cause their operations to cease. In addition, outfitters stated that hunting on refuges is generally less accessible due to the restrictions on mechanized transportation. Others noted that if the USFWS acquires remnants of private lands as they become available, established guiding services may benefit from the additional habitat protection. In general, most outfitters expressed interest in guided trips on refuges and noted that conservation easements are more desirable because they provide more flexibility.

(2). Hunting on Refuge Complex

There are approximately 37,300 acres currently designated for hunting on the Refuge Complex. Hunting of geese, ducks, and coots is permitted during the waterfowl and September teal seasons on designated areas of the Anahuac, McFaddin, and Texas Point NWRs. Hunting is permitted three days per week until noon with a valid permit (50 CFR 32.63). Moody NWR is privately owned property upon which USFWS holds a perpetual non-development conservation easement. Moody NWR is not open for hunting to the general public, but this privately-owned property is hunted through a commercial guide/outfitter service.

If additional lands were acquired for the Refuge Complex, designated hunting areas would be opened considering conservation objectives, access issues and the quality of hunting to be supported. A consideration for lands acquired with Migratory Bird Conservation Stamp (Duck Stamp) funds is the 40% statutory limitation on the maximum amount of lands which can be opened for hunting. For those lands, management at the Refuge Complex has traditionally strived to maintain areas open to hunting at or near the 40 percent maximum. Migratory waterfowl use of wetland habitats is generally related to the quality of habitat (presence of food resources, proper water levels, etc.) and is influenced by factors such as disturbance. Establishment of sanctuary areas on any newly acquired lands would occur in areas of high quality habitat and low susceptibility to disturbance, which would ensure benefits to wintering and migrating waterfowl and other migratory birds, consistent with Refuge establishment purposes.

(3). Impacts to Commercial Hunting Operations - Acquisition of Private Land

The expansion of Refuge boundaries and subsequent land acquisition by the USFWS is likely to result in some impact on hunting activities within the study area. However, it is unclear at this point if the impact will be positive or negative on the local community. Some commercial hunting operations and local hunting guides may be negatively impacted if the USFWS purchases lands where current hunting leases are held. If the terms of these purchases restrict hunting guides from operating, then it is likely that individual operators would realize a reduction in business. However, areas opened to hunting by the USFWS on newly acquired lands would increase the amount of land available to the general public for hunting, and may actually increase hunting opportunities in the project area. The following section discusses these potential impacts in more detail.

General information on hunting activity was obtained through interviews with local stakeholders; however, there is a lack of detailed information on private activities and exactly where these activities may occur in relation to areas within the Refuge Boundary Expansion Alternatives. Since some private hunting activities may occur through informal agreements with private landowners, the information regarding the extent of these activities and income generated is unknown. Therefore, this analysis is primarily qualitative and based on interviews and maps of the acquisition alternatives. Two local hunting guide services and three landowners who provide hunting leases were interviewed in May 2003.

For the purposes of this analysis, it is assumed that all lands would be acquired in fee simple title. It was also assumed that hunt areas on refuges would be designated at or near the 40 percent maximum and will primarily include desirable and historically hunted areas. Open water areas and impoundments as well as rice acreage were considered desirable hunting areas for waterfowl. These desirable areas were also based on vegetation habitat maps prepared by the USFWS. Desirable hunting areas slated for acquisition are primarily located near McFaddin and Anahuac NWRs, with some acreage near Moody NWR and no acreage near Texas Point NWR. Although lands will be acquired over time from willing sellers as funding becomes available, this analysis focuses on the greatest possible impact scenario to define potential long-term impacts. Estimates of the number of acres within desirable hunting areas that may be converted from private to public ownership if the USFWS were to buy all properties at once within any of the Refuge Boundary Expansion Alternative are shown in Table 4-46.

Acreage	Refuge Boundary Expansion Alternative			
	No Action	Alternative B	Alternative C	Alternative D
Desirable Hunting Acreage	0*	4,265	6,423	17,071
Total Acreage	0	33,590	64,260	104,120

*Alternative A would result in no land acquisition and would not affect current hunting operations. However, indirect impacts may occur over time such as decreased hunt quality from lack of adequate sanctuary areas.

Most outfitters are reliant on the leases provided by the private landowners for locations where they can provide hunting opportunities. If landowners sell to the USFWS rather than provide hunting leases, the quantity of prime areas where guide services operate will decline. Since most outfitters identified operate near Refuge boundaries, lands acquired near refuge areas would directly impact those hunting outfitters. Some outfitter services that depend on leases may cease to operate as a result. As commercial outfitters cease to operate, the limited employment offered by the business will no longer be available and the surrounding community may be indirectly affected. However, those outfitters that operate on land they already own would benefit if they retain their land. Those remaining establishments would have less competition for commercial guide services and the quality of the hunting opportunities may improve.

It is important to note that other factors may have important impacts on hunting outfitters regardless of any actions implemented by the USFWS under Refuge Boundary Expansion Alternatives B, C or D. This includes such things as natural phenomenon, stricter hunting regulations, changing land uses and land ownerships, or decreased interest in hunting. Natural phenomenon, including climatic conditions (e.g. drought in nesting areas), disease, and predation, may reduce continental waterfowl populations. Lowered continental waterfowl populations would result in implementation of more restrictive harvest regulations. Reduced bag limits and shortened seasons would negatively impact commercial hunting operations. Changes in habitat quality and quantity (for example, the recent decline in rice production) in the project area can greatly impact local waterfowl numbers. Changing land uses such as the conversion of former rice fields to pasture or improved pasture or to residential development and changes in land ownership will also impact the waterfowl outfitter businesses in the project area. Finally, human factors, such as poor economic conditions or reduced hunting interest, may result in fewer hunters and less business for outfitter services.

d. Potential Development

For most of the area within the Refuge Boundary Expansion Alternatives B, C and D, future potential development appears low, at least in the immediate future. However, urban sprawl from the greater Houston area is already resulting in rapid development in western Chambers County, and ultimately development pressures are expected to increase in the relatively undeveloped portions of mid and eastern Chambers County.

Some lands within the expanded refuge boundaries proposed in Refuge Boundary Alternative D were found to have some development potential based on current activity. The area in question is commonly known as Taylors Bayou and is located north of Highway 73 in Jefferson County. Much of the acreage in and around the bayou was formally used for rice production with the remaining acreage comprised of bottomland hardwoods. There is already some residential development near the boundary expansion area. This includes a well established country club and residential neighborhood to the east of Taylors Bayou. Adjacent to the country club is a new development, which consists of single-family residential properties. Additionally, scattered residential development is also occurring to the south of the refuge expansion boundary.

Evaluation was conducted to determine the development potential of the Taylors Bayou area. This included interviews with the Jefferson County Tax Appraisal office²⁶ and review of tax assessment records on properties in this area. Tax records contain information on market values of individual properties. These market values will reflect the value of the parcel in its highest and best use even if it is not being used for this purpose. For instance, agricultural lands, which have high potential for development, will show a higher market value compared to other agricultural areas. The market values associated with a select sample of properties in and around Taylors Bayou were examined to determine if development potential is being reflected in market values obtained by the Tax Appraisal Office. The results are summarized in Table 4-47 on the following page.

The most significant development in the area is the Lake Estates residential development just south of Taylors Bayou overlooking the Belle Oaks Golf Course on Country Club Road (east of Labelle Road). The development consists of 60 home sites on 80 acres of land, 23 of which are wetlands and unusable for development. Pre-construction lots begin at \$70,000 and finished lots begin at \$300,000. Lot sizes range from one-half to one-acre in size.²⁷

Market values of parcels in and around Taylors Bayou do reflect that development is possible in this area and is occurring. However, further interviews with the Tax Appraisal District and the Southeast Economic

26 Personal communication with Larry Harrington of Jefferson County Tax Appraisal District, Beaumont, Texas 409-840-9944.

27 Personal communication with Jerry Braxton of Excavators & Constructors, Inc., Beaumont, Texas, 409-721-6030.

Table 4-47
Estimated Market Values of Parcels near Taylors Bayou

Location of Parcel	Market Value (\$/acre) ¹	Comments
Fishcamp Area - Subdivision East of Jap Road	\$1,200 - \$1,500	Lots are available in this area but values reflect lands values only. This area is low in elevation and would require any structures to be built on stilts.
Fishcamp Area - West of Jap Road	\$300	This area is very low in elevation and marshy; little potential for development.
West of Jap Road and North of Taylors Bayou	\$500	Area is a bit higher in elevation which is reflected in market value.
Rice acreage south of Highway 73	\$500	Low elevation; marshy.
Acreage south of new development to the east of boundary expansion area	\$500	Low elevation; these areas will need a fair amount of work before development can take place.
New development area; east of current country club	\$70,000 per lot ²	Higher elevation but still requires a fair amount of work before development can take place

¹ Market values were obtained from the Jefferson County Tax Appraisal District.

² Lot sizes range from one-half to one-acre in size.

Development Association²⁸ indicate that the development is limited due to certain challenges. First, much of this area is low in elevation and would require development modifications, which increase the cost of construction. Additionally, this area is located some distance from urban areas (Port Arthur) which limits the demand for development due to the long commuting distance. Officials interviewed felt that while this area does have development potential, it is still quite speculative at this point and will remain so in the future unless significant changes were to occur.²⁹

At this time, if the USFWS were to acquire acreage in the Taylors Bayou area, there is potential that it could limit some future development. The likelihood of this impact is dependent on the development potential. For instance, development potential in the low-lying floodplain adjacent to Taylors Bayou itself appears low, thus potential impacts to development would be low as well. However, areas that are somewhat higher in elevation do appear to have development potential which could be lost if these areas were acquired by the USFWS.

2. Fiscal Impacts to Local Governments

Fiscal impacts to local government jurisdictions may occur if the USFWS acquires land within the study area that is currently owned by private parties. Impacts arise since the federal government would not pay property taxes on acquired acreage; therefore, the property taxes that are currently paid by private landowners would no longer accrue to the affected local government jurisdictions. To gain an understanding of how local government entities may be impacted, a model was developed to evaluate changes in tax revenues if lands were acquired by the USFWS. The model is based on several assumptions as follows.

- Changes in tax revenues are estimated for acquisition of all acreage in fee simple title under each Refuge Boundary Expansion Alternative.
- Only taxing jurisdictions within Galveston, Jefferson and Chambers Counties would be impacted by the acquisition actions of the USFWS.
- Lands to be acquired are assumed to be in agricultural production and are currently taxed at a reduced rate from other types of property (e.g. industrial and commercial).

²⁸ Personal communication with Mike Foster of the Southeast Texas Regional Planning Commission, Beaumont, Texas 409-899-8444.

²⁹ Development potential for this area could increase with the completion of a large drainage project which is planned by Drainage District #6.

The following steps were used to develop the model in detail:

Step 1: Identify Acreage by Taxing District and Land Use Category

The first step in implementing the model was to estimate the acquisition acreage by taxing jurisdiction. For each county where lands may be acquired, all districts that were likely to be impacted were identified using maps provided by the tax assessors’ offices and interviews with county officials. The jurisdiction maps were compared with maps of the Refuge Boundary Expansion areas prepared by the USFWS to identify which districts may be impacted. Table 4-48 summarizes these districts.

Table 4-48 Taxing Districts with Jurisdiction in Acquisition Areas		
Chambers	Jefferson	Galveston
Chambers County, East Chambers ISD*, Anahuac ISD*, Chambers-Liberty Navigational District, Hospital District, Trinity Bay Conservation District	Jefferson County, Sabine Pass ISD*, Hampshire- Fannett ISD*, Drainage District 3, Drainage District 6, Port of Sabine Pass, Jefferson County Waterways & Navigational District	Galveston County, High Island ISD*, Galveston County Road and Flood District

* ISD – Independent School District

Next, USFWS vegetation maps, in a GIS format, were overlaid on the acreage within each of the impacted districts. The vegetation types in the acquisition areas were then converted to land use categories utilized for tax assessment purposes. The conversion used for this analysis is summarized in Table 4-49.

Table 4-49 Vegetative Type to Tax Category Conversion	
Vegetation Types	Land Use Category for Tax Assessment Purposes
Non-Saline Prairie/Agricultural	Rice Acreage/Natural Pasture/Improved Pasture
Salty Prairie	Natural Pasture/Marsh Pasture
Fresh Marsh	Natural Pasture/Marsh Pasture
Intermediate Marsh	Natural Pasture/Marsh Pasture
Brackish Marsh	Natural Pasture/Marsh Pasture
Saline Marsh	Natural Pasture/Marsh Pasture
GIWW Spoil Areas	Barren
Contained Spoil	Barren
Forested Wetland	Rice Acreage/Natural Pasture
Inland open water	Natural Pasture/Marsh Pasture
Natural Lake - brackish marsh	Natural Pasture/Marsh Pasture
Natural Lake - intermediate marsh	Natural Pasture/Marsh Pasture
Prairie Grassland	Natural Pasture
Unclassified	Barren

Finally, the land use categories were overlaid on the Refuge Boundary Expansion Alternatives and the jurisdiction maps. From this information, we were able to estimate the acreage within each taxing district by land use category for all three of the expansion alternatives. Simplified summaries of the estimated acreage by land use category for each of the expansion alternatives are shown in Tables 4-50 through 4-52. (Note very small differences in acreage totals for each Alternative because of unrectified information on GIS maps).

Table 4-50 Land Use Categories by acres in Refuge Boundary Expansion Alternative B			
Land Use Category	Chambers Co.	Jefferson Co.	Galveston Co.
Irrigated Agriculture	2,702	311	
Improved Pasture	6,570		
Natural Pasture	16,425	1,871	415
Natural Pasture/Marsh		5,007	48
Barren Land	106	42	
Total Acreage	25,803	7,231	463

Table 4-51 Land Use Categories by acres in Refuge Boundary Expansion Alternative C			
Land Use Category	Chambers Co.	Jefferson Co.	Galveston Co.
Irrigated Agriculture	3,195	311	
Improved Pasture	16,794		
Natural Pasture	29,305	1,915	6,923
Natural Pasture/Marsh		5,546	334
Barren Land	106	42	
Total Acreage	49,400	7,814	7,257

Table 4-52 Land Use Categories by acres in Refuge Boundary Expansion Alternative D			
Land Use Category	Chambers Co.	Jefferson Co.	Galveston Co.
Irrigated Agriculture	10,073	3,218	
Improved Pasture	25,867		
Natural Pasture	30,376	6,221	6,923
Natural Pasture/Marsh		21,040	334
Barren Land	243	42	
Total Acreage	66,559	30,521	7,257

Step 2: Estimate Assessed Values of Acquisition Acreage

Once the acreages and land use categories were estimated for each district under each Refuge Boundary Expansion Alternative, it was then necessary to determine how the local tax assessor values these acreages for tax purposes. Given the location and rural nature of the lands that would be acquired by the USFWS, it was assumed that all lands that could be purchased by the USFWS are now in agriculture production. This assumption is important because agricultural lands in Texas are appraised

Table 4-53
Chambers County Land Assessments

Land Use Category	Value per acre
Irrigated Agriculture	\$223
Barren Land	\$36
Natural Pasture	\$56

Source: Chambers County Appraisal District, 2003 Chambers County Ag & Timber Values, Anahuac, Texas.

differently than other land uses. An agricultural appraisal considers the capacity of the land to produce crops, livestock, qualified wildlife or timber instead of its value on the real estate market.³⁰ Land must be principally devoted to agricultural use for five of the last seven years to qualify for this assessment. An agricultural appraisal is based on an estimate of the typical annual income during the five-year period proceeding the year before appraisal.

Table 4-54
Jefferson County Land Assessments

Land Use Category	Value per acre
Irrigated Agriculture	\$194
Natural Pasture	\$34
Marsh Pasture	\$9

Source: Jefferson County Appraisal District, 2003 Ag Schedule, Beaumont, Texas.

The Texas Comptroller's Office was contacted for information on agricultural assessments for each of the three counties where acquisition would occur. Mr. Jesus Longoria of the Texas Comptroller's Office was able to provide data on total acreage and agricultural productivity values by agricultural land categories for the affected school districts in Chambers, Jefferson and Galveston Counties. This data was taken from the annual Property Value Study, conducted by the Comptroller's Office. This report summarizes information provided by the counties each year and is used to certify tax assessments for school districts across the state. Mr. Longoria provided data for 1998-2001.

Table 4-55
Galveston County Land Assessments

Land Use Category	Value per acre
Natural Pasture and Hunting	\$40
Natural Pasture, Marshy	\$15

Source: Galveston Central Appraisal District, 2004 Agricultural Productivity Values, Galveston, Texas

The data on agricultural productivity values as well as information from the county appraisal districts was used to estimate an annual

average value per acre for each of the land classifications. A summary of these estimates for each county is provided in Tables 4-53 through 4-55.

³⁰ Texas Comptroller of Public Accounts, "Texas Property Taxes," January, 2003, Austin, Texas.

Step 3: Determine Property Tax Rates by District

The applicable tax rate for each impacted district was obtained from the counties as summarized in Tables 4-56 through 4-58. The tax rate will be applied to the total assessed value of lands per district to estimate total property tax revenues generated in the acquisition areas under current conditions.

Table 4-56
Chambers County Property Tax Rates by District

Code	Tax District	Tax Rate Per \$100/Value
01	Chambers County	0.528645
33	East Chambers Cons. ISD	1.65
30	Anahuac ISD	1.5
60	Chambers-Liberty Navigational District	0.0285
49	Drainage District #6	0.200039
65	Hospital District	0.75
79	Trinity Bay Conservation District	0.4827

Source: Chambers County

Table 4-57
Jefferson County Property Tax Rates by District

Code	Tax District	Tax Rate Per \$100/Value
01	Jefferson County	0.365
03	Hamshire-Fannett ISD	1.64
13	Sabine Pass ISD	1.689
35	Port of Port Arthur	0.131277
37	Port of Sabine Pass	0.295151
47	Drainage District #3	0.307738
49	Drainage District #6	0.200039
55	Jefferson County Navigational District	0.033023
79	Trinity Bay Conservation District	0.4827

Source: Jefferson County

Table 4-58
Galveston County Property Tax Rates by District

Code	Tax District	Tax Rate Per \$100/Value
GGA	Galveston County	0.5939
S13	High Island ISD	1.5
RFI	Galveston Co. Road and Flood	0.0124

Source: Galveston County

a. Estimated Reduction in Tax Revenues

The model was then used to calculate the potential decrease in tax revenues that would occur if the USFWS were to acquire all lands within the proposed expanded boundary in fee simple title.

Refuge Boundary Expansion Alternative B

For Refuge Boundary Expansion Alternative B, the estimated loss in property tax revenues from removing lands from the tax rolls was estimated to be \$47,278 as summarized in Table 4-59. Most of this reduction in tax revenues would occur in Chambers County based on the distribution of acquisition acreage. Within Chambers County, the largest impact would occur to the Anahuac ISD, which is estimated to lose \$19,721. The next largest impact to Chambers County jurisdictions would accrue to the County and the Hospital District, with each losing an estimated \$10,357 and \$9,245 respectively. The largest impact in

Jefferson County would occur to the Hampshire-Fannett ISD, which would lose an estimated \$2,470 in property tax revenues.

Table 4-59
Estimated Reduction in Property Taxes on Lands
in Acquisition Areas – Refuge Boundary Expansion Alternative B

Refuge Acquisition Areas	County		
	Chambers	Galveston	Jefferson
Anahuac NWR	\$35,644	\$15	
Moody NWR	\$7,550		
McFaddin NWR	\$277	\$346	\$3,237
Texas Point NWR			\$189
Total	\$43,471	\$361	\$3,426

Refuge Boundary Expansion Alternative C

Table 4-60 summarizes the tax implications for Refuge Boundary Expansion Alternative C. Removing 64,471 acres from the tax rolls has the potential to reduce tax revenues to all districts by a total of \$99,054. As with Refuge Boundary Expansion Alternative B, the largest impact would occur in Chambers County with a reduction of \$89,568 in tax revenues. Within Chambers County, the largest impact would occur to the Anahuac ISD, which is estimated to lose \$43,850, while the Hospital District would lose \$21,925, and the County would lose \$18,177. Districts within Jefferson County are estimated to lose over \$3,500 with the largest impact occurring to the Hampshire-Fannett ISD, which is estimated to lose over \$2,470.

Table 4-60
Estimated Reduction in Property Taxes on Lands
in Acquisition Areas – Refuge Boundary Expansion Alternative C

Refuge Acquisition Areas	County		
	Chambers	Galveston	Jefferson
Anahuac NWR	\$79,592	\$5,590	
Moody NWR	\$9,508		
McFaddin NWR	\$468	\$348	\$3,237
Texas Point NWR			\$311
Total	\$89,568	\$5,938	\$3,548

Refuge Boundary Expansion Alternative D

Refuge Boundary Expansion Alternative D, the largest acquisition alternative, has the potential to reduce property tax revenues to all districts by an estimated \$184,304 as summarized in Table 4-61. As with the other two alternatives, the largest impact would occur to taxing districts in Chambers County. Within Chambers County, the largest impact would occur to the Anahuac ISD, which is estimated to lose \$76,890, while the Hospital District would lose \$38,445 and the County would lose \$30,409. The districts within Jefferson County are estimated to lose \$21,485 with the largest impact occurring to Hampshire Fannett ISD (\$15,567) and Jefferson County (\$3,701).

Table 4-61
Estimated Reduction in Property Taxes on Lands
in Acquisition Areas – Refuge Management Alternative D

Refuge Acquisition Areas	County		
	Chambers	Galveston	Jefferson
Anahuac	\$146,944	\$5,590	
Moody	\$69,508		
McFaddin	\$428	\$348	\$21,180
Texas Point			\$305
Total	\$156,880	\$5,938	\$21,485

A comparison of the estimated tax revenues that could potentially be lost due to a change in land ownership with current tax revenues earned by impacted districts in the study area indicates that no district would incur a loss greater than one percent of their current annual tax revenues.³¹ Total estimated property tax losses for each alternative by government jurisdiction for the three counties are provided in Appendix A.

b. Offset from Refuge Revenue Sharing Payments

This analysis has not considered the annual Refuge Revenue Sharing payments that would be distributed to the counties from the USFWS if acquisition were to occur. The most recent data on these payments indicated that the USFWS has paid a minimum of \$43,000 to Chambers County and \$58,000 to Jefferson County in annual revenue sharing payments for lands currently owned. The dollar amount of past Refuge Revenue Sharing payments is substantial and significantly offsets the local tax losses. In some instances, largely for lands subject to the agricultural exemption, the past Refuge Revenue Sharing payments have been equal to or even greater than the amount paid in taxes while in private ownership. Future Refuge Revenue Sharing payments would be adjusted for any newly acquired lands using calculations described in Chapter 2, Part B, *Issues Common to all Refuge Boundary Expansion Alternatives*. It can be anticipated that these payments would offset at least a portion of the lost tax revenues estimated above and thus decrease potential negative impacts to the taxing districts.

3. Social Impacts

Along with the fish, wildlife, vegetation, and the physical environment, people are an integral part of ecosystems. Lifestyles, attitudes, beliefs, values, social structure, culture, and population characteristics affect, and are affected by, ecosystem management actions such as those made by the USFWS within the Refuge Complex. Additionally, the Refuge Complex lands and USFWS management of these lands have emotional meanings to many people.

³¹ Annual revenues for the Hospital District were not available.

a. Impacts to Social Structures and Lifestyles

Some of the social structure and lifestyle parameters that were examined as part of this analysis include:

- Community cohesion (the degree of unity and cooperation evident in a community as it defines problems and attempts to resolve them),
- Community stability (a community's capacity to handle change without major hardships or disruptions to component groups or institutions),
- Social organization (the structure of a society described in terms of roles, relationships, norms, institutions, lifestyles, infrastructure, and/or community cohesiveness and stability), and
- Lifestyles (patterns of work and leisure, customs and traditions, and relationships with family, friends, and others).

Overall, most people's lifestyles and social interactions (including community cohesion, community stability, and social organization) would essentially remain the same as current conditions. Any social and/or lifestyle effects from implementation of Refuge Boundary Expansion Alternatives B, C or D on individuals and groups would be lessened because the USFWS would only acquire lands from "willing" sellers; it must be assumed that a willing seller has individually determined that any associated impacts from this land transfer to the USFWS is acceptable, or the transaction would not be made. Issues would also arise when USFWS management activities on any newly acquired lands are perceived to adversely impact adjacent landowners or reduce economic benefits to the community. Those management actions that would continue to be controversial and may have localized impacts include water management and prescribed fire activities.

b. Impacts to Relationships between the USFWS and Stakeholder Groups

General categories of stakeholder groups describe those persons and/or groups that have an identified interest in or relationship with USFWS activities. A description of the potential relationships between the USFWS and stakeholder groups is contained in the impact analysis for Refuge Boundary Expansion Alternative A, the "No Action" Alternative. Please note that stakeholders can be either individuals, or formal or informal groups of individuals. Some of these categories can overlap, and therefore an individual or a group can be a member of more than one stakeholder category. Some potentially affected people are not members of any vocal or identified stakeholder group. Stakeholder groups seldom include a true representative sample of the affected population, meaning that any one stakeholder group can generally not speak for the population as a whole. The following is a list of local stakeholder groups who could be affected by refuge boundary expansion.

- Residents and/or Employees
- Landowners
- Recreationalists
- Governmental or Quasi-Governmental Agencies
- Businesspersons and/or Business Owners
- Conservation or Environmental Protection Advocates

Overall, USFWS management activities on newly acquired lands may conflict in some cases with some of the goals, beliefs, and objectives of many of the local stakeholders. Some members of a stakeholder group may support refuge boundary expansion and future USFWS management of those lands, while other members oppose it. Different stakeholder groups may agree or disagree with the size or location of a particular refuge boundary expansion alternative; or, even the need for refuge boundary expansion. This situation will lead to the continued need for the USFWS to interact with the public (see next section) and address their concerns. However, socioeconomic issues would continue to exist among the various

stakeholder groups with regard to their opinion of the USFWS role, responsibilities, and actions: many of these issues would remain unresolved in the future as discussed later in this section.

c. Impacts to USFWS Public Outreach Programs and Activities

In addition to informing the public of USFWS roles, responsibilities, and actions, one of the major goals of public outreach programs and activities conducted by the USFWS is to understand what people need, want, expect, and/or desire in regard to the management of the Refuge Complex. With new actions such as those proposed in Refuge Boundary Expansion Alternatives B, C and D, USFWS public outreach efforts would continue and may expand.

The future public outreach efforts would seek a mutually beneficial interaction between the public and the USFWS, although as noted elsewhere in this section, there would continue to be controversy about USFWS activities at the Refuge Complex under any of the alternatives being considered in this EIS.

The proposed USFWS refuge boundary expansion actions would have no major effect on the existence or resolution of current socioeconomic issues associated with USFWS activities at the Texas Chenier Plain Refuge Complex. Under any of the Refuge Boundary Expansion Alternatives:

- There would be points that continue to be in dispute or unsettled between different parties regarding the existence and/or management of the Refuge Complex
- Different people and groups would continue to have differing and sometimes conflicting beliefs, values, and goals with respect to USFWS actions
- Some people would continue to think positively about the role of the USFWS in the area; others would continue to think negatively about this role; and others would continue to have no opinion or be neutral about the USFWS role and activities within the area
- As with existing conditions, issues would be unresolved and one party could not be determined to be “right” and the other party “wrong” with their differing beliefs, values, and goals. For many persons in the area, important considerations affecting the continuation of existing issues would include their sense of personal freedom, self-sufficiency, and control over their future.

Under the Refuge Boundary Expansion Alternative A (No Action), existing conditions and trends would generally remain the same. The management of the Refuge Complex land and the extent of land holdings would not change in substantive ways.

Under Refuge Boundary Expansion Alternatives B, C and D, management philosophies and priorities would change from current conditions, and the amount of USFWS land holdings would increase. The USFWS management of newly acquired lands would continue to be primarily oriented to support wildlife habitat management and enhance fish and wildlife values which may differ from current private land management actions. These different management approaches and philosophies have a relationship with social structures and lifestyle, but the differences among alternatives from a specific social structure/lifestyle perspective would not be substantial except on a localized or case-specific basis. Under all the action alternatives for refuge boundary expansion, the USFWS priority would continue to be the support of high quality, effective, and efficient fish and wildlife habitat management and enhancement of fish and wildlife values; however the “appropriateness” of any chosen alternative would depend on individual and group values, beliefs, and goals.

While Refuge Boundary Expansion Alternatives B, C and D support different conservation priorities, and the differences among alternatives may be identifiable on a localized basis, the social structure and lifestyle conditions and trends within the project area would generally remain the same as current conditions. Because the USFWS would work only with willing sellers, the potential social and lifestyle concerns would lessen because changes in ownership would be a choice, not a requirement. Overall,

impacts to social structures and lifestyles would not be significant from any alternative considered in this EIS. No matter which Refuge Boundary Expansion Alternative was implemented, most socioeconomic issues would remain unresolved.

d. Environmental Justice

The need to conduct an environmental justice analysis for the Texas Chenier Plain Refuge Complex CCP/ EIS is based on Executive Order (EO) 12898. Several areas have been identified as having potential minority or low-income populations within the primary or secondary study areas. EO 12898 requires an assessment as to whether these populations might be disproportionately affected by the management alternatives.

Based on the results of the socioeconomic and environmental impact analysis conducted for this project, it can be concluded that those persons who reside in and around the Refuge Complex would bear both some adverse and some beneficial effects by the continued operation and/or expansion of the Refuge Complex. However, any identified socioeconomic or environmental impacts from continued operation of the Refuge Complex by the USFWS would not be localized nor be placed primarily on the identified minority and/or low-income population components. Overall, the identified minority and/or low-income populations would not be disproportionately affected compared to other segments of the general population in the area. Additionally, persons of all races and income levels were invited to participate in the public participation process for the EIS, and comments or input into the process from any minority or low-income persons were considered equally with all other persons. Therefore, implementation of any of the Refuge Boundary Expansion Alternatives would be in compliance with EO 12898.

III. IMPACTS ON CULTURAL RESOURCES FROM REFUGE BOUNDARY EXPANSION ALTERNATIVES

Impacts on Cultural Resources

Impacts on cultural resources can include inundation, destruction, damage, and/or disruption. Impacts can directly result from ground-disturbing activities or indirectly from human use or land use and management. Potential ground-disturbing activities include facilities construction, road construction, ditch digging, oil and gas activities, and water management 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. Natural phenomenon may also impact cultural sites through inundation, wind/water/wave erosion, subsidence, tree bioturbation, and animal burrowing.

Impacts on Cultural Resources from Refuge Boundary Expansion Alternatives

No additional lands would be identified for acquisition and the Refuge Complex would remain its current size under Refuge Boundary Expansion Alternative A. Seventeen known shell middens, one of which is NHRP eligible, and a potentially NHRP eligible historic shipwreck would be slated for acquisition as lands become available under Refuge Boundary Expansion Alternatives B and C. A total of 25 known shell middens, two of which are NHRP eligible, and the potentially NHRP eligible shipwreck would be slated for acquisition as lands become available under Refuge Boundary Expansion Alternative D. There is a potential for additional protection as well as impacts to federally acquired cultural sites under all of the acquisition alternatives; however, these impacts would not be considered adverse and most of the impacts would be considered minor in nature, unavoidable, or beneficial.

The transfer of lands with known cultural sites from private to federal ownership are not anticipated to impact known cultural sites, but would rather preserve the setting of the sites and may provide additional protections not afforded to the sites on private lands. Federal acquisition would provide additional protections under NHPA and associated regulations not afforded to cultural sites on private lands. Private lands acquired would also be subject to the actions and impacts identified for the preferred management alternative on existing Refuge Complex lands.

Natural impacts would continue to occur to the known cultural sites on acquired areas; however, additional protections may be afforded to the sites under Refuge Management Alternative D if water management projects extend to the acquired lands. The potentially eligible shipwreck has already experienced damage from waves and previous disturbance from U.S. Army Corps of Engineers jetty construction and repair; USFWS ownership would likely not result in any changes to the shipwreck site from its current condition.

Known cultural sites on federally acquired lands would be afforded additional protections from ground-disturbing activities through the Section 106 process. Any ground-altering projects proposed by the USFWS would have a new site-specific Section 106 consultation. Cultural sites on private lands may not experience ground disturbance as often as federal lands, but in some cases may be subject to more. The presence of cultural sites on private lands are typically unknown by the landowner and the sites have been subject to clearing, grading, or borrowed material that modified the condition of the original site. On occasion, private landowners may also collect and remove cultural materials from the sites for a personal hobby, which removes the cultural material from the benefit and knowledge of the greater public. The ground-truthing and the Section 106 consultation process may reveal more cultural sites previously undiscovered in private ownership and provide protection as appropriate.

The cultural sites on newly acquired lands may be subject to prescribed burning, cattle grazing, and recreation that may or may not have occurred previously in those areas. Regular prescribed burning or use of natural ignited fire on acquired lands would reduce the potential for higher intensity fires under Refuge Management Alternative D, and may reduce fuel loads that produce higher intensity fires that threaten the integrity of cultural items. The potential for inadvertent cattle tromping is likely to occur on

acquired lands slated for grazing under Refuge Management Alternative D. Cultural sites on newly acquired private lands may experience an increase in visitation as opposed to that occurred in private ownership. However, recreational activities typically occur in previously developed areas and access can be controlled as needed to protect sensitive cultural items. Boating restrictions on Refuge Complex lands would impose restrictions that may reduce the potential for damage to shoreline cultural sites from wake erosion.

IV. IMPACTS COMPARISON TABLE FOR REFUGE BOUNDARY EXPANSION ALTERNATIVES

The impacts discussed in detail in the preceding section, *Part B: Impact Analysis for the Four Refuge Boundary Expansion Alternatives*, are summarized and condensed in the following table. The impacts under the "No Action" Alternative A are the base of comparison for the other three "Action" Refuge Boundary Expansion Alternatives. The table is organized by resource area, the same way the detailed impact analysis in Part A is organized. The table allows for a quick comparison of the impacts in a specific resource area between Alternatives.

NO ACTION ALTERNATIVE	ACTION ALTERNATIVES
RBE Alternative A	RBE Alternatives B, C, & D
Impacts to Air Quality	
Smoke impacts to air quality from agricultural burning on private lands to improve forage for livestock and wildlife and control brush.	Smoke impacts to air quality from USFWS prescribed burning on newly acquired lands mitigated by strict adherence to prescription parameters.
Impacts to Geology and Soils	
Coastal land loss continues at existing or accelerated rates on private lands.	USFWS would expand interagency coordination to address threats from coastal land loss on newly acquired lands, with goal of implementing major erosion abatement projects implemented along Gulf, GIWW and East Galveston Bay shorelines. USFWS water management and prescribed burning on newly acquired lands may benefit soil formation and vertical accretion in marshes.
Impacts to Hydrology and Water Quality	
Economic considerations dictate type & scope of activities affecting large-scale hydrology on private lands. Less management of marshes resulting from trend to smaller ownerships.	Wetland management & hydrologic restoration by USFWS on newly acquired lands would help restore historic continuum of fresh, intermediate, brackish and saline marshes which support a natural diversity of native plant, fish, and animal communities. USFWS would increase efforts to improve water quality.

RBE Alternative A	RBE Alternatives B, C, & D
Impacts to Vegetation/Habitats	
Impacts from Habitat Management and Restoration Activities	
<p>Water management on private lands primarily supports agricultural uses, primarily livestock grazing. Rice production is declining with former rice fields fallowed or converted to improved pasture. Burning, grazing and water management on some private lands enhance wetland habitats for waterfowl and other migratory birds. Many private landowners actively control invasive plant species, particularly Chinese tallow.</p>	<p>USFWS would use structural water management on newly acquired lands to control salinities and water levels within marsh habitats to mimic natural marsh hydroperiods and provide more productive habitats for fish & wildlife. Moist soil management would be expanded and cooperative rice farming would be maintained where possible on newly acquired lands to provide freshwater habitat for waterfowl and other migratory birds. Prairie restoration & management on newly acquired lands would increase the abundance of native prairie grasses & forbs, protecting Globally Imperiled plant communities. USFWS would increase protection and enhancement of woodlot habitats. USFWS would use prescribed burning, controlled grazing and exotic/invasive species control to enhance native habitats on newly acquired lands. Shoreline protection/restoration and marsh restoration on newly acquired lands would positively impact nationally-declining wetland habitats.</p>
Impacts from USFWS Programs (Public Use, Biological, Oil and Gas Management, and Community Outreach/Partnerships)	
<p>Some private landowners participate in USFWS and other agency conservation initiatives, particularly to restore wetland habitats. Oil and gas development would continue as currently administered on private lands.</p>	<p>Motorized boating for fishing and hunting can impact wetland vegetation; impacts from other public uses are localized & minimal. Biological program supports adaptive management approach and oil & gas management reduce impacts to vegetation/habitats. Continuation of outreach and partnership efforts would result in additional habitat restoration & enhancement on Refuge Complex and private lands throughout the project area.</p>
Impacts to Fish and Wildlife Resources	
Impacts from Habitat Management and Restoration Activities	
<p>On private lands, economic considerations dictate land uses & management practices and resulting benefits to fish & wildlife. Agricultural practices provide substantial benefits to waterfowl but may reduce wetland habitat available for other wetland-dependent avian species. Combinations of burning, grazing, & water management on private lands which provide benefits to waterfowl also benefit other species.</p>	<p>Marsh habitats on newly acquired lands would be managed to enhance habitat for waterfowl, shorebirds, wading birds & other wetland-dependent migratory birds. Moist soil management would be expanded and cooperative rice farming continued on newly acquired lands providing additional high quality wetland habitat for wintering and resident waterfowl and other migratory birds. USFWS would provide and enhance habitats specifically needed by Mottled Ducks. USFWS would focus management/restoration activities to obtain a mosaic of diverse habitat types benefiting a wide variety of avian species, including several Avian Species of Conservation Concern. Restoration and enhanced management of native prairie habitats would benefit many declining landbird species. Integrated burning, grazing, & exotic/invasive species control on newly acquired lands would maintain naturally diverse and productive wetland and upland habitats benefiting avian species, T&E species, and a wide variety of other wildlife species. USFWS management of water control structures on newly acquired lands would benefit fisheries by increasing fish passage.</p>

RBE Alternative A	RBE Alternatives B, C, & D
Impacts from Public Use Program	
Dove and waterfowl hunting would continue as currently managed on private lands.	USFWS would open specific areas within newly acquired lands for public wildlife-dependent recreational uses. Waterfowl and dove harvest would not affect overall populations and their long-term viability. Sanctuary areas would be established on newly acquired lands to maintain local waterfowl populations & mitigate hunting pressure. Motorized boating can affect distribution & habitat use of waterfowl & other wildlife species. Impacts from other recreational activities are localized & minimal as to most species. No impacts to T&E species or long-term viability of fisheries resources.
Impacts from Biological Program, Oil and Gas Management, and Community Outreach/Partnerships	
Some private landowners allow wildlife surveys and studies (waterfowl banding), and participate in USFWS and other agency conservation initiatives which benefit wildlife, especially waterfowl. Oil and gas development would continue as currently administered on private lands.	USFWS would implement a variety of new/expanded surveys, monitoring, & research on newly acquired lands to facilitate adaptive management approach allowing continual refinement and improvement of management activities. Biological program would focus on priority wildlife species needing conservation action. Net effect of oil & gas management is reduction of impacts to fish & wildlife resources from these activities. Expanded outreach/partnership efforts would result in benefits to fish & wildlife resources as important habitats are restored and enhanced on private lands.
Economic Impacts	
There are direct, indirect and induced impacts from existing Refuge Complex operations, agriculture, and recreation (same as impacts analyzed for Refuge Management Alternative. D in Part A of Chapter 4).	New land acquisition results in losses of agricultural support programs for rice farming by Alt.: Direct Payments, B) \$351,808 C) \$407,596 D) \$1,545,295; Counter-Cyclical Payments, B) \$249,720 C) \$289,319 D) \$1,096,880; Indirect/Induced, B) \$151,661 C) \$175,710 D) \$666,160. Represents maximum possible loss, more likely only a percentage of this because some acreage would be included in coop rice farming and some base acreage would be retained by current landowners as farms are reconfigured. New land acquisition not expected to cause significant impacts in cattle grazing industry or commercial hunting operations. Some loss of development potential in and around Taylors Bayou by new land acquisition under Refuge Boundary Expansion Alternative D.
Fiscal Impacts to Local Governments	
Refuge Revenue Sharing Payments made to local governments based on already acquired lands.	New land acquisition results in losses of tax revenues to local governments by Alternative: B) \$47,258, C) \$99,054, D) \$184,303. Represents maximum possible loss if all lands were acquired within an expansion boundary. Refuge Revenue Sharing Payments on newly acquired lands would offset portion of loss in tax revenues.
Impact on Population and Social Impacts	
No impact on population or environmental justice. Social conditions remain generally the same with some unresolved issues.	Same as Refuge Boundary Expansion Alternative A.
Impacts on Cultural Resources	
Unavoidable adverse impacts from natural phenomenon are anticipated to continue to occur at cultural resource sites under all of the Refuge Boundary Expansion Alternatives. Acquisition of these sites would preserve the setting of these sites and provide additional protection through the Section 106 process from ground-disturbing activities.	

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 Refuge 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 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 Refuge 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.

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 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 and much of it has been lost through ongoing shoreline erosion and retreat along the Gulf of Mexico. 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 and 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 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, 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 in 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) 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 - Wildland Fire Suppression and Prescribed Burning

Natural fire and herbivory by native species now occur less frequently or at reduced levels in the project area 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). Invasive Species Management

Under the combined Preferred Alternatives, the USFWS would expand the scope of 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 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 introduced 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 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 effects 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 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 enhance habitat benefits. 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 waterfowl, 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 to native 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 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 and marshes 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) to restore open water habitats and increase availability of submerged aquatic vegetation which provides valuable food for waterfowl. Invasive species control activities for Chinese tallow would be intensified in permanently fallowed rice fields 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 invasive non-native and native plant species in prairie habitats 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, 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. 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 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. 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

Landbird 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 landbird species prefer grassland habitats including marshes and prairies (Peterson *et al.* 1995). In general, a mosaic of a variety of habitat types accommodates the greatest variety of species, as for most other bird and wildlife species.

All habitat management and restoration activities conducted 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, Nelson's Sharp-tailed 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 and 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 nesting habitat for species including Dicksissel and Eastern Meadowlark. Landbirds listed as Avian Species of Conservation Concern utilizing prairie habitats and which would benefit from conservation and management of native coastal prairie in the project area include LeConte's Sparrow, 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 (Shackelford and Lockwood 2000), and/or are among several species recently listed by the USFWS as "Avian Species of Conservation Concern" in the Gulf Prairies Bird Conservation Region (USFWS 2005). For example, White-tailed Hawk, 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) 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, 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. 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, invasive plant and animal control, marsh restoration through the beneficial use of dredge material, 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 all new and 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 waterfowl, 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 of 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 expansion of refuge boundaries and subsequent land acquisition proposed by the USFWS.

(2). Grazing

Much of the acreage within the Preferred Refuge Boundary Expansion 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 waterfowl 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, 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 refuge expansion.

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 Refuge 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 Refuge Complex and location of the shell middens along shorelines, full protection of the shell middens is not feasible without completely altering the site or removing the material from its context. Inundation of many of the sites has already occurred and the unavoidable adverse impacts are highly likely to continue. The eligible McFaddin beach site is already inundated by the naturally altered coastline and is subject to water erosion and loss of material. Cultural resource management actions are not proposed for the shell midden sites under the 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 management 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 management 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 management 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 management projects (such as levee

construction, repair, or removal), would be subject to a ground survey and consultation requirements with the State Historic Preservation Officer (SHPO) under the NHPA Section 106 regulations. Privately initiated oil and gas activities create the most ground disturbance in the Refuge Complex with road, pipeline, and well pad construction. Any dredge or fill projects in the Refuge Complex would be proposed and conducted by the U.S. Army Corps of Engineers. Shoreline protection projects 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 suppressed using direct attack tactics, construction of ground-disturbing firebreaks, or chemical retardants. 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 Refuge Complex is largely limited to existing roads and waterways. Recreational activities including hunting, fishing, wildlife observation and photography, environmental education and interpretation would continue under proposed management and would 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 in bayous and constructed canals and ditches that have already been modified from their original landforms through straightening and dredging. Impacts to shell middens from wake action created by smaller boats is likely to be minor. Continuing and expanding environmental education and interpretation programs under the combined Preferred Alternatives may indirectly lead to improved public appreciation and awareness of Refuge 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, marsh restoration through the beneficial use of dredge material, 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 Refuge 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 recreational 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. Refuge visitors and their activities may inadvertently damage cultural sites; however, access to the Refuge Complex is limited to existing roads and waterways. Cultural sites on newly acquired private lands may experience an increase in visitation. However, recreational activities typically occur in previously developed areas and access can be controlled as needed to protect sensitive cultural resources.

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 formally 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 forum 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 greater 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 providing 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 conservation 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 Channel 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 project was constructed in 2004 along 2,500 linear feet of severely eroding shoreline at the eastern end of the McFaddin NWR. The Research and Development project used geotubes to isolate sediment cells. After 3 years of detailed monitoring, the project was transferred to the TGLO..
- **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 Refuge 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 traditional 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 recreational 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 agricultural practices and habitat management. 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 Refuge 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 related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions. Of certainty is that the viability of the region's coastal wetlands will depend upon their ability to vertically accrete, or gain elevation, to keep up with relative sea level rise.

A coarse sediment deficit in the Gulf of Mexico's littoral system resulting from construction of navigation channels, jetties, and upstream dams on rivers has also accelerated rates of shoreline retreat and coastal land loss along the Gulf shoreline. This reduced sand supply has contributed to the loss of much of the region's low barrier beach/dune system, which formerly reduced shoreline erosion and retreat by buffering wave action and prevented inundation of inland freshwater marshes with saltwater during all but major storms and tidal surges. Shoreline erosion and retreat along the Gulf of Mexico in the project area is resulting in coastal land loss at rates as high or higher than those in coastal Louisiana. The historic barrier beach/dune system has been almost entirely 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 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 and restoration, seagrass restoration, shoreline protection, and mangrove and saltmarsh wetland creation.

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 region 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 this coastal ecosystem include construction of navigation canals, infrastructure, and road access for oil and gas activities, and channelization and deepening of natural waterways to promote inland drainage and navigation. 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 as a contributing factor in the conversion of vegetated emergent marsh to open water.
- New channels and modifications of natural waterways introduced tidal energies into historically non-tidal or micro-tidal marshes, resulting in decreased plant productivity, plant mortality, peat collapse and erosive loss of organic marsh soils. All have contributed to the conversion of the vegetated emergent marsh to open water. Introduction of tidal influence also altered marsh hydroperiods or wetting and drying cycles. Non-tidal and microtidal marshes whose soil surfaces were exposed only seasonally or during periods of drought became subject to daily tidal fluctuations.
- Increased saltwater intrusion reduces plant productivity in plant communities adapted to fresher hydrological regimes. Plant productivity, especially below-ground biomass in root systems, is an important component of soil formation in the Chenier Plain region's fresher coastal marshes. Reduced plant productivity may reduce soil formation and limit marsh surface elevation gain.
- Alterations to the natural drainage systems in the region have resulted in a rapid transport of freshwater and sediments from inland areas directly to the GIWW, bays and the Gulf, and have generally eliminated the slower historic sheet flow of freshwater from the prairies into the marshes. Historic hydroperiods in the marshes have been altered as rapid drainage of inland flood waters has increased the frequency and depth of precipitation-driven flood events in downstream marshes. Conversely, drainage improvements in and adjacent to the marshes has promoted more rapid drainage and drying during normal or low precipitation cycles.
- Natural and human-caused subsidence has resulted in submergence or "drowning" of emergent wetlands and conversion to deeper, open water. Natural subsidence is the compaction of recent geologic sediments. Human-induced subsidence in the region occurs primarily from groundwater withdrawal and oil and gas extraction. Oil and gas extraction is believed to induce movement of near-surface geologic faults, causing a rapid drop in marsh elevation (White and Tremblay 1995). Subsidence also contributes to saltwater intrusion and is a causative factor in shoreline erosion/retreat and resultant coastal land loss along the Gulf, bays and larger waterbodies. The mean sea level trend for Sabine Pass, Texas is 6.54 millimeters/year (2.15 feet/century) with a standard error of 0.72 mm/year, based on monthly mean sea level data from 1958 to 1999 (National Oceanic and Atmospheric Administration, www.tidesandcurrents.noaa.gov). Recent scientific information on changes in polar ice caps related to global climate change suggests that current projections of relative sea level rise are underestimating future conditions.

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..

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 and 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 comprise 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 brackish or 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 forested wetlands 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). 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 economic 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 increasing 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 must support refuge purposes and the Refuge System mission. 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.

CHAPTER 5: COORDINATION AND CONSULTATION

This chapter describes the USFWS' coordination and consultation activities with local, State, and Federal government agencies and representatives. The USFWS' public outreach for this project with the general public and other interested persons/groups is documented in Chapter 1 in the Scoping section. The public scoping included a number of public meetings and workshops for the general public and other interested persons or groups. A number of local, State, and Federal government representatives attended and participated in these public scoping meetings and workshops. Additionally, the USFWS formally and informally coordinated and consulted with the local, State, and Federal governments/agencies outside of the public scoping process.

I. FEDERAL REGISTER NOTICES

- A formal "Notice of Intent To Prepare a Comprehensive Conservation Plan and Associated Environmental Impact Statement" was published in the Federal Register on October 21, 1999
- A formal "Notice of Availability of Draft EIS/CCP/LPP" was published in the Federal Register on October 17, 2006, announcing the availability of the Draft EIS/CCP/LPP for public review with a closing date of January 16, 2007 for comments. The notice announced that the USFWS would hold public meetings on November 28, 2006 in Port Arthur, Texas and November 30, 2006 in Hankamer, Texas, and that the USFWS would make a presentation on the Draft EIS/CCP/LPP and take comments at these public meetings..

II. FEDERAL AGENCIES

A. Cooperating Agencies: U.S. Army Corps of Engineers and Federal Highway Administration

The USFWS invited two federal agencies to participate as Cooperating Agencies in this planning effort. "Cooperating Agencies" are federal agencies that have legal jurisdiction or special expertise on the proposed action's environmental effects. The U.S. Army Corps of Engineers (COE) was invited because they operate/manage the Gulf Intracoastal Waterway which runs through or adjoins large areas of the refuges; and, because of their jurisdictional authority in wetlands and coastal waters. Also, the COE is actively involved in studying and seeking remedies for the coastal erosion problem in the project area. The COE accepted the USFWS invitation and agreed to participate as a Cooperating Agency by letter dated July 19, 2000, from the Galveston District, Corps of Engineers. The Federal Highway Administration (FHWA) was invited because they are the lead federal agency on an Environmental Impact Statement currently addressing the proposed relocation and rebuilding of State Highway 87. The USFWS was invited and agreed to participate as a Cooperating Agency on FHWA's EIS. A large portion of the State Highway 87 right-of-way was located on refuge lands and most of the road has been destroyed by coastal erosion. The EIS would most likely address relocating the road right-of-way on other refuge lands in one or more of its alternatives. The FHWA accepted the USFWS invitation and agreed to participate as a Cooperating Agency by letter dated July 20, 2000, from the Texas Division Office, Federal Highway Administration.

The FHWA established an Interagency Coordination Team (ICT) as part of the planning process for the EIS on State Highway 87. The USFWS, the Corps, and FHWA are all participants on the ICT and they have all met a number of times to discuss the planning process for the SH 87 EIS. The USFWS has also used the ICT as an opportunity to keep the COE and FHWA advised of progress on the Refuge Complex EIS/CCP/LPP. The Refuge Project Leader, who has attended all of the ICT meetings, informally briefed the COE and FHWA representatives at the ICT meetings. The Refuge Complex Project Leader also maintains telephone contact with these agency representatives regarding new developments and issues. The COE and FHWA were notified of and invited to participate in all public meetings; and, a pre-

publication copy of this draft document was delivered to both of the cooperating agencies for final comments.

Additionally, the Refuge Complex Project Leader has actively participated in two COE activities affecting the project area. He has been a member of the Interagency Coordination Team (ICT) for the COE Sabine Pass to San Luis Pass Shoreline Erosion Feasibility Study. This is a COE project (Galveston District Office) which includes several other local governmental sponsors and addresses the important EIS issue of coastal erosion. The Refuge Complex Project Leader has also been an advisory team member on the Sabine-Neches Waterway Channel Improvement Project, Feasibility Study Phase. This COE project would have direct impacts to coastal wetlands on Texas Point and McFaddin NWRs. By participating as a team member, the USFWS representative has had access to the COE's special expertise in the project area and has shared the USFWS' position on management issues being addressed in this EIS/CCP/LPP.

In late March and early April of 2005, the USFWS provided both agencies with comprehensive briefings summarizing both sets of alternatives considered and detailing more specific information on the two Preferred Alternatives. On March 31, the Refuge Complex Project Leader and Lead Planner briefed the Federal Highway Administration's District Engineer and a staff member in his office in Austin, Texas. The USFWS answered several questions raised by the FHWA concerning the USFWS' proposed actions, and discussed the status of the State Highway 87 Relocation EIS and its relationship to the USFWS' planning document. On April 1, the Refuge Complex Project Leader and Lead Planner briefed two members of the U.S. Army Corps of Engineers' Environmental Section at its District Office in Galveston, Texas. Following the briefing there was a discussion about the COE's ongoing shoreline erosion study in the area of the Refuge Complex and its possible linkage to the State Highway 87 project. Also, the USFWS explained how it was addressing several local COE projects in the cumulative impacts section of this EIS/CCP/LPP.

B. National Marine Fisheries Service

Habitats within the Refuge Complex include areas that have been identified by the Gulf of Mexico Fisheries Council (GMFMC) as Essential Fish Habitat (EFH) for juvenile white and brown shrimp and juvenile red drum. EFH known to occur on the Refuge Complex and the project area includes estuarine emergent wetlands, estuarine mud, sand and shell substrates, submerged aquatic vegetation and estuarine water column. The USFWS discussed the development of this EIS/CCP/LPP with the National Marine Fisheries Service, and provided the NMFS with a Draft EIS/CCP/LPP for review and comment. Required consultation with NMFS for impacts to EFH from individual projects/strategies implemented under this EIS/CCP/LPP will be conducted as mandated under the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 104-297).

III. STATE AGENCIES

A. Texas Parks and Wildlife Department

The USFWS recognizes that both the USFWS and the State fish and wildlife agencies have authorities and responsibilities for management of fish and wildlife on national wildlife refuges, as described in 43 CFR 24. Consistent with the National Wildlife Refuge System Administration Act, as amended by the National Wildlife Refuge System Improvement Act, the Director of the USFWS will interact, coordinate, cooperate and collaborate with the State fish and wildlife agencies in a timely and effective manner on the acquisition and management of national wildlife refuges. Under the Administration Act and 43 CFR 24, the Director as the Secretary's designee will ensure that the National Wildlife Refuge System regulations and management plans are to the extent practicable, consistent with State laws, regulations, and management plans.

The USFWS wanted to ensure coordination and cooperation with the State fish and wildlife agency early in the process of developing the Texas Chenier Plain Refuge Complex EIS/CCP/LPP. Therefore, in February of 2000, the USFWS invited the Texas Parks and Wildlife Department (TPWD) to name a representative to participate as a member of the core planning team for this project. TPWD nominated Jim Sutherlin, Project Leader of the Upper Texas Coastal Ecosystem Office, as TPWD representative on the planning team. A core planning team meeting was held on April 10, 2000, with the TPWD representative at the J.D. Murphree State Wildlife Management Area headquarters in Port Arthur, Texas. At this meeting, the EIS/CCP/LPP planning process, scoping issues to date, and ways to ensure good coordination between the USFWS and TPWD were discussed. Notices of core planning team meetings and notes for all subsequent core planning team meetings were provided to Jim Sutherlin via electronic mail. There was also recurring informal coordination between Refuge Complex staff and Mr. Sutherlin, including regular updates of EIS/CCP/LPP progress and discussions of specific biological, habitat management, and public use program activities and uses.

In January of 2002, the USFWS requested a meeting with the TPWD representative to present draft conceptual refuge management alternatives and to obtain comments/suggestions. The meeting at Anahuac NWR headquarters was attended by TPWD staff biologist, Michael Reszutek, representing Mr. Sutherlin. Mr. Reszutek was very helpful in that he has experience in both field biology in the project area and the preparation of NEPA documents. The USFWS presentation was made by the Refuge Complex Manager, Complex staff, and the lead planner. At a May 15, 2002, meeting with TPWD Project Leader Jim Sutherlin at J.D. Murphree WMA in Port Arthur, Texas, the draft conceptual Refuge Boundary Expansion alternatives along with draft maps were presented and discussed. There was also discussion on the draft conceptual Refuge Management Alternatives, earlier presented to Mr. Reszutek. This meeting was preliminary to a planned pair of June public meeting presenting the two sets of draft conceptual alternatives to the local public. TPWD was represented at the June 2002 meetings just as they had also been represented at the earlier January 2000 meetings and the November 2000 public workshops. The local TPWD participation in the planning process has been very helpful and is very much appreciated by the USFWS planning team.

The USFWS and TPWD have jointly hosted an annual fall meeting on public waterfowl hunts on the McFaddin, Texas Point, and Anahuac National Wildlife Refuges and local State Wildlife Management Areas for a number of years. Typically the meeting provided hunters with information on current hunt programs and invited their input on possible changes/improvements for future hunts. Beginning with the meeting on Monday, October 23, 2000, at the Port Arthur Public Library in Port Arthur, Jefferson County, Texas, the USFWS and TPWD have asked the participants to provide input on the hunt program and/or any other issues they wished to comment on for the EIS/CCP/LPP. At that meeting, attended by 24 interested hunters, the hunters were given worksheets listing five hunt program issues identified in earlier scoping efforts and were broken into workgroups of 6-8 individuals for discussion. Most of the worksheets and comments were collected at the end of the meeting, but several were received by mail in the weeks following. This annual meeting has been used every year since as a coordination opportunity between the USFWS and TPWD; and, also, as a forum to obtain input on both the hunt programs and the EIS/CCP/LPP from the interested hunting community.

On May 18, 2004, the Complex Manager and lead planner met with senior TPWD staff at TPWD headquarters in Austin, Texas. They presented an overview of the EIS, CCP, and LPP and the scoping processes to date and a summary of the two sets of draft Refuge Management and Refuge Boundary Expansion alternatives proposed for the draft document. Proposed changes/enhancements to waterfowl hunt and habitat management programs were highlighted along with details of the refuge expansion/land acquisition being proposed. There was considerable discussion about the two sets of draft alternatives which developed some useful suggestions and comments. Also, a prepublication copy of this draft document was presented to both local TPWD staff and the senior TPWD staff in Austin for comments prior to publication.

B. State Historic Preservation Office (Texas Historical Commission)

The USFWS contracted with Texas Archeological Research Lab (TARL), part of the University of Texas at Austin, to perform a literature survey of the available reference databases for all cultural resource sites (historical and archeological) located within both the existing refuge boundaries and all of the areas included in the refuge boundary expansion alternatives. The USFWS provided TARL with GIS map layers identifying the existing refuge boundaries and the areas proposed for expansion of the refuge boundaries. This research produced a GIS map layer locating all of the found sites and site summary files containing all of the available discovery, research, and evaluation information for each of the sites. The map and site summary files will be retained at the Refuge Complex headquarters to assist the USFWS in the future management of cultural resources on the Refuge Complex.

The USFWS also used the TARL cultural resource survey information to request a formal project review under Section 106 of the National Historic Preservation Act from the State Historic Preservation Officer, Mr. F. Lawrence Oaks, the Executive Director of the Texas Historical Commission. In May of 2004, the lead planner made a presentation to the Texas Historical Commission staff providing the proposed management and boundary expansion alternatives along with the TARL cultural resource survey map with the sites keyed to the Historical Commission's database records. Following a discussion and question/answer session with the Commission staff, the USFWS representative requested a written Section 106 review. A copy of the State Historic Preservation Officer's review document, dated June 8, 2004, is contained in this document at Appendix I.

IV. COUNTY AND LOCAL GOVERNMENTS

The USFWS planning team, in particular the Refuge Complex Project Leader, made extensive efforts to inform and involve the counties and other local governments in the planning process. A number of formal briefings were provided for the Jefferson, Chambers, and Galveston County Judges and various County Commission members. Briefings were also provided for several local Drainage Districts and School Districts. Additionally, many of the County and other local government officials attended and participated in almost all of the public meetings held in their jurisdictions. The following is a summary of most of the briefings given county and local governments:

- January 3, 2000, briefing for Carl Griffith (Jefferson County Judge), Waymon Hallmark (Jefferson County Commissioner), John C. Cannatella (Jefferson County Engineer), and John B. Johnson (Assistant to Judge Griffith). The USFWS planning team discussed the upcoming EIS with the group and answered questions mostly relating to land acquisition and State Highway 87 reconstruction. Also, Judge Griffith had some comments and concerns regarding the USFWS' prescribed burning program.
- January 10, 2000, briefing for the Chambers County Commission in the Chambers County Courthouse, Anahuac, Texas. Jimmy Sylvia (Chambers County Judge), Mark Huddleston (District 1 Commissioner), Judy Edmonds (District 2 Commissioner), Buddy Irby (District 3 Commissioner), and Bill Wallace (District 4 Commissioner) attended the briefing by the USFWS planning team. The planning team presented a summary of the CCP/LPP planning process and discussed possible future land acquisition.
- January 11, 2000, briefing for Jefferson County Drainage District 6 in their office in Beaumont, Jefferson County, Texas. The USFWS planning team presented a brief project description to Judge Richard LeBlanc (District 6 Chairman), Doug Canant, Jr. (District 6 Engineer), and Jim Broussard (District 6 Assistant General Manager for Operations). The District 6 representatives discussed their specific concerns with the USFWS planning team and described a major new drainage project the District is planning.
- March 1, 2000, briefing for Chambers County Commissioner Mark Huddleston in his office in Winnie, Texas. The Refuge Complex Project Leader and his staff provided the Commissioner a

summary of issues identified to date through public scoping and outlined the EIS/CCP/LPP process.

- March 13, 2000, briefing for Galveston County Judge Jim Yarborough at the Galveston County Courthouse, Galveston, Texas. The Refuge Complex Project Leader provided the County Judge a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process.
- March 14, 2000, briefing for Chambers County Commissioner Judy Edmonds at Anahuac NWR. The Refuge Complex Project Leader guided Commissioner Edmonds on a vehicle tour of the Anahuac NWR and provided her a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process. Various management programs and activities on the Anahuac NWR were discussed.
- March 14, 2000, briefing for Chambers County Judge Jimmy Sylvia at the Chambers County Courthouse, Anahuac, Texas. The Refuge Complex Project Leader provided the County Judge a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process.
- March 29, 2000, briefing for Chambers County Commissioner Bill Wallace at his office in Baytown, Texas. The Refuge Complex Project Leader provided the Commissioner a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process.
- March 31, 2000, briefing for Jefferson County Commissioner Mark Domingue at his office in Beaumont, Texas. The Refuge Complex Project Leader provided the Commissioner a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process.
- April 5, 2000, briefing for Jefferson County Commissioner Waymon Hallmark at his office in Port Arthur, Texas. The Refuge Complex Project Leader provided Commissioner Hallmark a summary of issues identified to date through public scoping and an outline of the EIS/CCPLPP process.
- April 17, 2000, briefing for Chambers County Commissioner Buddy Irby at his office in Mont Belvieu. The Refuge Complex Project Leader provided the Commissioner a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process.
- April 18, 2000, briefing for Jefferson County Judge Carl Griffith. The Refuge Complex Project Leader accompanied Judge Griffith on a trip to Nacogdoches, Texas, for a meeting of the Texas Region 1 Water Planning Group. Various management programs and activities on the Refuge Complex, issues relative to land acquisition by the USFWS, and water issues affecting the region were discussed. Also, the County Judge was provided a summary of issues identified to date through public scoping and an outline of the EIS/CCP/LPP process.
- May 23, 2002, briefing for Chambers County Judge Jimmy Sylvia at the Chambers County Courthouse, Anahuac, Texas. The Refuge Complex Project Leader provided information on conceptual Refuge Boundary and Refuge Management alternatives for the EIS/CCP/LPP and advised the Judge of upcoming public scoping meetings to be held in June.
- May 28, 2002, meeting of the Chambers County Commissioner's Court in the Chambers County Courthouse, Anahuac, Texas. The Refuge Complex Project Leader presented the Court and other attendees information on the conceptual Refuge Boundary Expansion and Refuge Management alternatives and advised of the upcoming public scoping meetings to be held in June.

- May 29, 2002, briefing for Jefferson County Commissioner Mark Domingue at his office in Beaumont, Texas. The Refuge Complex Project Leader provided information on the conceptual Refuge Boundary Expansion and Refuge Management alternatives and advised the Commissioner of the upcoming public scoping meetings to be held in June.
- May 30, 2002, briefing for Jefferson County Commissioner Waymon Hallmark at his office in Port Arthur, Texas. The Refuge Complex Project Leader provided information on the conceptual Refuge Boundary Expansion and Refuge Management alternatives and advised the Commissioner of the upcoming public scoping meetings to be held in June.
- May 31, 2002, briefing for Jefferson County Drainage District #6 Director Richard LeBlanc and Mr. Jim Broussard at the Drainage District #6 headquarters in Beaumont, Texas. The Refuge Complex Project Leader provided information on the conceptual Refuge Boundary Expansion and Refuge Management alternatives and advised them of the upcoming public scoping meetings to be held in June.
- June 10, 2002, meeting of the Jefferson County Commissioner's Court, at the Jefferson County Courthouse in Beaumont, Texas. The Refuge Complex Outreach Specialist presented the Court and other attendees information on the conceptual Refuge Boundary Expansion and Refuge Management alternatives and advised them of the upcoming public scoping meetings to be held in June.
- June 12, 2002, meeting with representatives of the Jefferson County Drainage District #3 at the Anahuac NWR headquarters in Anahuac, Texas. The Refuge Complex Project Leader presented information on the conceptual Refuge Boundary Expansion and Refuge Management Alternatives and advised them of the upcoming public scoping meetings to be held in June. The Drainage District representatives expressed specific concerns about USFWS land acquisition in the Mayhaw and Taylors bayous area.
- June 19, 2002, briefing for Dr. Larry Schimkowitsch, Superintendent of the Hamshire/Fannett School District. The Refuge Complex Project Leader provided information on the conceptual Refuge Boundary Expansion alternatives and advised him of the upcoming public scoping meetings to be held in June.

V. ELECTED REPRESENTATIVES

Congressman Nick Lampson (Texas Ninth Congressional District) was involved very early in the planning process for this document. Since the start, the USFWS planning team has strived to keep Mr. Lampson and the other local elected representatives fully advised of issues and progress in the planning process. A number of briefings, mostly by the Complex Project Leader, were made in person or by telephone to the elected representative or their appropriate staff members. The following is a summary of most of the briefings given to elected representatives or their staff:

- January 3, 2000, briefing for Congressman Lampson's staff. The USFWS planning team explained the CCP and land acquisition components of the EIS to J. Leney, Constituent Services Representative for Congressman Nick Lampson.
- March 24, 2000, briefing for Texas Representative Zeb Zbranek at the Anahuac NWR headquarters in Anahuac, Texas. The Refuge Complex Project Leader provided Representative Zbranek a summary of the issues identified to date through public scoping and an outline of the EIS/CCP/LPP process. Afterwards, Representative Zbranek was given a guided vehicle tour of Anahuac NWR during which various management programs and activities on the Anahuac NWR were discussed.

- May 30, 2002, briefing for Mr. Jason Fuller, a member of U.S. Senator Kay Bailey Hutchison's staff. The Refuge Complex Project Leader briefed Mr. Fuller by telephone on the conceptual land acquisition and refuge management alternatives and advised him of the upcoming public scoping meetings to be held in June.
- May 30, 2002, briefing for Mr. Dan Easely, a member of Congressman Nick Lampson's Washington, D.C. staff. The Complex Project Leader briefed Mr. Easely by telephone on the conceptual land acquisition and refuge management alternatives and advised him of the upcoming public scoping meetings to be held in June.
- June 10, 2002, briefing for Ms. Natalia Soto, a member of Congressman Nick Lampson's staff, at the Congressman's District Office in Beaumont, Texas. The Refuge Complex Project Leader provided Ms. Soto information on the conceptual land acquisition and refuge management alternatives and advised her of the upcoming public scoping meetings to be held in June.
- June 20, 2002, briefing for Texas Representative Allen Ritter at his office in Nederland, Texas. The Refuge Complex Project Leader provided information on the conceptual land acquisition and refuge management alternatives and advised him of the upcoming public scoping meeting to be held later that day at Lamar University in Beaumont.
- June 21, 2002, briefing for Mr. Dan Easely a member of Congressman Nick Lampson's Washington, D.C. staff. The Refuge Complex Project Leader gave a summary of the two June, 2002, public meetings by telephone to Mr. Easely.
- June 26, 2002, briefing for Mr. Jason Fuller, a member of Senator Kay Bailey Hutchinson staff, at Senator Hutchinson's office in Houston, Texas. The Refuge Complex Project Leader presented to Mr. Fuller a summary of the two June, 2002, public meetings.
- April 28, 2005, an informational refuge tour and briefing was conducted for staffs of Congressmen Ron Paul and Ted Poe and Senators Kay Bailey Hutchinson and John Cornyn. The two Congressmen were new to the project area by virtue of the recent re-districting and the results of the 2004 elections.

CHAPTER 6: COMMENTS ON DRAFT EIS/CCP/LPP AND SERVICE RESPONSES

PART A: DISTRIBUTION OF DRAFT EIS/CCP/LPP

The Notice of Availability for the Draft EIS/CCP/LPP was published in the Federal Register on October 17, 2006. It was also announced that the public comment period would close on January 16, 2007. The Draft EIS/CCP/LPP was published both in a digital format available on CDs and paper hard-copies. The Draft EIS/CCP/LPP was made available to the public in the following ways:

A copy was posted on the Service's internet web-site at:
<http://www.fws.gov/southwest/refuges/Plan/completeplans.html>

Both digital and hard-copies were provided to fifteen public libraries in the project area to be made available to the general public.

Digital and/or hard-copies were provided to the two Federal cooperating agencies and Texas Parks and Wildlife Department. Hard-copies were also provided to the Environmental Protection Agency (EPA) for the required NEPA review.

Digital copies were sent to a total of 58 Federal or State agencies, local governmental entities, and elected representatives; and, digital copies were also sent to a total of 38 organizations which had expressed interest in the document.

Letters were sent to the nearly 400 landowners within the area contained in the Preferred Refuge Boundary Expansion Alternative C describing the actions being considered in the Draft EIS/CCP/LPP and informing them of the ways to obtain a copy of the document. Similar letters were sent to all 272 of the individuals who had participated in either public meetings or workshop; and, letters were also sent to about 220 members of the two "Friends groups" in the Refuge Complex.

All of the letters which were sent distributing or providing notice of availability of the Draft EIS/CCP/LPP also advised the recipients of the January 16, 2007, closing date for comments and the opportunity to verbally provide comments at two public hearings to be held November 28 & 30, 2006.

In response to the numerous letters, notices and internet posting; the Service received a little over a dozen written or e-mail requests for a hard-copy or CD copy of the Draft EIS/CCP/LPP.

PART B: COMMENTS ON DRAFT EIS/CCP/LPP

I. COMMENTS FROM FEDERAL AND STATE AGENCIES.

A. Comments from Cooperating Federal Agencies: Federal Highway Administration and US Army Corps of Engineers

The points-of-contact for both of the cooperating federal agencies were offered personal briefings at their offices but neither agency accepted the offered briefing.

1. Federal Highway Administration

No comments

2. US Army Corps of Engineers

No comments

B. Comments from other Federal Agencies

1. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA)



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue S
St. Petersburg, Florida 33701

January 3, 2007

Mr. Doug St. Pierre
Natural Resource Planner
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico 87103

Dear Mr. St. Pierre:

The NOAA's National Marine Fisheries Service (NMFS) has reviewed the October 2006, document titled, "Texas Chenier Plain Refuge Complex *Draft Environmental Impact Assessment/Draft Comprehensive Conservation Plan/Draft Land Protection Plan*" (DEIS). The DEIS was transmitted by your letter of October 20, 2006. The U.S. Fish and Wildlife Service (FWS) propose two federal actions: 1) development of a 15-year management plan for the refuge complex; and 2) expansion of the approved land acquisition boundaries for the four refuges in the complex. The refuges in the complex consist of the Anahuac, Moody, McFaddin and Texas Point Refuges located in Chambers and Jefferson Counties, Texas.

We have reviewed the DEIS and have no comments to provide regarding National Environmental Policy Act issues. However, the preferred plan indicates that future additional structural marsh management strategies will be pursued in the refuge complex and that FWS will continue to coordinate these activities with NMFS and other federal and state agencies. The DEIS does not provide enough detail for NMFS to provide essential fish habitat (EFH) conservation recommendations on the proposed structures at this time. Consequently, NMFS will provide EFH conservation recommendations, if needed, as these projects become more fully developed. NMFS would like to take this opportunity to remind the FWS of your Magnuson-Stevens Fishery Conservation and Management Act EFH consultation responsibilities for any federal funded, permitted or authorized activity that may adversely affect EFH.

We look forward to working with your staff on the 15-year plan. If we may be of further assistance, please contact Mr. Rusty Swafford of our Galveston Facility at (409) 766-3699.

Sincerely,

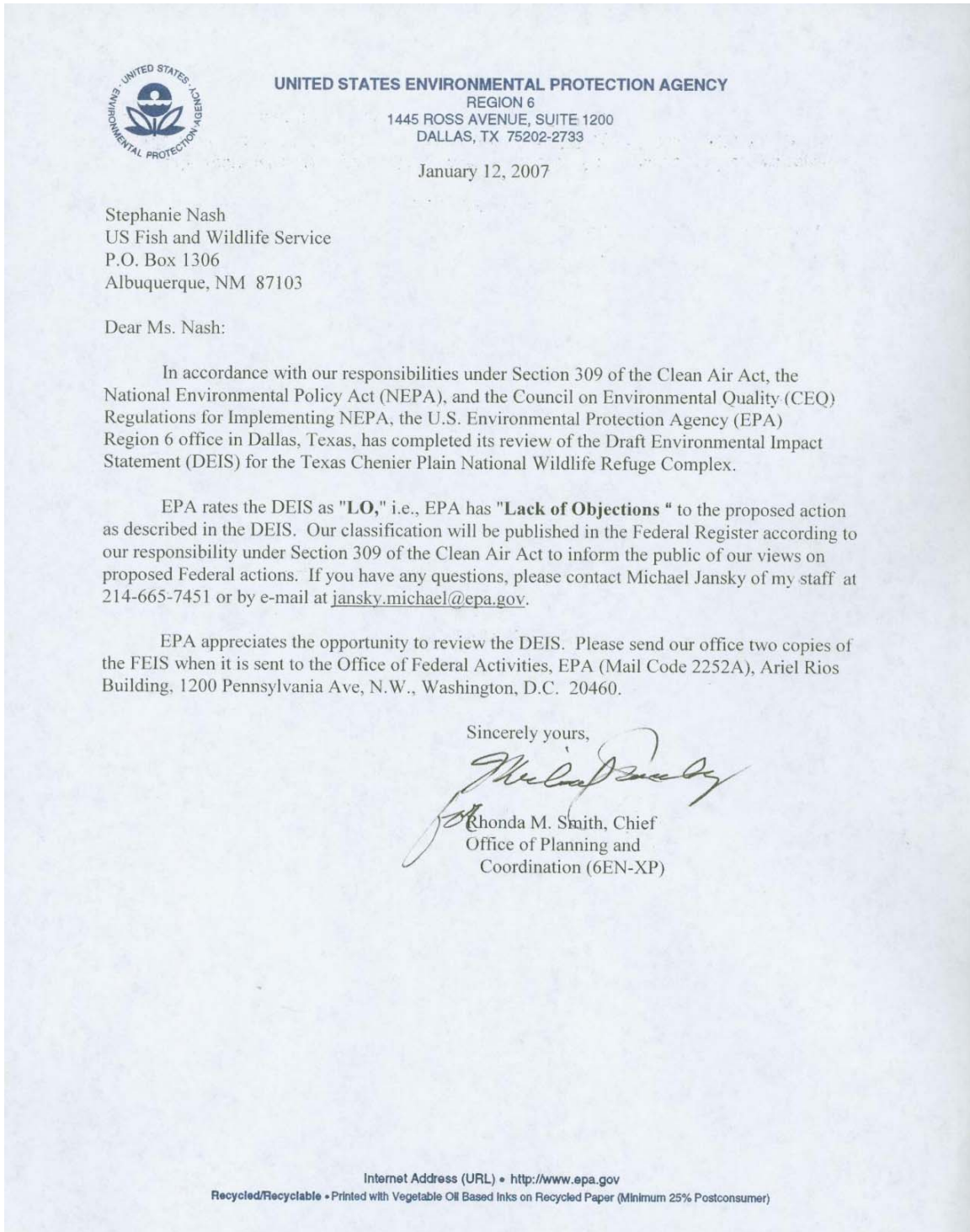
Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division



Service response:

Because this is a "programmatic" EIS addressing conceptual, broad-issue management strategies, the Service agrees that there is not enough detail on future structural marsh management strategies for NOAA to provide essential fish habitat conservation recommendations at this time. However, the Service recognizes its consultation obligations under the Magnuson-Stevens Fishery Conservation and Management Act and will consult with NOAA if and when proposed structural marsh projects are fully developed and ready for implementation.

2. Environmental Protection Agency (EPA)

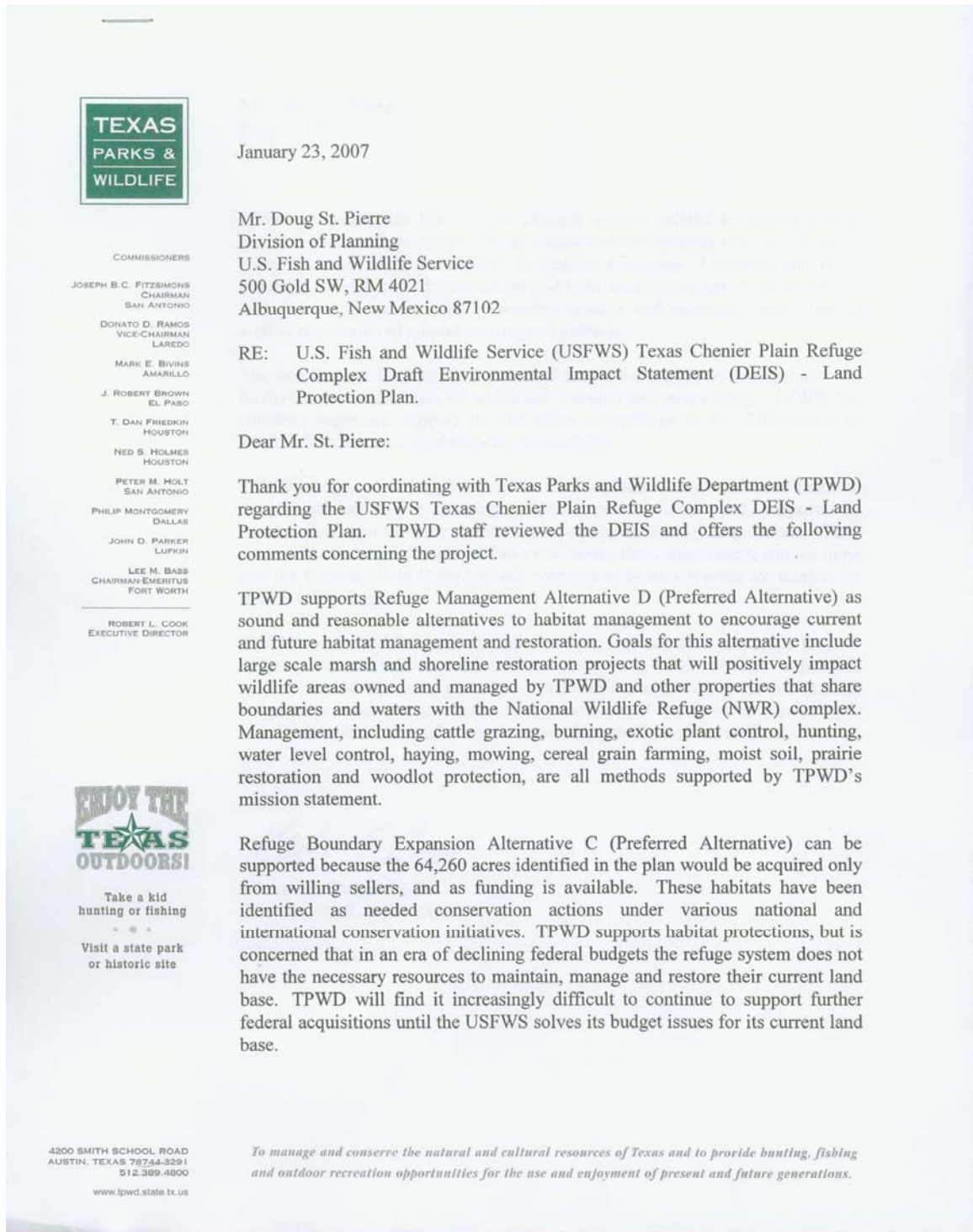


Service response:

The Service thanks the EPA Region 6 office for reviewing the Draft EIS/CCP/LPP and registering a "Lack of Objections" comment.

C. Comment from Texas Parks and Wildlife Department

Texas Parks and Wildlife Department was also offered a personal briefing on the Draft EIS/CCP/LPP which they accepted. On October 23, 2006, Andy Loranger and Doug St. Pierre briefed the Director of the TPWD Wildlife Division and key members of his staff at the TPWD offices in Austin, Texas.



Mr. Doug St. Pierre
Page 2 of 2
January 23, 2007

TPWD concurs with USFWS on changes needed related to coastal habitat resource loss trends in Texas. Texas coastal wetland systems face near identical crises as those coastal marsh lands in adjacent Louisiana. Louisiana and Texas coastal issues are closely interrelated and both states recognize these issues that include loss of coastal habitat, shoreline erosion, and emergent marsh loss, as well as conversion of coastal prairies and uplands.

The two Preferred Alternative goals and strategies emphasize management and recognize the importance of additional research and monitoring. TPWD has concerns regarding support for the other alternatives in the EIS related to wildlife habitat and coastal resource stewardship.

TPWD recognizes and appreciates The Chenier Plain Complex's commitment to maintaining an active hunting program on its lands and supports its continuation. Hunters play a vital role in funding for Refuge acquisitions. Other coastal Texas refuge complexes have not shown this commitment, and we hope that the Chenier Plain Complex will continue to be an advocate for hunters on federal refuge lands.

TPWD and USFWS should continue to work together on a landscape level to address coastal habitat management, restoration, and wildlife dependent recreational use of coastal resources. The DEIS is comprehensive in recognizing the problems and concerns that must be addressed if we are to be successful in sustaining wildlife and fisheries resources along the Upper Texas Coast.

Sincerely,



Michael E. Berger, Ph.D.
Director, Wildlife Division

MEB:AJH:dg.12113

Service response:

The Service greatly appreciates the participation and cooperation of TPWD in the development of this Draft EIS/CCP/LPP. Thank you for your comments supporting both our Preferred Refuge Management Alternative D and our Preferred Refuge Boundary Expansion Alternative C. We agree with TPWD's comment that habitat management and restoration are essential in this ecosystem and believe that the

environmental impact analysis for the Management Alternatives illustrates the need for and benefit from the management activities employed by the Service on the Refuge Complex.

We think that the Preferred Refuge Boundary Expansion Alternative provides the very best opportunity to achieve additional habitat protection with minimal, if any, increase in operational costs. Each year the Service requests the funding necessary for operations and maintenance of its Refuge land base within the context of the total national budget; and, we have enjoyed the support of the recently founded Congressional Wildlife Refuge Caucus with more than 140 members.

The Texas Chenier Plain NWR Complex intends to continue its commitment to providing the public with high-quality, wildlife dependent recreational opportunities on refuge lands including hunting and fishing.

II. LOCAL GOVERNMENTS AND ELECTED OFFICIALS

We did not receive any direct comments from the many local government entities and elected officials, except for an action initiated by Chambers County. The Chambers County Commissioner's Court has approved donating up to 25 acres of uplands out of a tract of county land to the United States to be used by the Service as an administrative and visitor center for the Texas Chenier Plain NWR Complex.

III. PUBLIC COMMENTS

A. Contact from Landowners Wanting to Sell their Land

The Service was contacted in writing by two landowners whose sole comment was to express their current interest in selling their land to the United States for inclusion in the Refuge Complex.

Service response:

After a Record of Decision implementing the refuge boundary expansion is issued, the two landowners will be contacted by the Service's realty specialist to discuss possible acquisition of their land.

B. Comments Received at the Service's Two Public Hearings

Port Arthur, Texas

A public hearing was held at the Holiday Inn Park Central, Port Arthur, Texas, on Tuesday night, November 28, 2006. Following a short presentation on the document by its authors and a question and answer session, three individuals presented the following verbal comments, which were recorded by a court reporter:

1. Mr. Chuck Reddell

Mr. Reddell, a Jefferson County businessman who lives in Chambers County, had comments primarily about two issues in the Draft EIS. First, he expressed strong support for land acquisition and expansion of the refuge boundaries; noting the current significant economic impact to Southeast Texas from ecotourism. Secondly, he emphasized the importance of the Service's active habitat management program ranging from restoring agricultural fields to controlling water levels. It is his opinion that the Refuge Complex will provide tremendous future economic impacts from ecotourism in addition to the positive impacts from opportunities for people to enjoy the natural beauty of the land.

Service response:

We thank Mr. Reddell for his strong support and we will continue providing quality wildlife-dependent recreational opportunities for the public.

2. Mr. James Cacioppo

Mr. Cacioppo, a Nederland Texas resident, expressed general support for the plan and refuge expansion. However, he would like to see increased access to Service lands with clarified/simplified access rules and additional hunting opportunities for other species. Also, he would like to see more aggressive restoration projects on Texas Point NWR including filling man-made canals, restoring cheniers, necking down Texas Bayou, and plugging the old pilot station ditch.

Service response:

We will continue working with the public and interested hunters to improve our hunting program and have already proposed dove hunting for Anahuac NWR. We would point out to Mr. Cacioppo that Refuge Management Alternative D does specifically include strategies for wetland restoration on Texas Point NWR.

3. Mr. John Whittle

Mr. Whittle, a Nederland Texas resident and Audubon Society member, expressed his own comments outside of the comments which will be submitted by the Audubon Society. He feels that management is weighted excessively toward the marshes and should support more shorebird and wading bird habitats. He pointed out the great ornithological importance of the Refuge Complex to neotropical/nearctic migrant land birds and stated that the Service should create woodlot habitat for these migrants on a much greater scale than the CCP proposes. He strongly supports the comprehensive biological survey program, the addition of more biologists, and expansion of biological studies to the other refuges besides Anahuac NWR. He would like to see a more appropriate balance between the opportunities provided for the various consumptive and nonconsumptive recreational and educational groups using the refuge lands. He opposes opening any refuge lands for dove hunting and opposes fishing either along the banks of Shoveler Pond or between Shoveler Pond and West Line Road. While supporting the logic of our preferred boundary expansion, he would like to extend these perimeters to permit acquisition of more varied habitats based on the willing seller doctrine. Finally, he believes that the estimated 250 annual wildlife watchers at Texas Point NWR is very significantly underestimated based on the heavy birder use along Pilot Station Road.

Service response:

The Service's response to Mr. Whittle's comment is identical to our response to the Golden Triangle Audubon Society's comment which follows in this Chapter. We thank him for taking the time and effort to state his comments at our public hearing.

White's Park

A public hearing was held at White's Park near Hankamer, Texas, on Thursday night, November 30, 2006. Following a short presentation on the document by its authors and a question and answer session, two individuals presented the following verbal comments, which were recorded by a court reporter:

1. Ms. Winnie Burkett

Ms. Burkett, a Houston resident and sanctuary manager for the Houston Audubon Society, commented for herself and the Houston Audubon Society. She favored the preferred refuge management alternative because it increases wetland management for the benefit of wetland dependent species who suffer from declining available habitats. She was also pleased with the boundary expansion that included additional prairie and woodlot habitats which have been negatively impacted by development on the coast. She pointed out the importance of ecotourism and the fact that wildlife viewing and fishing brings in income to Chambers County businesses, little businesses that need additional income. She finished by stating that if we're going to have ducks and fish and birds for the future, then we're going to have to make sure that we protect more habitat, and this plan does that.

Service response:

The Service thanks Ms. Burkett and the Houston Audubon Society for their continued support of our efforts to protect wildlife habitats. We also wish to recognize her and the organization for their substantial conservation accomplishments along the upper Texas Gulf Coast.

2. Mr. Steve Fitzgerald

A private landowner adjacent to Anahuac NWR, had comments which followed up on earlier discussions of feral hogs during the question and answer session. He wants to see a written management program to control feral hogs on the Refuge Complex and prevent damage to adjacent landowner's crops. He further suggested that the Service provide restitution for damage by feral hogs to crops on his land.

Service response:

Feral hog populations appear to be increasing throughout the region, and high populations are damaging native habitats and infrastructure on the Refuge Complex as well. The Service is proposing to increase feral hog population control efforts on the Refuge Complex under Refuge Management Alternative D (Preferred Alternative). The Service will coordinate these efforts with neighboring landowners.

C. The Beaumont Enterprise Newspaper Editorial - November 28, 2006

The Beaumont Enterprise is the daily newspaper for Beaumont, Jefferson County, Texas and serves all of East and Southeast Texas. The Enterprise which is owned by the Hearst Corporation also publishes the Southeast Texas Business Monthly and is believed to be Southeast Texas' oldest continually operated business, serving the region for over 115 years. This editorial was published the day of the Service's public hearing in Port Arthur and is quoted in full from their web-site:

11/28/2006***Land purchases could protect valuable habitat***

Selling land to the federal government can be a sensitive issue for some property owners. The way it's being done by the U.S. Fish and Wildlife Service along the Gulf Coast seems to be the right way. No landowners are being forced to sell their property, and the federal bidding helps increase the land's value. If the feds buy the land, it will become part of a wildlife refuge.

Federal officials are making it known they might buy some land in the Texas Chenier Plain Refuge Complex, which includes the McFaddin, Anahuac, Moody and Texas Point national wildlife refuges. Some landowners are eager to sell to the highest bidder. Others want to keep their property in private hands so it can continue to have multiple uses, such as farming and ranching.

Good arguments can be made for either course. Some land must remain available for private development to create jobs and tax revenues. Yet history shows that if some wildlife habitat isn't preserved, eventually it will be lost. Southeast Texas, like all parts of the country, needs a good balance. About 64,000 acres are eligible to be purchased in this latest round.

The Fish and Wildlife Service is holding two public hearings on this issue. One is at 7 tonight at the Holiday Inn-Park Central in Port Arthur. The other is at 7 p.m. Thursday at White's Park in Hankamer.

Southeast Texans who want to learn more about his issue should try to make one of the meetings. This region has been blessed with some wonderful lands for birding, hiking, hunting, etc. All of us alive today have to ensure that some of this land is available for future generations to cherish as well.

Service response:

Thank you for your expression of support for our efforts to protect wildlife habitats in Southeast Texas for the benefit of both present and future generations. As noted, any future acquisition of land will be on a "willing sellers only" basis, just as it has been in the past. Hopefully, lands protected within the Texas

Chenier Plain Refuge Complex do help to provide some “balance” to the development which has already occurred and will inevitably occur in the future in this area.

D. Comments from organizations

1. The Golden Triangle Audubon Society (GTAS)

GTAS, the National Audubon Society Chapter in Southeast Texas based in Nederland, Texas, provided a written set of comments signed by John A Whittle, Secretary. They begin with a statement that GTAS is generally in agreement with the basic premises and conclusions in the EIS. They then provided some suggestions and comments focusing principally on the CCP portion. They feel that other habitat types, in particular woodlots, are being out-weighted by the focus on marshes; and point out the great ornithological importance of the Complex area to trans-Gulf Neotropic-Nearctic migrant landfalls in the spring.

The GTAS strongly supports the biological (survey) program along with the addition of more biologists and offers volunteer assistance to refuge staff to carry out the program. However, they point out that obtaining statistical significance in biological data is not always possible given expense and the time frames required, and that waiting to obtain enough biological data to make inferences about the significance of population trends for certain wildlife species often results in difficult and expensive recovery programs. They state that the reality is that we need to both intensify survey efforts and act on data that is less statistically sound than we would like.

They question the balance between the various types of recreation users; specifically urging more access for wildlife watchers, the numbers of which they claim has been increasing geometrically. Also, GTAS expressed its opposition to the proposal to make some areas available for dove hunting, and opposed allowing fishing along the banks of Shoveler Pond and between Shoveler Pond and West Line Road. Finally, although they recognized the logic behind our preferred refuge boundary expansion alternative, they would like to see these perimeters extended even more to provide more varied habitat.

Service response:

The Service fully recognizes the great importance of near-coastal woodlands to trans-Gulf migrant songbirds and the strategically important location of the Refuge Complex along this migration route. The Service proposes to reassess the potential for creation of additional woodland habitat on the Refuge Complex, and to work with partners to achieve any new restoration objectives both on and off of Service lands. The Final EIS/CCP/LPP has been revised to reflect this. In addition, the Service will fully evaluate woodland restoration potential on any new lands added under the Preferred Refuge Boundary Expansion Alternative C.

Under Refuge Management Alternative D (Preferred Alternative), the Service proposed several strategies to expand the biological program on the Refuge Complex including conducting new biological surveys, monitoring and research to guide an adaptive management approach and to meet information needs for sensitive or declining species. Implementation of these strategies will depend on new and emerging partnerships with other agencies, organizations and universities. The Service welcomes and appreciates the support and volunteer assistance provided by conservation groups and individuals in meeting biological program objectives.

The Refuge Complex currently provides opportunities for all six of the Refuge System's priority wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. All wildlife-dependent recreational uses on the Refuge Complex are managed such that sensitive fish, wildlife and plant resources are protected, fish, wildlife and plant populations are not adversely impacted, conflicts among the different recreational users are avoided or minimized, and public safety is protected. The Service uses a variety of management approaches on the Refuge Complex including strategic location of public use facilities, establishment of undisturbed sanctuaries, seasonal openings and closures, and regulations governing means of access to achieve these objectives. The Service believes that the objectives and strategies proposed under Refuge

Management Alternative D represent the most feasible approach to managing public uses on the Refuge Complex over the next fifteen years in a manner which ensures that these uses remain compatible with the establishment purposes of the refuges and mission of the Refuge System, and consistent with protection of public safety.

Under Refuge Management Alternative D (the Preferred Alternative), the Service will enhance and expand all wildlife-dependent recreational programs on the Refuge Complex. This includes implementation of several strategies which expand and enhance opportunities for wildlife observation and photography, fishing and environmental education and interpretation, including opening additional areas on McFaddin NWR for these uses. The Service also proposes to open dove hunting in designated area(s) of the Anahuac NWR. Initiating a dove hunt on Anahuac NWR in partnership with the Texas Parks and Wildlife Department will provide additional public hunting opportunity on the Refuge Complex. This hunt will be managed in a manner so as to ensure that it is compatible with refuge establishment purposes and the Refuge System mission and does not conflict with other public uses.

Bank fishing along the roadside borrow areas on Shoveler Pond has been traditionally allowed on Anahuac NWR, and is not a newly proposed use of this area. Management of Shoveler Pond has and will continue to focus on providing freshwater wetland habitat and on providing high quality opportunities for wildlife observation and photography, environmental education and interpretation. The Service believes that allowing bank fishing in the borrow area along the levee trail between Shoveler Pond and Westline Road on Anahuac NWR will not negatively impact waterbirds or other avian species, nor will it conflict with other allowed uses.

2. The Houston Audubon Society (HAS)

HAS, the National Audubon Society Chapter in Houston, Texas, provided comments on both the CCP and the LPP. They expressed support for preferred Refuge Management Alternative D which they state would help restore, maintain, and enhance the level of natural species diversity (floral and faunal communities) indigenous to the Texas Gulf Coast ecosystem. However, they did encourage the Service to include in the plan the creation of more woodlots that the proposed 29 acres because woodlots are extremely important to migrating songbirds. They further support the CCP objectives and strategies to enhance habitats through management and restoration benefiting all bird species, including shorebirds, colonial waterbirds, waterfowl, neotropical migratory songbirds, and grassland species. The Society also supports Refuge Boundary Expansion Alternative D because they feel it will increase protection for migratory birds and other species now threatened by loss of habitat. They stated that the acquisition and protection of any remaining coastal tallgrass prairie is a high priority and of great concern to the Houston Audubon Society because North America's grassland bird species are in serious decline due to loss of habitat.

Service response:

The stated objectives and strategies for protecting and enhancing existing and restoring woodland habitats on the Refuge Complex under Refuge Management Alternative D take into account several factors. Historically, the limited upland habitats currently found on the Refuge Complex consisted of native tallgrass coastal prairie with the possible exception of the riparian woodland habitats that naturally occurred on higher elevation bayou banks and the chenier ridges along the northern boundary of Texas Point NWR. Naturally-occurring fires and grazing by native ungulates such as bison helped maintain this native grassland community. The Service believes that managing existing prairie remnants and restoring prairie on suitable upland sites such as fallowed croplands on Anahuac NWR is critical to maintaining the region's overall biological diversity and biological integrity given the extremely rare and threatened status of this habitat type in the region. This approach is also consistent with the Service's Refuge System Biological Integrity policy (601 FW 3) which establishes the restoration of historic habitat conditions where feasible as the ideal. Proposed objectives for protecting existing and restoring additional woodland habitat on the Refuge Complex under Refuge Management Alternative D also considered site suitability. Site-specific conditions including soil chemistry, soil salinity, hydrology and elevation dictate site suitability for woodland habitat restoration. Suitable sites for creating woodlots on the Refuge Complex are extremely limited.

In determining its preferred Refuge Boundary Expansion Alternative the Service considered ecological values, benefits to management of existing refuges, levels of threat, and feasibility as affected by land ownership patterns and projected availability of funding. Under Refuge Boundary Expansion Alternative C (Preferred Alternative), the Service is proposing to include areas containing the largest remaining tracts of native coastal prairie on the upper Texas coast, in addition to important areas of coastal marsh adjacent to existing refuges, within new approved refuge boundaries. This would allow the Service to acquire lands or interests in lands from willing sellers within those areas (subject to availability of funds). The Service recognizes that the forested wetlands along Taylor's Bayou and woodland and wetland habitats on the Bolivar Peninsula are extremely important to neotropical-nearctic migrant songbirds and other native wildlife species. As identified in Appendix C of the Draft EIS/CCP/LPP, there are many additional Federal, State and private conservation programs available to assist private landowners. As noted, the Service will continue to work with landowners, other agencies and conservation organizations under its Preferred Refuge Boundary Expansion Alternative to promote habitat conservation, restoration and management in these important habitat areas and throughout the region.

3. The Gulf Coast Bird Observatory (GCBO)

GCBO, based in Lake Jackson, Texas, has as its mission the study and conservation of birds and their habitats in and around the Gulf of Mexico. Their conservation efforts focus primarily on landbirds and their comments emphasize the impacts on that group. Their comments primarily focused on Alternatives C & D of the Refuge Management Alternatives, which they state best represent their ideas and goals. They had fundamental problems with the emphasis in each of the other Refuge Management Alternatives. They also pointed out that an important reference for most of the upland habitats, (Texas Parks and Wildlife Department, 2000), was missing from the reference section of the document. Additionally, they are preparing the Partners in Flight landbird conservation plan for the Coastal Prairies and Marshes, in conjunction with the Gulf Coast Joint Venture. They attached a first rough draft of their plan for our reference

They state that Alternative C with its emphasis on native habitat restoration represents a desired scenario since only 1% of coastal prairies remain on the Texas Gulf Coast. They pointed out the many wintering and resident species of grassland birds directly threatened by loss of this unique habitat. Although maintaining row crop agriculture may benefit some shorebirds and waterfowl, it is directly related to loss of prairie. They note that millions of migrant nearctic-neotropical passerine birds depend on the small and isolated woodlots along the coast after a perilous trans-Gulf migration.

Further, they stated that Alternative D is an innovative new approach to management which they think would work well; especially, because of the emphasis on monitoring and using the results for management decisions. They would like to see the federal refuges involved in their ongoing landbird monitoring program take a more active role in collecting data on migrating landbirds and add additional biologists to accomplish the increased monitoring efforts.

Service response:

The Service thanks the GCBO for its comments and recognizes its conservation efforts focusing on landbirds in the Gulf Coast area. We erroneously used the citation, (Texas Parks and Wildlife Department, 2000), in the document when the citation should have been (Shackelford and Lockwood 2000). We corrected the mistake in the text and it is included in the Reference section. t.

For the reasons outlined below, the Service believes that Refuge Management Alternative D (Preferred Alternative) represents the most desirable approach to meet the establishment purposes of the refuges in the Refuge Complex, the mission of the National Wildlife Refuge System, and the conservation of Trust fish and wildlife species including migratory birds and Threatened and Endangered species, while recognizing the need to address emerging threats to biological integrity, biological diversity and environmental health. This alternative focuses on protecting and enhancing existing wetland and upland habitats on the Refuge Complex through active management, continues and expands efforts to enhance and restore native tallgrass coastal prairie and woodland habitat on suitable sites, continues and expands efforts to address major ecosystem threats, uses additional scientific monitoring and studies to guide an

adaptive management approach with increased emphasis on declining or sensitive species, and expands wildlife-dependent recreational uses with an emphasis on enhancing the quality of the refuge visitor experience.

The intensive management of wetland habitats on the Refuge Complex proposed under Refuge Management Alternative D is needed to counter habitat changes and losses which have occurred on a landscape scale in the region. Moist soil management and rice farming replace many benefits historically provided by natural prairie wetlands which have almost completely disappeared in the region, and provide concentrated food resources and other habitat benefits for migratory birds and other wetland-dependent wildlife. Similarly, by replacing former natural disturbance regimes which would otherwise not occur due large-scale conversion of surrounding habitats to other land uses, prescribed burning and controlled grazing help maintain biological diversity in both plant and animal communities in Refuge Complex wetlands, and enhance habitat values for waterfowl and many other migratory bird species. Use of actively-managed water control structures or passive structures such as rock weirs helps maintain the historic continuum of fresh, intermediate, brackish and saline marshes in support of maintaining natural biological diversity, enhancing habitat values for waterfowl and other migratory birds, and reducing the negative impacts of saltwater intrusion into non-tidal or micro-tidal fresh and intermediate marshes.

The Service fully recognizes and concurs with the importance of restoring and managing native coastal prairie on the Refuge Complex. It is estimated that less than one percent of the over 9 million acres of the western Gulf Coast's native tallgrass prairie which existed at the turn of the 20th century now remains. The Service believes that the proposed objectives and strategies for native prairie restoration under Refuge Management Alternative D represent the most feasible approach to restoring prairie on the Refuge Complex over the next fifteen years. The techniques required to restore native prairie on the upper Texas coast are extremely labor intensive and expensive. Other limiting factors to prairie restoration on the Refuge Complex include limited site suitability due to hydric soil conditions, the availability of a viable seed supply, alterations of soil chemistry and soil microbial communities resulting from previous conversion to rice agriculture, and extreme competition from non-native invasive grasses and woody plant species.

4. The Houston Regional Group of the Sierra Club (HSC)

HSC provided extensive written comments (62 pages plus an attachment) signed by Brandt Mannchen, Chair, Forestry Subcommittee of this group. Also, five individuals provided very similar comments addressing exactly the same three positions/issues raised in the Sierra Club's comments. Three of the individuals were Holly Eaton, Bill Tarbox, and Alison Tyler all from Houston; while the other two individuals were identified only by their e-mail addresses, which were Rebelljb@aol.com and disillusionedx@hotmail.com.

All of these comments similarly addressed the following:

- Support for Refuge Boundary Expansion Alternative D, which would add a total of 104,120 acres to the Refuge Complex.
- Support for Refuge Management Alternative C; but, strongly urging the removal of cattle to be replaced with the introduction of bison.
- Opposition to the implementation of an entrance fee for Anahuac NWR.

The following is the Service's response to the above three issues before addressing the balance of the Sierra Club's comments:

- In determining its preferred Refuge Boundary Expansion Alternative the Service considered ecological values, benefits to management of existing refuges, levels of threat, and feasibility as affected by land ownership patterns and projected availability of funding. Under Refuge Boundary Expansion Alternative C (Preferred Alternative), the Service is proposing to include areas containing the largest remaining tracts of native coastal prairie on the upper Texas coast, in addition to important areas of coastal marsh adjacent to existing refuges, within new approved refuge boundaries. This would allow the Service to acquire lands or interests in lands from willing

sellers within those areas (subject to availability of funds). The Service recognizes that the forested wetlands along Taylor's Bayou and woodland and wetland habitats on the Bolivar Peninsula are extremely important to neotropical-nearctic migrant songbirds and other native wildlife species. As identified in Appendix C of the Draft EIS/CCP/LPP, there are many additional Federal, State and private conservation programs available to assist private landowners. As noted, the Service will continue to work with landowners, other agencies and conservation organizations under its Preferred Refuge Boundary Expansion Alternative to promote habitat conservation, restoration and management in these important habitat areas and throughout the region.

- For the reasons outlined below, the Service believes that Refuge Management Alternative D (Preferred Alternative) represents the most desirable approach to meet the establishment purposes of the refuges in the Refuge Complex, the mission of the National Wildlife Refuge System, and the conservation of Trust fish and wildlife species including migratory birds and Threatened and Endangered species, while recognizing the need to address emerging threats to biological integrity, biological diversity and ecosystem health. This alternative focuses on protecting and enhancing existing wetland and upland habitats on the Refuge Complex through active management, continues and expands efforts to enhance and restore native tallgrass coastal prairie and woodland habitat on suitable sites, continues and expands efforts to address major ecosystem threats, uses additional scientific monitoring and studies to guide an adaptive management approach with increased emphasis on declining or sensitive species, and expands wildlife-dependent recreational uses with an emphasis on enhancing the quality of the refuge visitor experience. Refuge Management Alternative D does specifically include strategies for wetland restoration on Texas Point NWR.

The intensive management of wetland habitats on the Refuge Complex proposed under Refuge Management Alternative D is needed to counter habitat changes and losses which have occurred on a landscape scale in the region. Moist soil management and rice farming replace many benefits historically provided by natural prairie wetlands which have almost completely disappeared in the region, and provide concentrated food resources and other habitat benefits for migratory birds and other wetland-dependent wildlife. Similarly, by replacing former natural disturbance regimes which would otherwise not occur due large-scale conversion of surrounding habitats to other land uses, prescribed burning and controlled grazing help maintain biological diversity in both plant and animal communities in Refuge Complex wetlands, and enhance habitat values for waterfowl and many other migratory bird species. Use of actively-managed water control structures or passive structures such as rock weirs helps maintain the historic continuum of fresh, intermediate, brackish and saline marshes in support of maintaining natural biological diversity, enhancing habitat values for waterfowl and other migratory birds, and reducing the negative impacts of saltwater intrusion into non-tidal or micro-tidal fresh and intermediate marshes.

The Service concurs that using bison in native grassland management and restoration has many ecological advantages over the use of cattle. However, there are both ecological and practical constraints to using bison on the Refuge Complex. First, over 90 percent of the Refuge Complex is comprised of wetland habitats which will not support grazing by bison, and most adjacent low-lying non-saline "wet prairies" and salt prairies on the Refuge Complex are also not suitable for grazing by bison. The controlled grazing program is used primarily as a management tool during the cool season to manage plant communities in fresh and intermediate coastal marshes. Most upland units on the Refuge Complex (almost all are on Anahuac NWR) which contain native prairie remnants, sites being actively restored to prairie, and/or mixed grasslands on fallowed former croplands consist of small, non-contiguous tracts which also cannot effectively support grazing by bison. Logistical constraints to implementing a bison grazing program on the Refuge Complex also exist, and include the need for specialized fencing and other infrastructure and the feasibility of integrating bison management with other management activities and public uses. Also, it should be noted that the Service does not own the cattle currently used in the controlled

grazing program relying instead on local private cattle ranchers for both stock and the ranch hands to manage them. Grazing bison as an alternative would also depend upon the availability of privately owned bison herds in the local area. The Service would assess the feasibility of using bison in a grassland management program should suitable large tracts of native coastal prairie be acquired and become part of the Refuge Complex in the future.

- The Service began considering the establishment of an entrance fee at Anahuac NWR following public comments in support of initiating such a fee expressed during a series of scoping meetings for a Service planning effort conducted during the mid-1990's which proposed expansion of the approved refuge boundaries and working with conservation partners to protect important wildlife habitats in the region. The Anahuac NWR originally proposed and was approved for the collection of a general entrance fee (for that portion of the Refuge which is open to the public 365 days per year) under the Recreation Fee Demonstration Program (Fee Demo Program) in 1997. Participation by the Service in the Fee Demo Program was authorized under the Omnibus Consolidated Recission and Appropriations Act (P.L. 104-154) of 1996. This law was superceded by the passage of the Federal Lands Recreation Enhancement Act in 2004, which rolled all approved programs under the Fee Demo Program into the new Recreation Fee Program.

In addition to collecting a general entrance fee, the Refuge concurrently proposed to make an annual \$40 permit for waterfowl hunting on the East Unit hunt unit available to refuge hunters (as an option in addition to the existing \$10 per day user fee). Although the Refuge was approved to collect both the entrance fee and the annual hunting permit fee under the Fee Demo Program in 1997, to date only the East Unit annual waterfowl hunting permit has been implemented.

Public support to collect an entrance fee at Anahuac NWR, as expressed by many refuge visitors and groups such as the Friends of Anahuac Refuge, remains high. Public-private partnerships have been instrumental in the recent development of new visitor facilities and programs on the Refuge. They have in fact supported almost all recent recreational and educational facility and program developments and enhancements on the Refuge, including new trails, boardwalks, observation platforms, fishing piers, a photography blind, a butterfly landscape and native habitat demonstration area, multi-media interpretive displays, and an on-refuge environmental education program for school-age children.

Some commented that the Draft EIS/CCP/LPP did not provide enough information on the need for initiation of an entrance fee at Anahuac NWR, specify what the fees would be used for, or analyze the environmental and socioeconomic impacts of collecting an entrance fee. The goals of initiating an entrance fee on Anahuac NWR would be to continue to enhance the experience of refuge visitors and to expand wildlife-dependent recreational and educational opportunities. Specifically, Refuge entrance fees would be used to help maintain and expand existing visitor facilities and programs, as well as to develop new facilities and programs. The Final EIS/CCP/LPP has been revised to include this additional information. As is the case with many of the individual strategies proposed in the programmatic Draft EIS/CCP/LPP, should the Service initiate an entrance fee for Anahuac NWR, all compliance and notification requirements under existing laws and policy will be completed prior to implementation.

Balance of the HSC comments:

The comments from the HSC begin by stating that: "There are many good provisions in the management and boundary alternatives"; but, that there are also many problems that must be resolved before any record of decision is made. " Some of these problems include: 1) inadequate cumulative impacts analysis; 2) failure to quantify environmental impacts; 3) no analysis about the impacts of charging an entrance fee to Anahuac National Wildlife Refuge (ANWR), including its legality under the Federal Lands Recreation Enhancement Act; 4) failure to adhere to the National Environmental Policy Act (NEPA) and the President's Council on Environmental Quality's NEPA implementing regulations; and 5) other inadequately covered issues."

Specifically, HCS commented that the Service's list of projects in the cumulative impacts analysis is incomplete because it does not include: FEMA programs; a Galveston Bay/Bolivar Peninsular bridge; oil/gas activities on private lands; private recreational use; private silvicultural activities; roads and their associated right-of-ways; air pollution from the anticipated growth of refinery and chemical plant operations in the area; the total number of residential, commercial, and industrial developments in the area; and several other global issues. Further, they stated that FWS does not provide quantitative information about the cumulative impacts of over four million people (greater Houston); the world's largest petrochemical complex; and some of the busiest port facilities on the coast in the cumulative effects analysis.

HCS commented that the draft EIS/CCP/LPP lacked quantitative information detailing the impacts of Service activities and many other activities occurring within the cumulative impacts analysis area. They requested specific quantitative information on: number of oil/gas wells drilled in the past and an estimate for the future; how much of each water pollutant is generated for all water pollution sources (and the same information for all air pollution sources); total number of all residential, commercial, and industrial developments in both the past and reasonably foreseeable future; how many acres are currently in rice production and how many acres used to be in rice production; what the quantitative impacts will be of the implementation of the Region H and I State Water Plans; the amount of habitat fragmentation, including miles of linear openings/square mile of land; the population of each exotic species and how many acres are inhabited by each exotic species (for example, feral hogs); and total amount of herbicide, pesticide, and fertilizer use.

HSC also commented that the FWS failed to cover other diverse issues including: "many people kill snakes on sight, even in a NWR"; "FWS should state how many cows are grazed and not use animal units"; lack of vehicle visitor counters at entry points, "FWS should state that surveys, monitoring, research, community outreach and partnership efforts can result in wildlife disturbance", statement "that hunting disturbs others who recreate via noise"; statement "that oil from boats and the littering of monofilament line are impacts due to fishing"; "FWS must test fish, shellfish, and wildlife for contaminants and report what the levels are to the public"

Finally, HSC strongly favors the acquisition of mineral rights by FWS whenever this is possible, including being prepared to use its condemnation power for mineral rights if the need arises, so that over time the damage from oil/gas activities or other mineral rights development can be reduced and ultimately eliminated. Also, HSC opposes a dove hunting program as not being needed, is against hunting of snipe, gallinule and rail for the same reason, and is against control of muskrats (trapping).

Service's response:

In the cumulative impacts analysis, the Service identified nine major projects or activities that have the highest potential for having identifiable cumulative impacts with our preferred alternatives. Each of these had to be a reasonably foreseeable project or activity that has been formally proposed by a specific project proponent. Projects like the Galveston Bay/Bolivar Peninsular Bridge were not included because these projects have not reached the stage of having sufficient planning, design, and other information which could be used by the Service. A number of the other activities (oil/gas development, agricultural and recreational uses, etc.) that HSC mentions are not included in the cumulative impacts analysis, but are addressed in the section analyzing "Regional Economic Development Activities." Quantitative data is lacking for much of the information HCS recommends including in the cumulative impacts analysis. The huge social/political issues regarding America's petrochemical industry, development versus the environment, or other global problems are beyond the scope of this document and are not addressed.

As to the development of the CCP and the management strategies, this EIS is a comprehensive or "programmatic" EIS addressing a broad agency program which is the development of a formal plan for the management of the Complex. This differs from the more typical project-specific EIS which addresses a new construction project, substantial modification of a facility, or some similar type of project. This "programmatic" EIS does not attempt to provide NEPA compliance for site-specific projects which may be

undertaken in the future to implement the plan strategies. If these projects are proposed in the future, then the Service will provide whatever compliance is required for the project. This compliance may be accomplished within a step-down plan or on a project-by-project basis. Where a Federal agency adopts a formal plan which will be executed in a specific geographic area, and later proposes a specific activity to implement that plan in that area, both actions need to be analyzed under NEPA. The Service has added an additional explanation regarding the “programmatic” nature of the EIS in Chapter 1 under the description of the CCP Planning Process. The Service believes that this programmatic EIS is consistent with all CEQ regulations and has followed NEPA procedures.

Finally, the Service does not agree that condemnation of reserved or excepted mineral interests underlying refuge lands is a viable alternative for managing oil and gas exploration and development activities. The Service manages oil and gas activities on refuge lands using the Special Use Permit process such that impacts to refuge resources are minimized through the required use of best management practices. Full public disclosure of our oil and gas management activities is met through project-specific NEPA compliance.

E. Comments from Other Individuals

1. Metalforms, Inc.

Metalforms, Inc., of Beaumont, Texas, provided a comment signed by its Executive Vice President, Glenn Mabry. He stated their enthusiastic support for the acquisition of additional land for the refuges as the preservation and care of these uniquely sensitive properties is a most worthwhile project. He complemented the local personnel for doing an effective job of managing the existing refuges and stated their opinion that the silent majority does support this effort.

Service’s response:

The Service thanks Mr. Mabry for his comments and support.

2. Bill Stransky

Mr. Stransky, from Pierce, Texas, sent an e-mail containing his comments. He encouraged the Service to develop more wetland units in current and abandoned rice farmland; and, strongly urged the Service to stop the erosion on the GIWW and along the beachfront. He sees the need for an extensive effort to reverse the effects of salt water intrusion into all of the fresh and intermediate marshes through the use of saltwater barriers, rock weirs, and water control structures. Also, he recommends an independent review committee to judge the performance of refuge managers and employees based on the quality of habitat to ensure that bad management is not tolerated.

Service’s response:

The Service thanks Mr. Stransky for his comments and concurs that habitat management and restoration is necessary to meet objectives for migratory birds and other fish and wildlife, and to maintain and restore biological integrity, biological diversity and environmental health, on the Refuge Complex. Under its preferred Refuge Management Alternative D, the Service proposes intensive management of wetland habitats on the Refuge Complex to counter habitat changes and losses which have occurred on a landscape scale in the region. Use of actively-managed water control structures or passive structures such as rock weirs is proposed to help maintain the historic continuum of fresh, intermediate, brackish and saline marshes in support of maintaining natural biological diversity, enhancing habitat values for waterfowl and other migratory birds, and reducing the negative impacts of saltwater intrusion into non-tidal or micro-tidal fresh and intermediate marshes. Moist soil management and rice farming proposed under this Alternative will replace many benefits historically provided by natural prairie wetlands which have almost completely disappeared in the region, and provide concentrated food resources and other habitat benefits for migratory birds and other wetland-dependent wildlife. Under this Alternative, the Service will also expand efforts to reduce erosion and land loss along the GIWW, Galveston Bay, and the Gulf of Mexico. Global climate change and rising sea levels will increase both the urgency and difficulty of these efforts.

The Service also proposes to expand and enhance its adaptive management approach on the Refuge Complex. Habitat management activities on the Refuge Complex will be guided through the development of annual habitat work plans for each refuge management unit receiving management treatments. Management activities will continually be assessed, and refined as needed, to ensure that habitat quality is maintained for migratory birds and other Trust resources. The Refuge Complex always welcomes input from its partners and the public on its management activities.

3. Susan and Brad Billetdeaux

Mr. Billetdeaux, from Houston, Texas, wrote to register their support for maintaining and restoring wetlands and the surrounding ecosystem. They support the CCP objectives which enhance habitats for wildlife; and, they also support Refuge Boundary Expansion Alternative D.

Service's response:

The Service thanks Mr. and Mrs. Billetdeaux for their comments. The Service has already responded in the preceding pages to comments from both the Houston Audubon Society and the Houston Regional Group of the Sierra Club in support of Refuge Boundary Expansion Alternative D, the largest boundary expansion alternative.

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