Appendix B. Environmental Assessment

1.0 PURPOSE OF AND NEED FOR PROPOSED ACTION

1.1 Introduction

The United States Fish and Wildlife Service (Service) proposes to implement a Comprehensive Conservation Plan (CCP) for the Texas Mid-coast National Wildlife Refuge Complex (Complex), which would guide management on the Brazoria, San Bernard and Big Boggy National Wildlife Refuges for the next 15 years. This Environmental Assessment (EA) is being prepared to evaluate the effects associated with this proposal and it complies with the National Environmental Policy Act (NEPA) in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (516 DM 8) and Service (550 FW 3) policies (see Section 1.7 for a list of additional regulations with which this EA complies). NEPA requires examination of the effects of proposed actions on the natural and human environment. In the following chapters, we describe three alternatives for future refuge management, the environmental consequences of each alternative, and our preferred management direction. Each alternative includes a reasonable mix of fish and wildlife habitat prescriptions and wildlife-dependent recreational opportunities consistent with the Refuge System Improvement Act and specific refuge purposes.

The environmental consequences of each alternative are described and form the basis for selection of the proposed action. This EA covers the environmental consequences for future management actions and current facilities on the Complex. However, some future actions such as the construction of major facilities will require further environmental documentation.

1.2 Location

The Complex is located in Brazoria, Fort Bend, Matagorda, and Wharton Counties, Texas. The Refuge is approximately 45 miles south of Houston, and approximately 45 miles southwest of Galveston, Texas (See Figure EA 1-1 or Map 3-3. Texas Mid-coast National Wildlife Refuge Complex Location in the CCP).

1.3 Background

The Complex includes the Brazoria, San Bernard, and Big Boggy National Wildlife Refuges (NWR), comprising a total of 105,000 acres along the Texas Gulf Coast. Brazoria NWR and most of the San Bernard NWR occur in Brazoria County with satellite units of San Bernard NWR in Matagorda, Fort Bend and Wharton Counties. Big Boggy NWR is entirely in Matagorda County. Figure 1 shows the location of the core refuges. Brazoria NWR is the oldest refuge of the Complex (1966) followed by San Bernard (1969) and Big Boggy (1983). The Service established the refuges to provide quality habitat for wintering migratory waterfowl and other wildlife.

The Complex supports a myriad of plant communities, co-evolving with biotic and abiotic systems, soil and flat to low topography (0 - 50 ft. elevation) to form an ecosystem of marshes, prairies and bottomland hardwood forests that are increasingly disappearing from the coastal landscape. Further influencing the preponderance of plant communities is the varied marine type

climatic conditions that result from the flow of warm gulf air modified by surges of continental air, resulting in a humid subtropical climate with hot summers and mild winters (Hatch et al. 1999).

Figure EA 1-1. Refuges of the Texas Mid-coast National Wildlife Refuge Complex (U.S. Government Printing Office. 2003).

The Complex is home to thousands of wintering snow geese and recognized as an internationally significant shorebird site. Scattered woodlots in the refuges, as well as the remaining portions of the Columbia Bottomlands forest in the San Bernard NWR, are vital stopover points for neotropical migrants.

The wide variety of habitats include saline and non-saline prairie, mudflats, fresh and salt marsh, fresh and saltwater lakes, bottomland hardwood forest, and two intermittent freshwater streams. A 5,000-acre tract of native bluestem prairie on Brazoria NWR represents one of the last coastal prairies in Texas.

The Complex is one of the principal wintering areas in North America for snow geese as well as hundreds of thousands of shorebirds that use the mudflats during spring and fall migration. Over 230 species of neo-tropical passerine migrants have been recorded in the Complex.

Ongoing management is necessary to maintain these important and varied habitats. Water management projects help to maintain the shallow, freshwater ponds used by many birds, especially during times of drought. Controlled burning of grasslands recycles nutrients and helps control the spread of invasive species. A multitude of coordinated efforts related to preservation of the remaining Columbia Bottomland forests continue throughout the Complex to benefit the wildlife and habitat encompassing the entire Complex.

1.4 Purpose

The purpose of the proposed action is to specify a management direction for the Complex over the next 15 years. The selected management direction for the Complex achieves each Refuge's purposes, vision and goals; contributes to the mission of the National Wildlife Refuge System (NWRS or Refuge System); is consistent with principles of sound fish and wildlife management; and address relevant mandates and major issues during scoping. The proposed management direction is described in detail through a set of goals, objectives, and strategies in the CCP. The purpose of this EA is to assess the impacts of proposed management actions.

1.5 Need for Action

The action is needed because a long-term management plan does not currently exist for the Complex. Management is guided by various general policies and short-term plans that do not reflect current conditions or recent scientific knowledge. The action is also needed to address current management issues and to satisfy the legislative mandates of the National Wildlife Refuge System Improvement Act of 1997, which requires the preparation of a CCP for all national wildlife refuges in the United States.

1.6 Decision to be Made

The Regional Director for the Southwest Region (Region 2 of the Service) will make two decisions based on this EA: (1) select which alternative the Refuge will implement, and (2) determine if the selected alternative is a major federal action significantly affecting the quality of the human environment, thus requiring preparation of an Environmental Impact Statement (EIS), or whether the Proposed Action alternative can proceed.

The Complex's proposed action is Alternative B. Assuming no significant impact is found, the final CCP will include a Finding of No Significant Impact (FONSI), a statement explaining why the selected alternative will not have a significant effect on the quality of the human environment. This determination takes into consideration the Service and Refuge System mission, the purpose(s) for which the refuges were established, and other legal mandates. Once the FONSI is signed, the CCP will be implemented, monitored annually, and revised when necessary.

1.7 Regulatory Compliance

National Wildlife Refuges are guided by the mission and goals of the National Wildlife Refuge System (NWRS), the purpose(s) of an individual refuge, Service policy, and laws and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act) , Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations and Fish and Wildlife Service Manual.

The CCP's overriding consideration is to carry out the purposes for which the refuges were established. The laws used to establish the refuges and provide the funds for acquisition, state the refuge purposes. Fish and wildlife management is the first priority in refuge management, and the Service allows and encourages public use (wildlife-dependent recreation) as long as it is compatible with, or does not detract from, refuge purposes.

The Service prepared this EA and represents compliance with applicable federal statutes, regulations, Executive Orders, and other compliance documents. Appendix A contains a list of the key laws, orders, and regulations that provide a framework for the proposed action. Further, this EA reflects compliance with applicable State of Texas and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources. The Complexe will complete an Endangered Species Act Section 7 Consultation for inclusion in the CCP (Appendix G).

Comprehensive Conservation Plans include a review of the appropriateness and compatibility of existing Refuge uses and of any planned future public uses. If a use is determined to be an 'Appropriate Refuge Use' by a refuge manager, it then goes through the 'Compatibility Determination' process. For more information on Appropriate Refuge Uses and Compatibility Determinations, including a list of currently approved CDs, see Chapter 5, Section 2 of the CCP.

1.8 Scoping/Public Involvement and Issues Identified

Formal scoping began with publication of a notice of intent to prepare a CCP and EA in the *Federal Register* on June 23, 2009. Planning Update #1 was released to the public in August of 2009, announcing the beginning of the planning process and asking the public for help identifying the issues that need to be addressed in the CCP.

The Complex held three public open house meetings during the June 23rd to September 21st, 2009 comment period. The Complex held all three meetings the week of September 14, 2009. The first meeting was held at the Lake Jackson Library in Lake Jackson, Texas from 6–8 p.m. with 18 in attendance, the second at Demi-John Fire Hall in Freeport, Texas from 6–8 p.m. 9 in attendance, and the last at the Complex Headquarters in Brazoria, Texas from 10 a.m.–3 p.m. with 14 people attending.

The Planning Team held an ecoregional coordination meeting at Brazoria NWR on December 9, 2009, to coordinate with other conservation agencies and organizations in an attempt to gain a

greater understanding of issues occurring at the landscape-scale, and what management actions are taking place to address those issues. This joint effort helped gain a better understanding of the management actions occurring within the Gulf Coast Prairies and Marshes Ecoregion and attempted to highlight areas that each agency, including the Texas Mid-coast NWR Complex, can focus management efforts in addressing issues impacting fish, wildlife, and their habitats within the larger landscape. Table EA 1-1 lists agencies and organizations that attended the ecoregion coordination meeting.

Table EA 1-1 Agencies and Organizations attending Ecoregional Coordination Meeting

Texas Parks Wildlife Department	Attwater Prairie Chicken NWR
Texas Chenier Plains NWR	The Nature Conservancy
Gulf Coast Joint Venture	Trinity River NWR
FWS Ecological Services	Texas Mid-coast NWR Complex

In addition to three open house public meetings and the ecoregional coordination meeting, the Complex hosted a government-to-government meeting and invited Texas Parks and Wildlife Department (TPWD) on February 9, 2010. The Complex held the meeting at its Headquarters and provided a forum for sharing ideas, concerns, and issues regarding management and outcomes on the Complex to benefit the development of the CCP. This interagency meeting proved to be a great asset with the State of Texas and helped the Complex form many of its wildlife related alternatives and management consideration of multiple species such as quail, turkey, and deer.

The Complex released Planning Update # 2 in March of 2010, to offer an opportunity to the public to review and comment on the issues identified during the public scoping process and announced the draft goal statements as well as the preliminary range of management alternatives developed by the planning team.

Additional public scoping for the Land Protection Plan (LPP) planning process was conducted in January, 2012, with a comment period open from January 15, 2012 until February 5, 2012. Three public (open house) meetings were held to provide information on the proposed expansion and respond to questions and concerns; January 20, 2012, at the Discovery Center on Brazoria NWR near Freeport, Texas; January 24, 2012, at the Complex Office near Brazoria, Texas; and February 2, 2012 at the Hudson Woods Unit of San Bernard NWR near Angleton, Texas. A total of 30 people attended the public meeting, with attendance of 15, 7, and 8 respectively, at each public meeting. A response card indicating support or non-support of the proposal was handed out at each meeting, enabling participants to provide a quick response. In addition, The Facts newspaper printed articles twice during the open comment period, which generated 8 email responses. Of the 27 total responses, 22 supported the project expansion and five did not.

The feedback received at the conclusion of the public scoping period and throughout the planning process identified concerns from a variety of stakeholders. The issues and concerns provided the basis for developing the Complex's management direction and played a role in determining desired conditions for each refuge. The issues are divided into five categories: ecoregion-related management, habitat management, wildlife management, public use

opportunities, and facilities/infrastructure management as described below. All the following issues are Refuge management concerns unless otherwise specified.

The planning team identified the following issues after reviewing The Nature Conservancy's Gulf Coast Prairies and Marshes Ecoregional Assessment, Texas Comprehensive Wildlife Conservation Strategy, and other supporting documents to identify threats and issues for the Gulf Coast Prairies and Marshes Ecoregion. In addition to these documents, conservation and research organizations; local, state, and federal government agencies; and the public also identified issues during our scoping process and open house meetings. These issues helped us further our outreach efforts, gain a better understanding of what is occurring on the landscape surrounding the Complex, and determine the role of the refuges in conserving wildlife and their habitats within the larger landscape. Although these issues are outside the scope of the CCP they were used when considering development of management direction.

1.8.1 Ecoregion Issues

The Complex is taking a landscape-scale approach to management over the life of the CCP. Comments and concerns from our partners, the general public, and our ecoregional meeting were addressed according to; but not limited to, major issues/threats such as the effects of climate change, erosion/saltwater intrusion, wildland fire use, petroleum development, and land conservation and are described in detail below.

Fragmentation

Remaining tracts of wetland, marsh, and prairie habitats are being broken up, divided, and impacted from development of roads for commerce, development for housing, and businesses, and for agricultural purposes throughout the ecoregion. Fragmentation of the landscape has also been identified as having a highly detrimental impact on species that are less mobile (Fahrig 2003).

Commercialization

Commercialization activities are having negative impacts on both wildlife and habitat within the ecoregion, which is encompassing expanding human encroachment from the Houston Metropolitan approximately 45 miles north of the Complex. One of the biggest challenges is the sale of sand deposits developed throughout the ecoregion for commercial resale out of wetland and riparian areas that affect water quality downstream as well as in the bays.

Petroleum development, timber cutting, commercial crabbing and oyster harvest, livestock grazing and haying, turf farms, pollution from fertilizer and pesticides, and illegal dumping have all been identified as major impacts of commercialization affecting the entire ecoregion.

Urbanization

Changing from vegetative environments to those of asphalt and concrete reduces wildlife species, produces monocultures of grass that do not benefit wildlife, and creates barriers for many less mobile species. Urbanization is fragmenting native plant communities and resulting in a direct loss of plant diversity. Increasing pesticide and herbicide use around managed lands and an increase in fertilizer use are some of the many contributing factors of urbanization with negative impacts on prairie habitat. Urbanization also adds additional stressors on a limited

amount of public lands in Texas with an increased amount of natural resource users such as boaters, anglers, hunters, and outdoor enthusiasts. Urbanization is a serious issue since the Complex is just about 45 miles of the 3.9 million people living in and around Houston.

Disturbance

The effects of disturbance in some coastal habitats to a number of coastal wildlife species, particularly certain groups of birds, (waterfowl, colonial waterbirds, shorebirds) is largely unquantified and merits investigation. The Complex identified increased boat use and increased air traffic as well as oil and gas exploration as disturbances that affect wildlife in the ecoregion.

Prairie Conversion, Habitat Conversion

Habitats are being converted into monocultures and are changing to urban environments through development and draining of wetlands. These projects are directly contributing to a net loss of prairie habitat affecting both flora and fauna prairie-dependent species. This direct loss of habitat is a major concern for the ecoregion.

Climate Change

As habitats change, the wildlife species that utilize those habitats will also change. Although the Complex can do little to resolve this issue, it can realize that such change is occurring, document these changes through data collection, and adapt management to reflect/address changes in hydrology and plant communities. Sea-level rise will have a direct impact on all three of the coastal refuges. Various models are being used to evaluate the loss of coastal marshes. Estimates from some models are showing that nearly 90 percent of the marshes on the Complex today may be converted to open water by 2100. Water, or lack of water, is expected to become a major environmental crisis throughout the state in the near future if conservation measures are not taken seriously. Combined with climate change, this issue has the potential to impact many refuge management activities such as wetland management, farming, habitat restoration, grazing, and fire management. Although climate change and other factors have the potential to alter the distribution of habitat types in this area, the effects of this change on resources across the landscape, including wildlife species, are still unknown.

Erosion/Saltwater Intrusion

Concerns on the impacts of navigation traffic that introduces saltwater into freshwater marshes and causes drastic changes in native local plant communities and a loss of habitat for many other species was expressed by the planning team as well as in the ecoregional meeting. Natural processes such as storms, hurricanes, and SLR all contribute to saltwater intrusion that affects prairie habitat.

Wildland Fire Use

The suppression of wildfire has changed local prairie communities and this suppression supports the growth of invasive and exotic species, which compound prairie restoration efforts. The planning team expressed concerns on the use of wildland fire from suppression tactics to the negative impacts of smoke in local communities surrounding the Complex.

Petroleum Development
The public had concerns of petroleum development and the potential impacts it can have on both Complex habitats and wildlife species. Many members of the public would like to see no petroleum development on refuges and many would like to see special mitigations incorporated to minimize negative impacts to wildlife.

Land Conservation
The expected effects of climate change, urban encroachment, development of small ranchettes with a few livestock and horses, as well as fragmentation, continue to expand near the Complex highlighting the importance of land conservation and continued expansion of Refuge-managed lands. Stakeholders expressed a desire to continue the acquisition process and promoted the management activities occurring throughout the Complex promoting land conservation.

The San Bernard NWR is approaching the 28,000-acre cap originally set by the Service in 1997 in decision documents with the Austin's Woods Conservation Plan Land Protection and Compliance Document. The Plan outlines the need to counter the rapid development and expansion of urban areas within the Columbia Bottomlands and protect a unique ecosystem essential for maintaining populations of migratory birds and resident species. The concerns identified in 1997 are still relevant and to date less than 5 percent of the historic habitat has been conserved. Recent research has continued to support the importance of these habitats for migratory songbirds, while nation-wide populations of songbirds continue to decline. Millions of Nearctic-Neotropical migrants make landfall in the bottomlands during spring and fall migration to rest and feed after and before crossing the Gulf of Mexico, respectively.

Acquisition efforts are a watershed-scale ecosystem type approach; focusing on the conservation of ecosystem integrity, function, heterogeneity, and biologic diversity addressed as a "bioreserve" network. The bottomlands are home to rare plants and several species that are at the edge of their range as well as newly defined species. Where the landscape is flat and unencumbered, the native forests are unique and add to the natural beauty of the area. An updated Land Protection Plan (LPP) (Appendix I) includes a proposal to allow the Service to continue conservation efforts within the Columbia Bottomlands, including raising the 28,000-acre cap to 70,000 acres. During the separate scoping meetings held for the LPP, concerns from the public regarding this expansion included feral hogs, the "thicket" appearance, removing lands from the tax base, acquisition funding, and additional public use opportunities. These issues are addressed in this document, the EA and the LPP.

1.8.2 Habitat Management Issues

Gulf Coast Prairies and Marshes
The Gulf Coast prairies and marshes were once part of an immense ecosystem covering nine million acres, in the states of Texas and Louisiana. Many of the tall grasses typically found in the Midwest prairie region occur on the coastal prairie as well, where bluestems are intermixed with species native to the coastal wetlands. The coastal prairie underwent intensive man-made development starting in the mid-20th century (Allain et al. 1999) and now totals less than 250,000 acres in Texas. Many native plant and animal components have

already been lost, but the Service along with partners recognize the need to maintain existing remnants and restore native coastal prairie habitats.

Members of the public, TPWD, other federal agencies, and the planning team expressed concern on how the Complex will manage to ensure the conservation, diversity, and enhancement of the Gulf Coast prairies and marshes. Comments and concerns from our partners and the general public on issues related to the conservation, diversity, and enhancement of Gulf Coast prairies and marshes were addressed consistent with, but not limited to, major issues such as development, erosion, fragmentation, invasive species, land management and other land use practices, natural occurrence, and pollution and are described in detail below.

Development **-** The effects of development include construction activity (i.e. building roads, structures, hardscape, oil and gas exploration), urbanization, urban sprawl, utility lines, and right of ways, as well as creation and modification of reservoirs. Direct effects of development in the Gulf Coast prairies and marshes are loss and habitat, and direct mortality of wildlife. Associated affects to development include impacts on water quality due to fertilizers, pesticides, herbicides and sanitary waste systems.

Erosion – Erosion may occur on beaches, along rivers, streams, creeks, shipping channels, jetties, ditches and other locations. Sea level rise, siltation, beach erosion, and subsidence are also major contributors to erosion.

Fragmentation – Habitat fragmentation results from changes in land use for purposes such as agriculture, land transportation (roads and highways), water transportation (shipping channels), housing, and commercial and industrial development. Ecoregional partners have linked fragmentation to inhibited wildlife dispersal, lack of available habitat and reduced gene flow. Fencing and saltwater intrusion have been linked to fragmentation as well.

Invasive Species (Flora) – Invasive species are a sub-set of non-native species that can aggressively alter an ecosystem. Several invasive species, including Chinese tallow, Macartney rose, deep-rooted sedge, and salt cedar are common on the Complex and are reducing the quality and potential of native prairie and marsh habitats. Invasive species out-compete native vegetation, reduce plant diversity, alter hydrology, change soil characteristics and nutrient cycling and can impact the effectiveness of prescribed fire. Fire is the predominant management tool in the coastal prairies and salt marsh to control brush and invasive species encroachment. The use of herbicides may be employed during habitat restoration to remove invasive species and improve overall habitat conditions to support native wildlife.

Land Management and Other Land Use Practices **-** Land management practices including, prescribed fire, farming, moist soil management, grazing and haying have avariety of impacts on the Gulf Coast prairies and marshes. Effects of management practices vary but the intent is to provide quality habitat for native wildlife, including non-natural management areas. Water management is the one tool that the refuges do not have control over. Although the refuges do have some water rights, they are not sufficient for even current management needs. In addition, the ability to purchase water in support of farming programs and wildlife wetlands is solely determined by the Water Development Boards.

Natural Occurrences **-** Natural occurrences such as drought, floods, and stochastic events such as hurricanes and wildfire have both positive and negative impacts on Gulf Coast prairies and marshes. Although unpredictable, these events are regularly occurring and impact management decisions.

Pollution **-** Pollution outside the Complex, but within the Gulf Coast prairies and marshes—such as petroleum/chemical spills, non-point and point source pollutants, contaminated water discharge, airborne sulfates, nitrates, heavy metals, and pesticide use—have lasting negative impacts on both wildlife and habitat.

Bottomland Hardwood Forest

Comments and concerns from our ecoregional meeting, as well as concerns from partners and the general public, were expressed according to, but not limited to, major issues such as residential development, incompatible forestry and livestock production practices, and stream channelization, and are each described in detail below.

Residential Development **-** Residential development in the bottomland hardwood forests and floodplain is affected by habitat being converted for residential use and the associated effects of development such as the impacts on water quality with septic systems outside city limits, use of fertilizers, as well as pesticide and herbicide run-off into river systems. The development of subdivisions usually alters the entire hydrological system of a given area.

Incompatible Forestry and Livestock Production Practice **-** Forestry and livestock production also affects the productivity and function of bottomland hardwood forests through efforts such as clear cutting of trees to convert forests to grasslands as well as an increased number of "hobby ranchers." These types of incompatible practices can eliminate or alter a system drastically enough to change the entire production of flora and provide ideal conditions for exotic flora to become established, decrease soil stability, and change the hydrology of the entire system.

Stream Channelization **-** As residential areas continue to expand as well as increased livestock production and forestry practices the natural hydrology of a system becomes difficult to maintain and manage, especially in the constantly flooded hardwood forest. Large developers as well as municipalities, typically alter hydrological activities on a large scale in an attempt to minimize flooding damage to newly developed areas.

Forest Restoration **-** The Complex allows some areas in the bottomland hardwood forests to grow and regenerate and in some areas, supplemental plantings are necessary to provide an additional seed source to help areas develop into mature stands.

Water Management **-** Alterations to associated wetlands in bottomland hardwood forests are to the extent that management efforts need to be initiated to restore wetlands. The Complex will continue to collaborate with natural resource partners to maximize wetlands for the benefit of waterfowl and all other wildlife dependent on bottomland hardwood forests.

Dune and Beach
San Bernard NWR has approximately four miles of beach habitat between the mouth of the San Bernard River and Cedar Lakes Cut. Due to re-dredging of the San Bernard River in January 2010, the Cedar Lakes Cut has since silted in enabling vehicle access to the San Bernard Beach from the Sargent Beach during lower tides. To access the Cedar Lakes cut, vehicles need to traverse above the vegetation line due to the erosion of the Sargent Beach. Prior to the silting in of the Cedar Lakes Cut the San Bernard Beach has been accessible only by boat for the past 12 years. The Refuge is extremely concerned about the beach resources, where unlimited access is contrary to the Refuges purposes.

1.8.3 Wildlife Management

Threatened and Endangered Species
Three listed bird species (piping plover, northern aplomado falcon, and interior least tern) have been documented on the Complex. The piping plover is listed as endangered in Brazoria and Matagorda Counties and can be found on refuge beaches and mud flats from late July to May annually. The northern aplomado falcon is listed as endangered in Matagorda County. Irregular sitings of a transient bird have occurred on the San Bernard NWR. The interior least tern is listed as endangered in Wharton and Fort Bend Counties. These birds are migratory through the area and are usually associated with mudflats along river banks. In addition, the Sprague's pipit, which is a candidate species, has been documented in all four counties, but its current status on the Complex is unknown. It is a migrant species found during migration and winter, generally tied to upland native grasslands and can be found in large numbers in coastal grasslands. The red know is also a candidate species utilizing beach and tidal flats at San Bernard NWR. All five listed sea-turtles are found in the Gulf or Bays near the refuges. The Kemp's ridley sea turtle will nest on the San Bernard NWR beach. The refuge supports the Kemp's ridley Sea Turtle Recovery Plan by patrolling and responding to turtle stranding and nesting reports.

Two additional species, the Attwater's prairie chicken and the whooping crane, which do not currently occur on the Complex, may have potential recovery habitat on the Complex. In the future, the Service may consider reintroducing the Attwater's prairie-chicken onto refuge prairies and the expansion of whooping crane populations up the coast.

Migratory Bird Species and Species of Special Management Concern
Loss of prairie habitat has affected many grassland dependent bird species and is experiencing an alarming rate of decline. Waterfowl wintering throughout the Complex are dependent upon the wetlands provided by the Complex and are faced with additional challenges during periods of drought. Shorebirds and waterbirds are also dependent on moist soil management to get them through extended drought periods.

Monitoring the effects of management actions includes monitoring species of special management concern and focal species. These species are good representatives for a host of other species, with similar habitat requirements. The management staff selects focal species to monitor the effects of landscape scale characteristics that if properly managed will have beneficial effects on species sharing similar conservation needs.

Management of Invasive Species (Fauna)
Invasive fauna pose a biological threat to the entire Complex with their ability to displace native plant species, degrade wetlands and other natural communities, alter fire regimes, reduce natural diversity and habitat values. Once established, eliminating these plants is very expensive and labor intensive and continue to cause major economic and biological impacts throughout the entire ecoregion.

1.8.4 Visitor Services

Public Use Opportunities
The public has expressed concerns in growing each of the big six wildlife dependent recreational opportunities provided throughout the Complex including hunting, fishing, wildlife observation, wildlife photography, interpretation, and environmental education. Some members of the public felt that the Complex needs to expand public outreach as well as expand opportunities for the public to volunteer on the refuges.

Preservation of Historical Sites
The Complex is situated in an area recognized within a rich archeological and historical setting. The Complex will continue to incorporate historical interpretation into the public use areas.

Entrance Fees
Members of the public split, with some opposed and some in favor of implementing an entrance fee throughout the Complex.

1.8.5 Facilities/Infrastructure Management

The Complex identified the need to improve and expand upon visitor use and administrative infrastructure.

Visitor Use Infrastructure
Members of the public would like to see additional hiking and paddling trails, non-motorized boat launches, and signs and exhibits throughout the Complex.

Roadways - The public use roads are generally maintained gravel roads in good condition. The Complex paved the 3-mile entrance road to the Discovery Center over the past 7 years. Temporary road closures may occur during and after storm events. Large amounts of rainfall will result in tour road closures at San Bernard NWR as surface run-off may flood the road in several locations. Cedar Lake Creek periodically floods following heavy rainfall. The end of the tour loop at San Bernard may close until floodwaters recede and the turn-around is dry. Storm tides occurring at Brazoria often push debris and water across the public use area. The refuge may close the Big Slough Tour Road until floodwaters recede, debris is removed from the roadway, and washouts repaired. The Complex identified the need to maintain vehicular access on existing roads with some opportunities to provide additional pullouts in strategic locations to provide additional wildlife observation opportunities.

Administrative Infrastructure - The Brazoria NWR identified the need for additions and improvements in volunteer facilities, and relocating facilities to higher grounds.

1.8.6 Addressing Issues in the CCP and EA

The following landscape-level issues (as discussed above) are beyond the control of the Service. These issues, however, help the Complex further its outreach efforts, gain a better understanding of what is occurring on the landscape surrounding refuge lands, and determine the role of the Complex in conserving wildlife and their habitats within the larger landscape. Although these issues are outside the scope of the CCP, they were considered while developing the refuge management direction.

- Fragmentation
- Commercialization
- Urbanization
- Disturbance
- Prairie / Habitat Conversion
- Residential Development
- Incompatible Forestry and Livestock Production Practices
- Stream Channelization

The remainder of the issues (in sections 1.8.1 through 1.8.5) are addressed in the CCP (Chapter 4: Management Direct) and EA (as shown in Table EA 2-3.

2.0 ALTERNATIVES

2.1 Formulation of Alternative

Alternatives are different approaches or combinations of management actions designed to achieve a refuge's purposes and vision, the goals identified in the CCP, the goals of the Refuge System, and the mission of the Service. Based on the issues, concerns, and opportunities heard during the scoping process, the Planning Team developed three alternative management scenarios that represent a reasonable range of alternatives, which Complex may use.

The EA considered three alternatives. In addition, the planning team considered two other alternatives but eliminated them from detailed analysis for the reasons listed below (see section 2.2). These alternatives represent different approaches or management scenarios for the future protection, restoration, and management of the refuge fish, wildlife, plants, habitats, and other resources, as well as compatible wildlife-dependent recreation. Refuge staff assessed the biological conditions of refuge habitats and analyzed the external relationships affecting each refuge unit. This information contributed to the development of refuge goals and, in turn, helped formulate the alternatives, summarized in Table 2-4. The Complex will examine alternatives in five broad issue categories:

Ecoregion Management: How will the Complex contribute to addressing Gulf Coast Prairies and Marshes ecoregion conservation related issues?

Habitat Management: How will the Complex manage habitats to ensure the conservation, diversity, and enhancement of the Gulf Coast Prairies and Marshes? How will the Complex manage habitats to ensure the conservation, diversity, and enhancement of bottomland hardwood forests?

Wildlife Management: How will the Complex manage wildlife to ensure the protection of trust resources?

Visitor Services: How will the Complex manage public use opportunities while ensuring the protection of fish, wildlife, and their habitats?

Facilities/Infrastructure Management: How will the Complex provide for infrastructure and related developments while ensuring the protection of trust resources?

2.2 Alternatives Considered but Dismissed from Detailed Analysis:

NEPA and the Improvement Act designed the alternatives development process to allow the planning team to consider the widest possible range of issues and develop feasible management solutions that respond to these issues. The Refuge then incorporates these management solutions into one or more alternatives evaluated in the EA process and considered for inclusion in the CCP.

The Complex does not usually consider actions and alternatives that are not feasible or may cause substantial harm to the environment in an EA. Similarly, an action (and therefore, an alternative containing that action) should generally not receive further consideration if:

- It is illegal (unless it is the No Action Alternative, which must be considered to provide a baseline for evaluation of other alternatives, even though it may not be capable of legal implementation).
- It does not fulfill the mission of the Refuge System.
- It does not relate to or help achieve one of the goals of the refuge.
- Its environmental impacts have already been evaluated in a previously approved NEPA document.

However, if such actions or alternatives address a controversial issue or an issue on which the Planning Team received many public comments, they may consider these in detail in a NEPA document to demonstrate clearly, why they are not feasible or would cause substantial harm to the environment.

During the alternatives development process, the planning team considered a wide variety of potential actions on the Complex. The planning team ultimately rejected and excluded the following actions from the alternatives proposed here because they did not achieve refuge purposes or were incompatible with one or more goals.

The Complex considered eliminating the farming program at Brazoria NWR. They considered this alternative infeasible because it does not contribute to the objectives and goals outlined in the plan. The farm fields/wetlands provide valuable habitats as both wetlands and farm fields for large population of wintering waterfowl. Without active management of these areas, the refuge could not support the waterfowl, shorebird and sandhill crane population it currently supports. Abandoning this program will involve habitat restoration to combat invasive species encroachment. Areas currently farmed were previously disturbed before establishment of the Refuge. Farming is limited in scope and provides both "hot foods," natural foods, as well as freshwater and cover for migratory birds and resident wildlife in both the fields and secondary water catchment basins. The Complex uses farming as a wildlife management tool, where wildlife directly benefit from crops left in the field, but equally benefit from the presence of fresh water associated with rice farming.

The public made a request to concentrate efforts on buying existing mineral rights on the refuge so that no more drilling will occur, initiating in sensitive areas of the Rrfuge and slowly expanding until the refuge owns all the mineral rights. The Complex considers this infeasible because, oftentimes, mineral rights have been withheld prior to the current landowner's title policy and, therefore, do not transfer to the refuge upon acquisition. Acquiring mineral rights is unfeasible with current staff and budget.

2.3 Features and Management Common to All Alternatives

Although the alternatives differ in many ways, there are similarities among them; several elements of refuge management are common to all alternatives. We list these common management activities below to reduce the length and redundancy of the individual alternative descriptions.

2.3.1 Ecoregion Management

Climate Change

The Complex would continue to monitor prairie habitat and condition to determine the effects of climate change on refuge resources by conducting groundwater modeling, water quality/water quantity analyses to fully understand the refuge's water resources, and use the best available science to minimize the impacts associated with climate change. The refuges would use green infrastructure and related technologies when opportunities and funding permit to reduce its carbon footprint and contribution to climate change.

Wildland Fire Use

The Complex will suppress all wildland fires. Suppression strategies range from monitoring the fire while allowing it to burn itself out (as in the case where no life, property, or resources are threatened and/or smoke management is not an issue of concern), to full suppression (if life, property, and resources are threatened and/or smoke management is an issue of concern).
The Complex will use a decision support process to guide and document wildfire management decisions. The process will provide situational assessment, analyze hazards and risk, define implementation actions, and document decisions and rationale for all decisions. The Complex

will continue to manage wildland fires for multiple objectives, acknowledging that objectives can change as the fire progresses across the landscape.

Petroleum Development

Oil and gas exploration is occurring on four locations on the Complex (see Map 3-13. Brazoria National Wildlife Refuge Oil and Gas Exploration and 3-14. San Bernard National Wildlife Refuge Oil and Gas Operations in the CCP). Service policy 612 FW 2 states: "the objectives of oil and gas management on Service lands are to protect wildlife populations, habitats and other resources; and provide for the exercise of non-federal oil and gas rights while protecting Service resources to the maximum extent possible." In accordance with 50 CFR 29.32, persons holding mineral rights shall to the greatest extent practicable, conduct all exploration, development, and production operations in such a manner as to prevent the damage, erosion, pollution, or contamination to the lands, waters, facilities, and vegetation of the area. They must also conduct such operations without interference with the operation of the Refuge or disturbance to wildlife, and would be subject to prior approval by the Service. All operations would be required to operate under current local, state, and federal regulations and policies. Each operator is required to provide the Refuge Manager with an annual Development and Operations Plan for review and approval.

Operators would be required to prevent, to the maximum extent possible, releases of hazardous materials and substances, crude oil, and produced water. Each operator and/or facility operator would have a current Oil Discharge Prevention and Contingency Plan outlining procedures for accidental releases. Sampling, remediation, and restoration of contaminated sites would be the responsibility of the operator and/or facility operator and would occur in consultation with the Service and the appropriate state agency. All sites no longer being used by industry would be sampled for contaminants at the operator's expense to ensure proper disposal of material and that refuge staff and/or the visiting public are not exposed to contaminants.

The Service would request, on a case-by-case basis, that wells, roads, pipelines, and associated infrastructure and facilities not needed to support ongoing operations be removed and the sites restored to the satisfaction of the Refuge Manager.

Reasonable restrictions include restriction on time of year (October 15–March 15) for operations designed to minimize wildlife disturbance during the winter months; restriction on equipment to include low-pressure terra-tired vehicles or tracked equipment in the marshes and small "Bumble Bee" drillers in the bottomlands; and restrict ATV use in marsh habitats. The Refuge Manager will negotiate seismograph operations, pad placement, pipeline right-of-way, access roads, and all associated activities to reduce impacts on Refuge resources and management programs. The Refuge Manager will negotiate locations of production lines prior to drilling. Operators will generally place such lines along roadways and are directionally drill under wetlands or other sensitive environments. The refuge only permits closed-loop drilling operations. All seismic operations must hire an environmental monitor, selected by the Refuge Manager, who reports to the Refuge Manager, to monitor all seismic operations and ensure minimal habitat damage. In Texas, the refuges may accept payment for restoration work required after the seismic operations. The refuges will then conduct restoration and monitoring efforts using those funds.

2.3.2 Habitat Management

Gulf Cost Prairies and Marshes

Prescribed Fire

The Complex would continue to use prescribed fire as a management tool used for restoration and maintenance of fire-adapted ecosystems and integrate the natural fire regime into bottomland hardwood forests, marsh, and prairie habitats. Restoration of coastal prairie may require treatment with prescribed fire annually or once every two years depending on the response of the vegetation and the ability to carry fire.

Maintenance of coastal prairie habitats generally requires the application of fire to the unit on a three to four year cycle. The Complex would continue to treat 25 to 35 percent of the coastal prairie and salty prairie habitats annually. The Complex uses a helicopter on prescribed fire ignitions on larger burns and as funding permits, and ground ignition when feasible. The Complex uses backing fires (against the wind) and flanking fires (parallel with the wind) and limited head fires, with flanking fire preferred due to longer combustion rates. The Complex uses backing fires to reinforce the firebreak.

Prescribed fire will be used on a two to five year rotation on 25 to 35 percent of burnable acres within the Complex's coastal marshes (as environmental conditions allow) to mimic the historic fire regime of this ecosystem.

Regularly scheduled prescribed burning best mimics the historic natural fire regimes within the Gulf Coast Prairie Ecoregion. Table EA 2-1 identifies burnable acres that the Complex can best manage by applying fire along with acreages and desired management rotation and season. (See Map EA 2-1. Big Boggy National Wildlife Refuge Fire Management, Map EA 2-2. Brazoria National Wildlife Refuge Fire Management and Map EA 2-3. San Bernard National Wildlife Refuge Fire Management).

Table EA 2-1. Prescribed Fire Schedule for Texas Mid-coast NWR Complex

Burn Unit	Sub Units	Acreage	Rotation Cycle	Burn Season
Brazoria NWR				
Big Slough Units (5,725 acres)	Cox Lake Cross Trail Pond North Ridge Olney Pond Salt Lake Teal Pond Wolf Lake	1834 85 1002 134 1576 147 947	3 - 4 years	L. Summer – Winter
Marsh Unit (14,593 acres)	Alligator Marsh Middle Bayou Shrimp Farm Wharton Bayou	3857 1457 4828 4451	4 - 5 years	L. Summer – Fall
ICWW (Salt	Christmas Ridge	5808	4 - 5 years	L. Summer – Fall

Marsh) Units (8,253 acres)	Freshwater Lake Slop Bowl	3421 946	5 - 6 years 5 - 6 years	
Island Units (841 acres)	Island 1 Island 2 Island 3 Island 4 Island 5	26 420 88 38 269	3 – 4 years	L. Summer – Winter
Prairie Units (13,338 acres)	Austin Bayou Bermuda Triangle Bluestem Butterfly Chocolate Bayou Ditch 6 to 7 Canvasback Firehall Otter Slough Walker Ditch 2004 Crossroads	1524 1129 2441 755 3831 578 937 183 555 861 544	3 – 4 years	L. Summer – Winter
San Bernard NWR				
Sargent Units (4 subunits) (5620 acres)	Pentagon Marsh Sargent Check Station Sargent Pasture Smith Marsh	618 1719 835 2448	4 years	Summer L. Summer L. Summer Summer – Fall
Upland Units (7 subunits) (8,201 acres)	Cedar Lake Creek Storm Pasture Crawfish Ducroz Entrance Road Rail Pond Road Road Pasture	739 599 2092 1551 1096 1011 1113	3- 4 years 3- 4 years 3- 4 years 3- 4 years 3- 4 years 3 years 3 years	Summer – Fall Fall – Winter Fall – Winter Summer – Fall L. Summer Fall – Winter L. Summer – Fall
Tidal Units—2 subunits (15,611)	Cedar Lakes Cowtrap Marsh	4475 11,136	4 – 5 years	L. Summer – Fall L. Summer – Winter
Moist Soil Units- 2 subunits (1767)	Moccasin Pond Wolfweed Wetlands	368 1399	2 – 3 years	L. Summer – Fall
Bottomland Units—3 subunits (1123)	Big Tree Pasture Buffalo Creek Halls Bayou	205 850 68	4 - 5 years 3 - 4 years 4 - 5 years	L. Summer – Fall L. Summer – Winter L. Summer – Winter
Big Boggy NWR				
Freshwater Wetlands (742 acres)	Mallard and Julia's Pond McCoach	675 67	3-4 years	Summer – Fall
Uplands and Salty Prairie	North Marsh Hunter	1209 986	3 years	L. Summer – Winter

(2195 acres)				
Salt Marsh	Kilbride	1107	5 years	L. Summer

Bottomland Hardwood Forests

Forest Restoration
Although the focus of the Austin's Woods Conservation Plan is acquiring old growth hardwood forest, some tracts acquired have a combination of old growth and restoring forests. Often, the Refuge allows natural regeneration to occur and supplemental planting are not required to achieve the desired conditions. However if immediate seed sources are not available, the Refuge will complete supplemental plantings, generally with slower growing species (live oaks). These plantings are necessary to provide an additional plant resource to help areas develop into diverse mature stands. In addition, direct planting has occurred following illegal clearing, at the expense of the culprit.

Water Management
The San Bernard NWR, where appropriate, would restore historic hydrology by filling ditches, installing water control structures, or constructing levees in areas that have been hydraulically altered with drainage ditches prior to acquisition. The Complex acquired Hudson Woods (and possibly future tracts) and restored natural hydrology, in partnership with the Natural Resource Conservation Service (NRCS). NRCS purchased a conservation easement from the landowner with Wetland Reserve Program funds prior to the Service acquiring the remaining land (fee title) from the landowner. In collaborating with NRCS, the Service must adhere to any stipulations identified in the conservation agreement. The NRCS designed and paid for the water control structure installed at Hudson Woods to restore Willow Oxbow.

2.3.3 Wildlife Management

Migratory Bird Species and Species of Special Concern
Over 320 bird species use Complex habitats during parts of their lifecycles and the Texas Gulf Coast is the primary wintering area for most of the Central Flyway waterfowl. Additionally, these coastal salt marshes are the ancestral wintering grounds of the lesser snow goose, which are highly dependent upon native marsh plants produced on the Complex. The Complex is one of the few areas on the Texas coast where large numbers of snow geese still feed on the native salt marsh grasses rather than on agricultural crops. In addition, rookeries at the Complex provide nesting habitat for a large population of colonial water birds, while thousands of shorebirds use the tidal mud flats on the Complex.

Neotropical migratory birds nest in the understory and mid-story layers of un-grazed bottomland hardwood forests. Newly acquired, under-brushed tracts are allowed to naturally re-vegetate, which supports species of concern such as acadian flycatcher, prothonotary warbler, and yellow-billed cuckoo. During migration, a large variety of warblers, vireos, thrushes, tanagers, buntings, and goatsuckers take cover and refuel on insects and soft berries in these lush, multi-layered forests.

Coastal prairies and marshes provide nesting habitat for a variety of songbirds including Henslow's sparrow, LeConte's sparrow, sedge wren, and other species of concern overwinter in our coastal prairies. These wintering sparrows and wrens vary in cover requirements, so the wide range of species benefit greatly from the prescribed burn program's mosaic of different-aged prairie units. Painted bunting and dickcissel nest in these grasslands during the summer, using the cover for nest site concealment and feeding on seeds and insects provided by the variety of prairie plants that exist in non-grazed grasslands. Species benefit from our burn timing; which targets woody species and allows nesting birds' time to complete nesting attempts.

Yellow rails, black rails, and mottled ducks all use the heavy salty prairie grasses present in our 3–6 year burn rotations. Mottled ducks need these places to conceal their nests, and further benefit from their presence near brood water. However, they need these tracts in large acreages, as mammalian predators like raccoons search areas adjacent to water bodies. The larger grassland offers better concealment for this duck. Overlapping in nesting requirements is the black rail, a highly secretive species of concern. Present year-round, the Complex overlooks this bird due to its highly secretive nature and its unwillingness to emerge from beneath its canopy of grass cover. Similar to the black rails is the wintering yellow rails. Some estimates place the number of remaining North American yellow rails at less than 20,000. Both species of rails have very little "vertical lift," making it possible to enclose them when using ring fire ignition patterns. Our current practice of using low-mortality ignition tactics benefits both rails and more vulnerable herptiles, such as the Gulf Salt Marsh Snake, another high-level species of concern. All refuges on the Complex will provide habitat for mottled ducks. Mottled ducks are a priority species for management and the Complex will continue to provide nesting habitat in conjunction with freshwater wetlands that provide habitat for rearing young and cover for molting birds. Flooding impoundments will coincide with the nesting season. The Complex will also manage prairie for grassland wintering birds through three-year rotational burning. We will manage upper marsh habitat for black and yellow rails.

A variety of research and monitoring surveys in conjunction with these species and their habitat is occurring on a seasonal (winter) basis. Coordination with other agencies and other academic institutions would continue. Monitoring and banding will continue to monitor changes in vegetation, population trends and species diversity in response to habitat changes. Annual surveys would continue including the Christmas Bird Count, Mottled Duck Surveys (aerial), and Colonial Waterbird Counts. The Complex would continue to conduct diamondback terrapin surveys, annual breeding songbird census, feeding behavior study at Dance Bayou Unit, black and yellow rail banding, summer mottled duck banding, winter and migratory bottomland songbird banding, and grassland songbird banding. Special use permits would be issued to researchers and other cooperators for banding raptors, shrikes, bottomland migratory songbirds at the Brazos River Unit, bottomland wintering songbirds at Big Pond Unit, grassland songbirds, and diamond-back terrapins.

Rare and Protected Species (Flora)

Four plant species listed as both federal and state Species of Concern are Texas windmill grass, Coastal Gay-feather, three-flower broomweed, and Texas yucca. The Complex's prairie restoration efforts would benefit these and future rare and protected species should they become

present on any of the refuges. The Complex would continue to collect data on species present on its land and monitor any occurrence of rare or protected species.

Feral Hog Management

The Complex would continue to manage feral hog populations in accordance with the current Feral Hog Management Plan (2004), which identifies multiple options including; issuing Special Use Permits for trapping and use of hounds, public hunts and aerial shooting to control populations. All of these actions are needed to manage refuge habitats for native wildlife. It is estimated that only 20 percent of the population of feral hogs in Texas are removed annually. This is far below the recommended rate of 50 – 60 percent removal needed to maintain current numbers. Without control, feral hog populations will continue to grow, increasing impacts on soil, water, vegetation, habitat diversity and wildlife populations both on and off refuge lands.

Currently, Special Use Permits (SUPs) are issued so that hogs can be trapped or hunted with the aid of hounds. SUPs are issued on a 6-month or 1-year basis, for a specific area of the refuge. This is the principle method for feral hog management within the bottomland units. Hunters and trappers must provide harvest reports on a monthly basis to the appropriate refuge manager. These SUPs require that hogs be killed quickly and removed from the refuge. Approximately 120 hogs are removed from Brazoria NWR and 450 hogs removed from San Bernard NWR annually thru the issuance of Special Use Permits.

The Service would contract with U.S. Department of Agriculture Wildlife Services or a private contractor to aerial hunt and control feral hog populations within marsh and prairie habitats (excluding bottomland units of San Bernard NWR) at Brazoria, San Bernard and Big Boggy NWRs. For aerial control, a professional sharpshooter would conduct shooting from a helicopter. Hogs would be humanely killed by accurate shots taken from the lowest safe altitude at which the helicopter can operate. Eighteen hours of flight time in December 2011 removed nearly 400 hogs across the Complex.

Brazoria NWR and San Bernard NWR collaborate with the Texas Youth Hunting Association and hold a youth feral hog hunt on two weekends per year. The Refuges hold the hunt in February at San Bernard NWR and in March at Brazoria NWR. Approximately 20 hogs at Brazoria NWR and 30 hogs at San Bernard NWR are removed annually by youth hunts. Other than the special youth hunts, public hunting is not currently allowed; however, the Complex intends to complete a Hunt Plan and Hunt Open Package for white-tailed deer and feral hogs in selected units in the future. Additional NEPA assessment will be conducted at that time.

2.3.4 Visitor Services

Fishing

The Complex provides four public fishing areas, offering a variety of saltwater fishing and crabbing opportunities. Fishing occurs on all navigable waters throughout the Complex from designated locations and the Gulf Intracoastal Waterway (GIWW). State regulations determine all fishing restrictions with specific restrictions listed in 50 CFR. Navigable waters open to fishing are by boat access only and users must remain within the tidal margins.

The Complex allows fishing year-round in the designated areas in accordance with applicable state and federal regulations. All public fishing areas are available for use during daylight hours only, with the exception of Bastrop Bayou Public Fishing Area. This particular area is open 24 hours a day, but permits no overnight camping. All fishing must occur in accordance with state fishing regulations, and fishermen are required to have appropriate state fishing licenses. *Brazoria NWR* has three public fishing areas that allow land access to saltwater fishing: Bastrop Bayou, Clay Banks, and Salt Lake Public Fishing Areas. Bastrop Bayou Public Fishing Area is universally accessible and offers a 200-foot pier with fish attracting lights, five paved bank fishing pull-offs, a universally accessible toilet, paved parking, and night-lights. The Clay Banks Public Fishing Area offers bank fishing along a one-mile segment of Bastrop Bayou. The Salt Lake Fishing Area offers 1.4 mile of bank fishing and a non-motorized boat ramp.

Navigable waters within the boundaries of the refuge open to fishing are Salt Lake, Nicks Lake, and Lost Lake. State waters including Cox Lake, Alligator Lake, Bastrop Bayou, and bays adjacent to the Brazoria NWR are open to fishing as well.

San Bernard NWR has one public fishing area that allows land access to Cedar Lake Creek. The Cedar Lake Public Fishing Area offers an accessible 20 foot by 10 foot fishing pier, a fishing trail that offers .4 miles of bank fishing, and a small public boat ramp that gives visitors access to Cedar Lake Creek. Fishing is permitted in navigable waters including Cedar Lake Creek, Cedar Lakes, and Cow Trap Lakes within and adjacent to the boundary of the refuge. The refuge permits fishing from the San Bernard Beach also.

Big Boggy NWR allows public fishing on the navigable waters of Boggy Creek and adjacent state waters.

Fishing is a traditional use of the area's saltwater bays and lakes that adjoin and are within the refuges. With the expected continued growth in the Houston Metropolitan Area, the number of fishing visits is likely to increase. The Complex is currently providing fishing opportunities for up to 30,000 fishing visits, and with the anticipated increase of 55 percent over the life of the CCP, the Complex can still provide quality experience while minimizing conflicts with other Complex users.

Preservation of Historic Sites

The Complex would continue to identify, protect, and manage all significant cultural resources in a spirit of stewardship for the benefit of future generations. The Refuge would administer, preserve, and protect these resources in such a manner that sites, buildings, structures, and other objects of cultural value are preserved and maintained for scientific study and public appreciation and use. The Complex would ensure that during the appropriate stages of decision-making affecting these resources such as construction, land use or resource planning, and land acquisition or disposal, it will give full consideration to cultural resources and remains in compliance with the state historic preservation act.

A monument and a historical interpretation panel identify the former Maddox home site on Brazoria NWR. The area is open to the public and a short trail enables visitors to access the former home site along the tour loop.

There are no historic sites preserved or interpreted on San Bernard NWR and Big Boggy NWR.

2.3.5 Facilities/Infrastructure Management

Visitor Use Infrastructure

Roadways
Vehicle access is allowed on designated refuge roads. Section 3.4.5.1 of the CCP provides a list of public use roads. Other roads throughout the Complex are for Service personnel only. Maintenance of these roads is highly dependent on weather, but generally graded two to three times a year. Major storm events may require additional maintenance.

2.3.6 Coordination between Government Agencies and Private Interests

Coordination with governmental agencies and private interests is essential in carrying out the objectives of the Complex. The Complex would continue to work with state and federal agencies, academia, conservation organizations, interested entities, and private landowners to provide positive results in areas of conservation of lands, habitat management, science, and public outreach. The Complex will continue cooperation with Padre Island National Seashore and U.S. Geological Survey (USGS) sea turtle lab regarding the sea turtle stranding and nest collection from area beaches.

2.4 Alternatives Analyzed in Detail

The Complex developed the following alternatives to comply with NEPA and to provide ways to represent a number of issues, concerns, and opportunities identified during the public and internal scoping process. Though the alternatives may have different emphases, habitat maintenance, restoration, and preservation are common elements of each alternative. The Complex intends for the alternatives to provide a range of public uses and access and respond to issues or concerns identified during the planning process as discussed below.

2.4.1 Alternative A—No Action Alternative:

2.4.1.1 Ecoregion Management

Climate Change
San Bernard NWR would continue to implement limited carbon sequestration projects. These projects include natural forest restoration and supplemental planting totaling approximately 36 acres. The Refuge would continue to market the opportunity for carbon sequestration projects.

Brazoria NWR and San Bernard NWR would continue to incorporate climate change into their environmental education programs. Photovoltaic technology powers the Discovery Center located on Brazoria NWR and it uses green building products when feasible.

Big Boggy NWR would not conduct any climate change projects.

Erosion/ Saltwater Intrusion

The Complex will continue to engage in management activities and maintain facilities that reduce erosion and prevent saltwater intrusion on all three refuges.

At Brazoria NWR, projects include: bank armoring by use of concrete block/mats from Bastrop Bayou to Alligator Lake (approximately 2 miles) along the GIWW and shoreline rip rap along 2,000 feet of Cox Lake and 100 feet at Salt Lake.

At San Bernard NWR projects include: large concrete slabs placed as rip-rap along the south end to protect 1500 feet of levee from wind driven wave action; as funds and time allow, the refuge plants smooth cordgrass in "goose eat-outs" (barren mudflats) to encourage sedimentation of the marsh and plugging small tidal channels.

Big Boggy NWR would continue to implement projects to slow down erosion including rip-rap projects that occur on Dressing Point Island. The rip-rap does not prevent erosion but significantly reduces the rate.

Land Conservation

Under Alternative A the San Bernard NWR would complete the existing Austin's Woods Conservation Plan. The expected effects of climate change, urban encroachment, development of small ranchettes, as well as habitat fragmentation near the Complex highlight the importance of land conservation and expansion of refuge managed lands. Acquisition efforts are a watershed scale ecosystem type approach; focusing on the conservation of ecosystem integrity, function, heterogeneity, and biological diversity addressed as a "bioreserve" network.

Conservation with this approach requires a conservation design establishing an integrated network of individual tracts that provide representative samples of the regional landscape, or what is referred to as a "bioreserve" network. Reflecting the concept of a bioreserve network, the Columbia Bottomlands Conservation Partnership will have conserved 33,000 acres with its governmental and non-governmental partners by the end of fiscal year 2012, with 28,000 acres protected as refuge lands.

Currently, the emphasis of land acquisition focuses on bottomland hardwood forest and associated wetlands and prairie habitats. The bottomland forests of the ecosystem have high wildlife and wetland values. This ecosystem is the only expanse of forested wetlands adjacent to the Gulf of Mexico in Texas and originally covered 700,000 acres. In 1995, a Columbia Bottomlands Task Force (Task Force) estimated that only 177,000 acres of forest remained. This ecosystem is especially important for Nearctic-Neotropical migratory birds because of its proximity to the Gulf of Mexico. Millions of Nearctic-Neotropical migrants make landfall in the bottomlands during spring migration and use the area during fall migration. Migrating birds depend on the remaining forest tracts for rest and feeding both before and after crossing the Gulf. The Task Force found that 237 species of birds, totaling at least 29 million individuals, migrate through the forest every year. Dr. Sidney Gauthreaux, Jr., (2002) using Doppler radar, documented that the Columbia Bottomlands is a major stopover area for these migrants. The

area is located within the Texas Mid-coast Initiative Area of the Gulf Coast Joint Venture of the North American Waterfowl Management Plan.

Since 1997, the Complex has been working with partners conserving forested habitat, with the Service acquiring fee title and conservation easements to approximately 24,500 acres from willing sellers and donors. Under the approved Austin's Woods Conservation Plan the Service can only acquire 28,000 acres. With this cap reached in 2012, the Service would stop acquiring bottomland forest tracts.

2.4.1.2 Habitat Management

Gulf Coast Prairies and Marshes

Prairie/Grassland Restoration
Because much of the Complex was working livestock ranch or farm prior to refuge establishment, there infrastructure remains in place that interfere with native prairie restoration and management including roads, levees, ditches, and water control structures that all affect the natural hydrology of the prairie.

With disturbances initiated through farming, grazing, and development, prairies and grasslands are often the first areas encroached by exotic species such as Chinese tallow and restoration efforts have proved to be a challenge on budget and resources. Exotic and invasive species have complicated restoration efforts in prairie habitats since they can quickly become established prior to implementing restoration plans. The Complex initially treats many tallow-infested tracts with herbicides as well as mechanical manipulation in an attempt to convert it back to a functional prairie habitat.

Many of the species of special management concern have life history requirements (i.e., nesting, wintering habitat, etc.) directly tied to grasslands. The coastal prairies of Texas are important wintering grounds for sparrows and wrens. With nationwide habitat loss of prairies and grasslands, there are fewer places migrating birds can feed, rest, and winter. Direct habitat loss is the biggest concern for prairie-dependent species.

As a management tool, the Refuge Complex is actively collecting native seed for restoration efforts from native prairie grasslands within its boundaries. However, this is challenging because production and access to seed harvested is highly dependent on weather conditions. To help overcome this challenge, the Complex has purchased native prairie hay and distributed that hay using a bale spreader to restore native prairie. The Refuge will use areas restored as healthy functioning prairie habitat to collect seed to aid in the restoration of other prairie habitats.

Cooperative Haying
Brazoria NWR is the only refuge in the Complex that administers a cooperative haying program. Cooperative haying of 35 to 50 acres annually would continue to maintain wildfire buffer areas for Wildland Urban Interface (WUI) areas at Brazoria NWR. The cooperative haying program reduces fuel buildup in salty and coastal prairie habitats where prescribed fire cannot be

implemented due to an expansion of WUI areas closing in on the Refuge boundary. The Complex generally conducts cooperative haying in late summer.

Restoration
Active restoration activities would occur on Brazoria and San Bernard NWRs. These refuges would actively restore old fields and coastal prairie through a combination of chemical, mechanical, fire, and planting of native prairie seed. Once restored, the refuges will use fire to maintain the habitat mimicking historic fire regimes.

Management of Invasive Species (Flora)
The Complex would continue not consider grazing as a management tool on all three refuges.

The Complex would continue to use mechanical, chemical, and prescribed fire treatments to control salt cedar, Chinese tallow, deep-rooted sedge, trifoliate orange and Japanese honeysuckle, and any additional species on an as-needed basis. Table EA 2-2 describes the chemicals used to target high profile invasive species throughout the Complex.

Table EA 2-2 Chemical Treatments on the TMC NWR Complex

Chemical	Target Species	Application	Purpose
Rodeo	Cattails & Phragmites	Boom sprayer & aerial	Create open water for wildlife
Clearcast	Chinese tallow	Aerial	Eradicate invasive flora in bottomland forest
Glyphosate	Various grasses and Deep-rooted sedge	Hand & Backpack sprayer	Manage various grasses in & around facilities for safety & esthetics
Garlon 4	Chinese tallow & Macartney rose	Hand & Backpack sprayer	Coastal Prairie restoration
Roundup & Arsenal	Various grasses	Hand & Backpack sprayer	Manage various grasses in & around facilities for safety & esthetics
Grazon P+D & Remedy	Chinese tallow & Macartney rose	Aerial	Coastal Prairie restoration
Grazon Next	Chinese tallow & Macartney rose	Aerial	Coastal Prairie restoration
Habitat	Cattails & Phragmites	Boom sprayer & aerial	Create open water for wildlife
Pasture Guard	Yaupon	Aerial	Coastal Prairie restoration

Brazoria NWR would continue to use mechanical treatment on up to 100 acres of invasive species, including salt cedar and Chinese tallow. Mechanical treatment is the direct removal of trees using a tub grinder on an excavator or grinding using a gyrotrac or hydroax. Mechanical removal of Chinese tallow trees along drainage ditches would continue to be done in partnership

with the drainage district. Approximately 1,600- 2,500 acres of Chinese tallow will be treated with chemical application as part of an annual on-going prairie restoration initiative. The chemicals generally used are Grazon P+D ® and Grazon Next® through aerial application. Ground application would continue to be used for road maintenance and in small problem areas of deep-rooted sedge using a backpack pump or an ATV. The use of herbicides will continue to decline as the refuge transitions from a restoration to a maintenance management approach in prairie habitats. Prescribed fire would be used as a management tool on approximately 2,500 - 3,000 acres of prairie annually. Prescribed fire techniques and schedule are discussed above in the Features and Management Common across Alternatives section under Fire Management.

San Bernard NWR would continue to treat up to 50 acres annually by the same mechanical means as Brazoria NWR designed to remove Chinese tallow. Chemical application (same chemicals as Brazoria NWR) would be applied to approximately 100 acres annually and the Refuge would burn approximately 600 acres of coastal and salty prairie habitats to control Chinese tallow. Because of the presence of native hardwood trees in the bottomland forests of San Bernard NWR, mechanical and ground applied chemical treatments would be used to control invasive species, including Chinese tallow. On average, the refuge would annually treat up to 100 acres of bottomlands for invasive species.

At Big Boggy NWR, the refuge would primarily utilize prescribed fire to control invasive species among the coastal and salty prairie habitats. However, mechanical and herbicide application will be utilized when species and density warrant their use. The refuge generally treats less than 100 acres of invasive species annually.

Farming Program

Brazoria NWR would continue to use cooperative farming on 10 farm fields that fall in a three-year rotation and range from 50 to 120 acres for a total of 1,000 acres. Out of these 1,000 acres, approximately 220-350 acres are farmed on a given year. Three out of ten units (approximately 220-350 acres) are put into production each year with the remaining seven left fallow. The fallow fields are generally manipulated through discing and flooding during the off cycles of the rotation. The units essentially become a moist soil unit and may be flooded to provide wildlife habitat during non-production years. Rice is the main crop in production with the occasional grain sorghum. The purpose of the cooperative farming program on Brazoria NWR is for habitat benefits from the farming operations. Rent equivalents from farmers may include discing in non-farmed marshes; purchase of herbicide used to spray invasive trees and brush on irrigation laterals and/or track-hoe or excavator work on irrigation laterals. Additional rent equivalents include maintenance of feeder ditches, pipes, and water control structures and water credits purchased by farmer to be used by the refuge as duck or shorebird water following harvest. The farmer ensures that after final harvest, all cropped fields will be prepared for re-watering. Levees would be made water tight next to control structures. Discing immediately after harvest is not allowed unless unusual conditions warrant ground disturbance because of excess rutting of fields and breaching levees. In the event that a second cutting of rice crop occurs, the farmer is required to leave 25 percent of second harvest uncut to provide forage for waterfowl.

San Bernard NWR would continue to farm a 10-acre plot located in the headquarters area. This field is planted with rye grass during the winter as a source of winter browse and to attract

wildlife with emphasis on white-fronted geese to the area for winter wildlife viewing. At other times, the field is used for administrative purposes such as testing plastic sphere ignition devices, testing and demonstrating rocket nets or other activities requiring a minimally vegetated area.

At Big Boggy NWR**,** a total of 90 acres would be farmed through force account at Mathis Field. The entire 90 acres would continue to be planted with rye grass to provide winter browse for waterfowl.

Water Management
Whenever possible, the Complex would continue to restore drained wetlands through plugging ditches or installing water control structures.

Brazoria NWR would continue to restore the wetland component of wet prairie mostly by reshaping and building up ditch borrows material. Water control structures are installed to manipulate water levels in the prairie. In addition, water delivery canals, and levees around farm field/moist soil units are rebuilt to improve water management and movement capability across the units.

Water Delivery Canals
Brazoria NWR and Big Boggy NWR would continue to maintain irrigation canals on the refuges for water delivery and movement. The drainage district general maintains ditches 1-14 on the Brazoria NWR, which includes Chinese tallow control, mowing and digging out ditches. Several of the ditches are utilized for water delivery as well.

San Bernard NWR - There are no irrigation canals on the refuge.

Water Purchases
Brazoria NWR and Big Boggy NWR have the ability to purchase and receive water. Brazoria NWR may purchase water from the Gulf Coast Water Authority and Big Boggy NWR from Lower Colorado River Authority. Water purchase is dependent on rainy seasons and may not be an option in extreme drought years. During droughts, water is extremely limited and may not be purchased for agricultural use. Water purchases will be determined on an annual basis and highly dependent on funding and availability. Freshwater from rice fields is captured and can provide wetland habitat below the rice fields. Brazoria NWR purchased approximately $15,000 and $18,000 worth of water in 2008 and 2009 respectively. Big Boggy purchased approximately $5,000 worth of water for the 2008 and 2009 fall/winters. At San Bernard NWR, no purchases are made because there is no infrastructure in place to support this operation.

Irrigation Wells
Brazoria NWR will continue to manage three irrigation wells but regularly uses only the 4-inch well at Teal Pond. During drought situations, this small pump may provide the only freshwater in the Big Slough area. Water from this pump can be diverted to Teal, Olney, or Crosstrails Ponds. San Bernard NWR will continue to utilize two large irrigation wells. The 8-inch well at Wolfweed is a backup to the Cedar Lake Creek diversion pump and is used when Cedar Lake Creek is salty. A 10-inch pump at Sargent is utilized to provide fresh water in the moist-soil

units in the Pentagon Marsh. This pump is essential to providing freshwater in this salt marsh habitat.

Big Boggy NWR has no wells.

Ponds, Reservoirs, and Moist Soil Units
All refuges on the Complex would continue to manage moist soil units and fields with a combination of draining and summer discing, utilizing a stubble roller while flooded, and where opportunity exists, flood units with saltwater to control vegetation. The reservoirs are generally self-sustaining but may be drained and refilled with saltwater to control encroaching vegetation.

Brazoria NWR would continue to manage 23 fields/ponds for freshwater habitats (See Map EA 2-4. Brazoria National Wildlife Refuge Moist Soil Units – Big Slough and Map EA 2-5. Brazoria National Wildlife Refuge Moist Soil Units – North Refuge).

San Bernard NWR would continue to maintain two reservoirs, eight moist soil units, and two ponds (See Map EA 2-6. San Bernard National Wildlife Refuge Moist Soil Units).
Big Boggy NWR will continue to manage four moist soil units (See Map EA 2-7. Brazoria National Wildlife Refuge Moist Soil Units).

Bottomland Hardwood Forest
The bottomland hardwood forests are both a mix of old growth, sustainable habitats and newly regenerative habitats. The old growth forest habitat of the San Bernard NWR (parts of Dance Bayou, Bird Pond, Big Pond, McNeil, Wilson, and other units) largely require no direct management to maintain dynamic ecological processes. Many units previously cleared for tree harvesting and cattle grazing are susceptible to non-native species invasion. Invasive species control coupled with a propensity for regeneration has allowed many units to overcome extensive habitat damage. Herbicide applications are generally by hand due to the need to limit drift.

Today, the San Bernard NWR has over 24,500 acres of bottomland hardwoods with continuing accrual of additional habitats under the auspices of the Austin's Woods Conservation Plan. Its objective is to conserve and restore these mature forests and protect this dynamic climax ecosystem and all the wildlife it harbors.

Across the Texas Gulf Coast marshes, prairies, and bottomland hardwood forests, the focus of restoration efforts is on converting previously disturbed areas back to native habitat to be fully utilized by native wildlife species.

Dune and Beach
San Bernard NWR has approximately four miles of beach habitat between the mouth of the San Bernard River and Cedar Lakes Cut. Due to re-dredging of the San Bernard River in January 2010, the Cedar Lakes Cut has since silted in enabling vehicle access to the San Bernard Beach from the Sargent Beach during lower tides. To access the Cedar Lakes cut, vehicles need to traverse above the vegetation line due to the erosion of the Sargent Beach. Prior to the silting in of the Cedar Lakes Cut, the San Bernard Beach has been accessible only by boat for the past 12

years. The refuge is extremely concerned about the beach resources, where unlimited access is contrary to the refuges purposes.

2.4.1.3 Wildlife Management

Threatened and Endangered Species

A total of five bird species (piping plover, northern aplomado falcon, interior least tern, Attwater's prairie-chicken, and whoopingt), one fish, (the smalltooth sawfish); and five reptiles (the Atlantic hawksbill, green, Kemp's ridley, leatherback, and the loggerhead sea turtles) are all protected under the Endangered Species Act and have potential habitat in or adjacent to the Complex. The piping plover is listed as endangered in Brazoria and Matagorda Counties and can be found on refuge beaches and mud flats from late July to May annually. The Service identifies portions of the Complex as critical habitat for the piping plover. The northern aplomado falcon is listed as endangered in Matagorda County. Irregular sittings of a transient bird have occurred on the San Bernard NWR. The interior least tern is listed as endangered in Wharton and Fort Bend Counties. These birds are migratory through the area and are usually associated with mudflats along river banks. The Attwater's prairie chicken and the whooping crane do not currently occur on the Complex; however, the Service identifies the Complex as potential re-introduction areas for both of these species with potential reintroduction of Attwater's prairie chickens onto refuge prairies and the expansion of whooping crane populations up the coast. Management staff will conduct coordination and studies to determine best potential management direction to maximize success if reintroductions occur on the Complex. With current and proposed management actions, habitat restoration efforts are providing larger tracts of functional native habitat that have the potential to eventually provide suitable habitat for other listed species that have been historically documented in the vicinity of the Complex.

In addition, the Sprague's pipit, which is a candidate species, has been documented in all four counties, but its current status on the Complex is unknown. It is a migrant species found during migration and winter, generally tied to upland native grasslands and can be found in large numbers in coastal grasslands. All five listed sea-turtles are found in the Gulf or Bays near the refuges. The Kemp's ridley sea turtle will nest on the San Bernard NWR beach. The refuge supports the Kemp's ridley Sea Turtle Recovery Plan by patrolling and responding to turtle stranding and nesting reports.

The Complex supports and assists with the implementation of the Kemp's Ridley Sea Turtle Recovery Plan. This includes beach sea turtle surveys during nesting season (May–July), flipper tagging, excavating sea turtle nests and transporting them to the incubation facility at Padre Island National Seashore. The Refuge monitors and responds to calls regarding sea turtles on Gulf coast beaches between the mouth of the Colorado River and Quintana Beach.

Management of Invasive Species (Fauna)

Invasive species such as feral hog, nutria, red imported fire ants, and Rasberry crazy ants have negative effects to both wildlife and wildlife habitat. In addition, areas disturbed by feral hogs become prone to the establishment of exotic plant species. Feral Hog Management is discussed in section 2.3.3 of this document. Nutria are rare but are present in Complex water impoundments. Alligators generally hold their population in check. Red imported fire ants

throughout the southeastern United States have seriously impacted numerous ground-dwelling species such as Northern bobwhite quail. Researchers in the academia and land management arenas are evaluating their impact on mottled ducks and black rails. Populations of Rasberry crazy ants have not been located on the Complex yet. However, impacts to tree and ground nesting birds, and reptile nests could be devastating if they move into the Complex.

Red Imported Fire Ants and Rasberry Crazy Ants
Throughout the Complex, staff would treat rookery areas for red imported fire ants using methoprene (insect growth regulator) bait like Extinguish®. Treatments will occur before nesting season in October-November when moisture starts and ants began surfacing.

At Brazoria NWR, staff would treat Wolf Lake Skimmer Lot rookery with the same chemicals. At San Bernard NWR, staff would treat Cedar Lakes rookery.

The Complex is monitoring the Rasberry Crazy Ant, a recently discovered invasive species, for presence and wildlife impacts on the Brazos River Unit of San Bernard NWR. The ants are in a nearby hayfield, but have not been located on the Complex. Currently, no field treatment has been developed for Rasberry Crazy Ants. As research and treatments become available, the Complex will use the best available science to control Rasberry crazy ants.

At Big Boggy NWR, staff would treat Dressing Point Island rookery.

2.4.1.4 Visitor Services

Approximately 35,000 visitors visit Brazoria NWR and 35,000 visitors come to San Bernard NWRannually. About a quarter of the visitors come during the spring season (March–April) to view birds and enjoy the coastal prairie habitat when a variety of flowering plants are blooming. Approximately 5,000 visitors come to Big Boggy NWR for hunting and fishing opportunities. The Brazoria Discovery Center is approximately 1,500 square feet and includes a visitor contact center, lab, and office, and can host up to 50 students at a time. It also contains a large screen television and projection screen for interpretive programs and contains a pavilion overlooking Big Slough in the back of the Discovery Center. The Discovery Environmental Education Program (DEEP) has been functioning at Brazoria NWR since 1994. DEEP currently serves approximately 3,000 students and in future years may expand to 6,000 students as the population of the area increases.

The Complex continues to serve as an outdoor education center where graduate students conduct research projects involving waterfowl and other migratory birds, agriculture and moist soil unit production, fish and wildlife, as well as forestry studies. Brazoria NWR and San Bernard NWR are open to the public throughout the year during daylight hours. Big Boggy NWR is closed with the exception of limited hunting and fishing opportunities.

San Bernard NWR maintains six areas that provide wildlife observation, interpretation, and photography opportunities. Cocklebur Slough Public Use Area provides an auto tour while the Hudson Woods, Dow Woods, Betty Brown, San Bernard Oak, and Little Slough are walking trails. Visitors can find interpretation of Refuge resources along all trails and the auto tour.

Expansion of the environmental education programs at Brazoria NWR occurs at San Bernard NWR proper, as well as at the bottomland units.

Boating is allowed in all navigable waters throughout the Complex in support of hunting, fishing, and wildlife observation.

Hunting

The Complex will continue to provide the current level of hunting opportunities. All three refuges in the Complex allow waterfowl hunting. In addition to waterfowl hunting opportunities, the Service cooperates with TPWD and the Stringfellow Wildlife Management Area (WMA) and Texas Youth Hunting Program (TYHP) to provide white-tailed deer/feral hog youth hunts on San Bernard NWR and feral hog hunts on San Bernard and Brazoria NWR's respectively.

Brazoria NWR has two public waterfowl hunting areas: Christmas Point and Middle Bayou Public Waterfowl Hunt Areas (see Brazoria NWR Hunt Area Map 3-30 and 3-31). The Christmas Point Public Waterfowl Hunt Area lies southeast of the GIWW and encompasses approximately 4,000 acres. Access is by boat only. The Middle Bayou Public Waterfowl Hunt Area encompasses approximately 1,500 acres and access to this site is by boat or by walk-in from CR227. On these units, the Refuge permits hunting of ducks, geese, and coots. It prohibits pits and permanent blinds.

During the youth feral hog hunts, in partnership with TYHP, youth hunt from temporary blinds located off FM2004, in the Otter Slough Area.

San Bernard NWR has three designated public hunting areas (Cedar Lakes, Smith Marsh, and Salt Bayou Public Waterfowl Hunt Areas) and one permit hunting area (Sargent Permit Waterfowl Hunt Area), illustrated on the San Bernard NWR Hunt Area Map 3-32 of the CCP. All of these public hunting areas are accessible by boat only, and are open for the pursuit of ducks, geese, and coots. The Cedar Lakes Public Waterfowl Hunt Area (2,400 acres) lies south of the GIWW, and the Smith Marsh Public Waterfowl Hunt Area (1,400 acres) is on the west side of Cedar Lakes Creek. Salt Bayou Public Waterfowl Hunt Area encompasses 3,600 acres accessible from Cedar Lakes Creek, the Gulf Intracoastal Waterway, or through the shallow Cowtrap Lakes system. The Sargent Permit Waterfowl Hunt offers a limited hunting opportunity on 4,000 acres with walk-in or boat access.

For the TPWD youth deer/feral hog hunts and the TYHP feral hog hunts, all hunting opportunities are limited to stationary blinds. There are a total of nine stationary blinds in the McNiel/Ducroz/Stringfellow Unit. This bottomland unit is contiguous with the Nannie M. Stringfellow WMA.

Big Boggy NWR has two public hunting areas: the Pelton Lake Public Waterfowl Hunt Area and Matthes Field Public Waterfowl Hunt Area. Pelton Lake encompasses 1,100 acres on the east end of the refuge, whereas the Matthes Field Public Waterfowl Hunt Area is located at the north end of the refuge along Chinquapin Road (see Big Boggy NWR Hunt Area Map 3-33). The Complex primarily maintains this 200-acre area for goose hunting, but both areas are open for the hunting of ducks, geese, and coots.

On the Complex, the Public Waterfowl Hunt Areas are open during the State Waterfowl seasons. Teal season is generally scheduled for 9 to 16 days beginning mid-September. Regular season generally begins late October through mid-January with one two-week mid-season closure. In addition, the Public Waterfowl Hunt Areas across the Complex are open during the Conservation Order Light Goose Season, following regular waterfowl season. The Complex holds youth hunts on the McNiel/Ducroz/Stringfellow Unit of San Bernard NWR three weekends per year; two in October and one in December. Youth hunts led by the Texas Youth Hunting Program (TYHP) occur at San Bernard and Brazoria NWRs two weekends per year (February/March) at each location.

All refuges on the Complex provide hunting opportunities. Issue 1, Management of Invasive Species (Fauna) discusses feral hog hunting opportunities. Public Waterfowl Hunting Areas are open access on a first come, first serve basis. Waterfowl hunting areas are open during the teal and general waterfowl seasons in accordance with state seasons. The Complex allows hunting from a half hour before sunrise to sunset.

Wildlife Observation

Existing Wildlife observation opportunities would continue to be available at San Bernard and Brazoria NWRs. The Complex estimates annual visitation at 70,000 with approximately 32,000 visitors coming to the refuges for wildlife observation opportunities. General public access to observe wildlife and refuge habitats including the means of access such as automobile, hiking, bicycling, boating, canoeing and kayaking. Bird watching continues to be the most popular form of wildlife observation on the refuge, where visitors can see large concentrations of waterfowl, wading birds, and neo-tropical songbirds. Big Boggy NWR would remain closed to public use other than special tours.

San Bernard NWR offers wildlife observation and hiking at several locations. The San Bernard auto tour and Moccasin Pond loop provide 9.4 miles of gravel roads with observation platforms, vehicle pullouts, trails, boardwalks, and a butterfly garden. The Cocklebur Slough Road provides opportunities to see wading birds, raptors, and passerines as well as resident wildlife in light forest and grassland habitats. Moccasin Pond loop is at the edge where the salty prairie meets the high marsh. From the loop road a variety of fresh and saltwater, open water, marsh, and grassland habitats support an array of migratory and resident wildlife. Bicyclists are welcome on all Refuge roads that are open to public vehicles. The San Bernard Oak trail, which is located .5 mile north of the Refuge entrance, along CR 306, provides a .6 mile trail through a mature bottomland forest to the largest live oak in Texas. The trail crosses a slough before reaching the tree, which provides excellent opportunity for viewing bottomland wildlife including wood ducks, reptiles, and songbirds.

Hudson Woods, located five miles west of Angleton, Texas, on SH 521 provides 5.9 miles of walking trails through early and mid-succession stage bottomland forest. Walking the trails provides excellent opportunities for viewing winter and migratory songbirds. Two oxbow lakes provide opportunities for viewing waterbirds including anhinga, waterfowl, and wading birds. An observation deck at Scoby Lake, the deck on the front of the Discovery Outpost and the photo blind provide excellent opportunities to view wetland wildlife.

Dow Woods is the most recent bottomland forest unit opened to provide wildlife observation opportunities. The unit is located on the north side of the City of Lake Jackson. Currently 2.7 miles of trail are available for wildlife observation through a restoring forest and along the shore of Bastrop Bayou. Visitors commonly see native wildlife including deer, armadillos, and raccoons along with migratory songbirds, woodpeckers, and owls.

Betty Brown, the smallest unit on San Bernard NWR, has a 3/8 mile loop trail that takes visitors to the shore of the San Bernard River. This mature growth forest provides excellent opportunities to see migratory songbirds as they move inland from the Gulf of Mexico.

Brazoria NWR will continue to emphasize wildlife observation and highlight these opportunities in a variety of strategic locations including: the Big Slough Public Use Area, Otter Slough, Bastrop Bayou, and Middle Bayou Trail. On Brazoria NWR, the 7.5-mile gravel auto tour route meanders through the Big Slough Public Use Area, wrapping around Olney and Teal Ponds and accessing Big Slough and Rogers Pond. The tour loop, accessible by foot, bicycle, or automobile, includes boardwalks, observation platforms, vehicle pull-offs, trails, and butterfly gardens, each of which is associated with offering opportunities for wildlife observation. In addition, a remote bird-viewing camera is set up at Gator Nest Pond to broadcast video of wildlife to the Discovery Center. The 3-mile paved entrance road from County Road 227 also provides wildlife observation opportunities.

Brazoria NWR also has viewing areas outside the Big Slough Public Use Area. Mottled Duck Marsh, off County Road 208 on the refuge's northern edge, rewards visitors on the lookout for views of waterfowl, wading birds, and shorebirds. The farm fields along County Road 227 and FM 2004 also offer wildlife-viewing opportunities from the public roadway. The Refuge is proposing to work with Brazoria County and develop pull-offs along the county roads for visitors to safely view wildlife without hampering traffic flow.

Wildlife Photography

In addition to the opportunities provided above for wildlife observation, San Bernard NWR would continue to provide a photo blind at Hudson Woods, which presents opportunity for photographing wildlife.

Brazoria and Big Boggy NWRs would provide no additional facilities for wildlife photography.

Environmental Education

The Complex would continue to provide environmental education through their Discovery Environmental Education Program (DEEP).

The Discovery Center at Brazoria NWR would continue to host the majority of the DEEP programs. However, the Discovery Outpost at Hudson Woods and the Wolfweed Wetlands at San Bernard NWR may continue to host field trips as well. The Discovery Center would continue to offer environmental education year round. Activities would include staff-led field trips and issuance of Special Use Permit for after hours or closed area access.

Picnicking may occur as an incidental use supportive of the environmental education program. Picnic tables are located outside of the Discovery Center and visitors may use them in conjunction with environmental education activities.

Interpretation

The Complex would continue to coordinate with the Friends of Brazoria Wildlife Refuges to host the annual Migration Celebration at San Bernard NWR, a weekend event held in April. The event hosted at the refuge features van and marsh buggy tours, numerous children hands-on learning activities, and presentations, including Birds of Prey and Reptiles. Over 1,800 visitors and volunteers attended the 2012 event.

Opportunities for interpretation occur throughout the Complex. People may encounter interpretive opportunities within any public use areas and administrative offices throughout the Complex.

Entrance Fee

Currently, there is no entrance fee required.

2.4.1.5 Facilities/Infrastructure Management

The Complex has three administrative sites. The Complex Office is located on San Bernard at the intersection of FM2611 and CR316. The facility provides office space for Complex management, administrative, biological, law enforcement, and fire program management. The field office for San Bernard NWR is located along CR306 and includes office facilities for refuge management, maintenance, and fire crew as well as maintenance and equipment storage facilities. The Brazoria NWR field office is located off FM2004 and south of CR208. The facility provides office space for refuge management, maintenance, law enforcement, and fire crew as well as maintenance and equipment storage facilities.

The Otter Slough headquarters of Brazoria NWR consists of the Refuge's field headquarters that is located off FM 2004. The office has eight individual offices and supports field operations including management, maintenance, fire, and law enforcement.

The field headquarters of San Bernard NWR is located on CR 306. The field headquarters include the Refuge's office and fire office, maintenance and storage buildings and storage sheds, quarters, two volunteer pads and a communications tower (repeater).

The primary facility resources on Big Boggy NWR are habitat management and resource protection related. No developed infrastructure occurs on this refuge.

Visitor Use Infrastructure

Visitor Orientation Facilities

The Discovery Center at Brazoria NWR is the only facility constructed specifically for visitor orientation in the Complex. However, visitors will continue to find printed information,

interpretive map panels, and a helpful staff member at the Complex Headquarters and Refuge Field Offices.

Trails
Both San Bernard NWR and Brazoria NWR would continue to provide trails for Refuge visitors. Big Boggy NWR does not have any trails. Please refer to Section 3.4.5.2 of the CCP for a full list of trails provided at each Refuge.

San Bernard NWR offers 12 miles of walking/hiking trails at four different locations; Hudson Woods, Betty Brown Unit, San Bernard Oak, and the Cocklebur Slough public use area.

Brazoria NWR offers 5 miles of walking/hiking trails at two different locations; Middle Bayou and Big Slough Public Use Area.

Non-motorized Boat Launches
The Complex would continue to provide four access points to use for launching canoes and kayaks at Brazoria and San Bernard NWRs. There are no access points on Big Boggy NWR.

Brazoria NWR has two non-motorized boat launches at Salt Lake and Bastrop Bayou.
San Bernard NWR has a boat ramp on Cedar Lake Creek that visitors could use for canoes and kayaks.

Signs/Exhibits
Exhibit and information panels at observation decks, kiosks, and trailheads would consist of photo panels.

Administrative Infrastructure

Volunteer Facilities
The Complex would continue to provide recreational vehicle pads at Brazoria NWR and San Bernard NWR. There would not be any volunteer facilities provided at Big Boggy NWR. The RV village at Brazoria NWR supports eight RV pads. San Bernard NWR has RV facilities to support two volunteer RVs.

Administrative Facilities
The Complex would continue to maintain a variety of facilities to support Refuge operations and programs including administrative, maintenance, and fire facilities. Find a full list of facilities and their descriptions in Section 3.4.6.2 of the CCP.

2.4.2 Alternative B—(Proposed Action):

2.4.2.1 Ecoregion Management

Climate Change
Management would be the same as Alternative A; however, the Complex would also consider monitoring prairies and marshes carbon sequestration. The Complex would implement a

baseline monitoring program for all species that occur on the Complex and would monitor population shifts. The visitor services program would consider expanding the climate change curriculum provided by their DEEP program as new information on climate change becomes available. The Complex would expand its use of green products where feasible. The Complex would add photovoltaics to old offices and new facilities and expand existing systems when opportunities arise.

San Bernard NWR would restore 10 percent of bottomland forests requiring restoration through native planting of oak using carbon sequestration funding. San Bernard NWR may also use exchange of carbon credits for restoration and would implement a habitat-modeling program to predict shifts in bottomland composition. San Bernard NWR would incorporate climate change into their Refuge displays and replace existing refuge displays with recycled products.

Erosion/Saltwater Intrusion

Management to address erosion and saltwater intrusion would be the same as Alternative A; however, there would be an increase in the types and amounts of structural and restoration techniques used and discussed below.

Brazoria NWR would rehab the Salt Lake weir, and increase cooperation with the Army Corps of Engineers (ACOE) to establish up to seven additional beneficial dredge projects, shoreline protection projects and approximately 10 miles of bank armoring along the GIWW. Brazoria NWR would also explore the option of planting smooth cordgrass to reduce erosion.

San Bernard NWR will also increase cooperation with the ACOE to identify and implement two beneficial dredge sites and approximately 6 miles of bank armoring or installation of break waters along the GIWW with breakwaters preferred.

Big Boggy NWR would install reef domes and/or geotubes to stabilize erosion of Dressing Point Island.

Land Conservation

Under Alternative B, the Service proposes to increase the 28,000 acre cap by an additional 42,000 acres (to a total of 70,000 acres); continuing conservation efforts in the Columbia Bottomlands and associated habitats, as described in the Land Protection Plan provide CCP Appendix I. This expansion would remain within the approved project geographical boundary in Brazoria, Matagorda, Fort Bend, and Wharton counties in Texas and would continue the conservation efforts within the Austin's Woods Conservation Project. The original Conservation Plan, approved in 1997, was intended to counter the rapid destruction of prime old growth bottomland hardwood forests in the Columbia Bottomlands ecosystem. That plan responded to concerns shared by the Service, the Texas Parks and Wildlife Department, local government agencies, conservation organizations and landowners over preserving a sustainable portion of this internationally significant ecosystem. The original overall goal shared by all of the project partners was to protect approximately 10 percent of the estimated original 700,000-acre ecosystem to sustain plant and animal populations and maintain the ecosystem's diversity. The Service would continue to utilize a variety of funding mechanisms for purchasing fee title or conservation easements within the Columbia Bottomland Ecosystem; work with partners finding

conservation solutions; and take a lead role in the conservation of additional forested habitats, identifying federal and non-federal funding sources in cooperation with private landowners, federal, state and local governments and non-profit organizations.

2.4.2.2 Habitat Management

Gulf Coast Prairies and Marshes

Cooperative Haying
Brazoria NWR would increase the cooperative haying program up to 75 total acres to increase the wildland urban interface (WUI) buffer area where it cannot implement prescribed fire due to the presence of houses adjacent to the Refuge boundary.

Restoration
Management would be the same as Alternative A; however, Brazoria NWR would establish partnerships for native prairie seed harvest. It would collect seed from refuge prairies and use it to restore other coastal prairie habitats on the refuge. The refuge would restore approximately 600–800 acres annually.

Management of Invasive Species (Flora)
The Complex would continue to use mechanical, chemical, and prescribed fire treatments as described in Alternative A, with the additional treatments as described below. This management alternative would incorporate limited livestock grazing throughout the Complex as a management tool for specific issues like invasive species management, pond management, or to control aggressive native plants. Livestock grazing would be seasonal with AUM (animal unit month) and acreage to be grazed determined annually. It would be a winter grazing program, short duration incorporating a rotation system in this time frame. Although the Refuge would maintain existing fences, the use of electric wires would be the primary method of keeping the livestock within the specific unit. An example may be to use grazing to control phragmites re-growth following a fall burn.

Brazoria NWR would increase the number of acres treated mechanically every year to approximately 200 acres. The Refuge would reduce chemical application to approximately 800–1200 acres annually as it restores areas. The Refuge would increase prescribed fire to approximately 5,000 acres annually. Brazoria NWR would also implement monitoring and control of phragmites stands and they would implement an early detection program to identify new invasive species.

San Bernard NWR (prairie and marsh habitats) would increase mechanical treatment to approximately 100 acres annually and increase use of prescribed fire to approximately 1,000 acres per year. Chemical application would continue to be the same as Alternative A.

San Bernard NWR (bottomland forest) would implement the same management as Alternative A, plus they would contract approximately 50 acres per year for mechanical and chemical treatments. The refuge would increase mapping of invasive and prevent the spread of invasive species along right-of-ways through monitoring and education.

Big Boggy NWR would implement the same management as Alternative A; however, it would treat Chinese tallow along fence lines, roads, and water delivery canals (approximately 20 acres) through chemical application.

Farming Program
Management would be the same as Alternative A; however, Brazoria NWR would increase farming acres to approximately 1,200–1,500 to include additional moist soil units into the crop rotation. The cooperative farmer would still only plant 350–400 acres annually. The acreage that would be included is already in moist soil production.

San Bernard NWR would explore potential for habitat restoration and protection partnerships with Texas RICE, Ducks Unlimited, and the Coastal Program. San Bernard NWR would also implement monitoring on prairie restoration areas listed in Alternative A.

Water Management
Management would be the same as Alternative A; however, there would be drilling of additional wells and development of new/rehabilitation of existing water control structures as outlined below.

Water Delivery Canals
Brazoria NWR would construct water diversions along ditches and canals to capture more runoff water. Lift pumps and check dams would be installed in drainage ditches.

Big Boggy NWR would clean out existing water delivery canals and drainage ditches to increase freshwater availability.

Water Purchases
Water will continued to be purchased, on an as needed basis, as described in Alternative A.

Irrigation Wells
Brazoria NWR would drill an additional well in farm fields.

San Bernard NWR would rehabilitate two existing irrigation wells. Rehabilitation of these wells would involve clearing out well and determining the reason for low water flow. The refuge would add one additional well for Moccasin and Rail Pond.

Big Boggy NWR would add an irrigation well at McCoach Unit.
Ponds, Reservoirs, Moist Soil Units
Big Boggy NWR would rehabilitate levee and water control structures at Matthes Pond and Mallard Pond.

San Bernard NWR would rehabilitate levees and level the west and middle units of Wolfweed Wetlands to improve management capability. The refuge would explore expansion of Wolfweed Wetlands and increase management capabilities at Sargent Pentagon Marsh by establishing two additional moist-soil units totally 120 acres and water canals.

Bottomland Hardwood Forest
Management would be the same as Alternative A.

Dune and Beach Management
San Bernard NWR would protect the San Bernard beach habitat and wildlife through limiting vehicle access above the tidal zone. Beach resources, including the debris that help to stabilize the dunes, are extremely critical to maintaining this habitat for a variety of native wildlife and protection of the adjacent marsh. Unintentional fires could have detrimental effects on marsh and dune habitats. The Service will restrict campfires and fireworks on the beach habitat.

2.4.2.3 Wildlife Management

Threatened and Endangered Species
In addition to the Alternative A, the Complex would begin monitoring for the potential reintroduction of APC and whooping crane. The Service lists the refuge as a potential reintroduction site for whooping crane, but given the fact that the refuge is outside of the whooping crane flyaway means the refuge will play a much smaller role in this recovery effort. Monitoring would include baseline data on freshwater availability and blue crab populations.

In preparation for a potential APC reintroduction, the refuge would monitor habitat conditions; conduct research on burning regimes, grazing, and cooperative haying; and collect baseline data on insect populations. If the Complex reintroduced APC, it would implement the APC Recovery Plan.

Management of Invasive Species (Fauna)

Feral Hog
Management of feral hogs would be the same as Alternative A.

Red Imported Fire Ants and Rasberry Crazy Ants
Management of invasive ants would be the same as Alternative A; however, the Complex would enable the release of Phorid flies as a natural predator to control red imported fire ants.

2.4.2.4 Visitor Services

Hunting
The Complex will continue to manage hunting as it is under Alternative A, but Brazoria NWR would provide a youth waterfowl hunting permit area, which would increase youth hunting opportunities by 20 percent over the life of the CCP. San Bernard and Big Boggy NWRs would provide hunting only until 1 p.m. Additional areas will be open to waterfowl hunting in Eagles Nest Lake after completion of a hunt plan and associated environmental compliance. The Complex may consider future deer hunts if populations and/or habitat conditions would benefit from enacting a white-tailed deer hunt program following environmental compliance.

Wildlife Observation
Wildlife observation would continue to be managed as it is under Alternative A; however, the Complex would increase opportunities by constructing new wildlife observation facilities. Brazoria NWR would provide a viewing area on Otter Slough (possibly a boardwalk across the slough) and establish pull-off points along FM2004, at the farm fields, and on CR 227.

Wildlife Photography
The Complex would continue to manage wildlife photography as it is under Alternative A, plus San Bernard NWR would add photo blinds at Dow Woods area. Brazoria NWR would add photo blinds to the Big Slough area.

Environmental Education
Environmental education would continue as it is under Alternative A and the Complex would increase the education program. Brazoria NWR and San Bernard NWR would expand outreach by contacting local media outlets, radio, and Web sites to provide information on the DEEP program, events, and refuge purposes. Provide a one-weekday camp focused on the "at-risk" group of youth (Boys and Girls Club, etc.).

The DEEP program at Brazoria NWR would expand to include an additional school district. The DEEP program at San Bernard NWR would expand to include seven additional school districts including: West Columbia, Sweeny, Bay City, Van Vleck, Angleton, Pearland, and Alvin schools. San Bernard NWR would also like to develop a partnership with Brazosport College at the Dow Woods Unit, enabling them to use the Unit as an outdoor classroom.

Interpretation
Management of interpretation would continue as in Alternative A, but organized interpretative programs would be expanded to include a variety of venues on a monthly basis. Interpretive activities would include day and night naturalist walks and audio/visual presentations conducted by staff and volunteers. Brazoria NWR would also construct an information kiosk along FM2004.

Entrance Fee
The Complex would implement a three-dollar entrance fee at Brazoria San Bernard NWRs to help support maintenance and development of public use facilities on the refuges.

2.4.2.5 Facilities/Infrastructure Management

Visitor Services Facilities

Visitor Orientation Facilities
Management of these facilities would be the same as Alternative A; however, San Bernard NWR would develop a stand-alone, unmanned visitor orientation facility for after-hour and weekend visitors.

Trails
Management would be the same as Alternative A, except Brazoria NWR would remove the Middle Bayou Trail at Brazoria NWR and a provide new trail at Otter Slough. San Bernard NWR would provide bicycle opportunities in the bottomland forest public use area at Dow Woods and Hudson Woods.

Non-motorized Boat Launches
Management would be the same as Alternative A; however, San Bernard NWR would provide a second launch and pullout location at the end of CR 318 that provides access to Cedar Lake Creek to provide additional opportunities for canoes and kayaks and establish a paddling trail.

Signs/Exhibits
Management would be the same as Alternative A, but this alternative would require construction of eight new exhibits and signs replacing signs in existing kiosks. The Complex will place new information signs at Cedar Lake Creek's kayak access and Dow Woods Unit. The refuge will also replace existing signs to improve the quality and content.

Administrative Facilities

Volunteer Facilities
Under this alternative, Brazoria NWR would develop a new RV facility near the new field headquarters at Otter Slough. This facility would replace the existing facility and would move it out of the immediate storm surge zone where it currently occurs. San Bernard NWR would expand volunteer facilities to five total volunteer pads and would construct a laundry/community building.

Administrative Facilities
San Bernard NWR would construct an equipment storage facility to use for staging equipment and supplies prior to landfall of a hurricane at Buffalo Creek Unit.

2.4.3 Alternative C

2.4.3.1 Ecoregion Management

Climate Change
Management would be the same as Alternative B; however, San Bernard NWR would increase restoration efforts to 25 percent.

Erosion/Saltwater Intrusion
Management would be the same as Alternative B; however, additional shoreline protection projects would occur.

Brazoria NWR would construct breakwater structures (rip-rap, reef domes, or geotubes) to Lost Lake to increase sedimentation behind the structure and prevent further erosion. The refuge would do these projects in partnership with the ACOE and through grants and other funds available.

San Bernard NWR would increase bank armoring or installation of breakwaters along the Intracoastal Waterway to 10 miles of shoreline protected.

Big Boggy NWR would expand Dressing Point Island using geotubes, beneficial dredges, and breakwaters, and also work with ACOE to implement two beneficial dredge sites off-refuge on the opposite side of the GIWW and install approximately two miles of bank armoring or installation of breakwater with breakwaters being preferred.

Land Conservation
Land Conservation within the Columbia Bottomlands will be the same as Alternative B.

2.4.3.2 Habitat Management

Gulf Coast Prairies and Marshes

Cooperative Haying
Management would be the same as Alternative B.

Restoration
Management would be the same as Alternative B; however, Brazoria NWR would develop a seed bank on 500 acres of native prairie to collect and distribute native prairie seed to increase restoration efforts across the ecosystem to include off-refuge locations.

Management of Invasive Species (Flora)
This management alternative would be the same as Alternative B, but Brazoria NWR would allow limited bison grazing instead of livestock as a management tool for specific issues such as invasive species control or reducing the progression of aggressive natives. Grazing with bison would be managed on a year-round basis across the larger coastal prairies rather than seasonal like livestock. Bison may be moved into a small part of a larger pasture using an electric fence to obtain the desired habitat outcome, for instance in moist soil unit to control phragmites. Brazoria NWR would decrease the number of acres treated mechanically every year to approximately 100. Chemical application would be reduced to approximately 200 acres annually and only occur where the refuge cannot use fire as the primary management tool (i.e. levees). The refuge would continue to increase its use of prescribed fire to burn approximately 8,000 acres annually. Reduction in mechanical and chemical treatments is due to conversion from active restoration to maintenance.

San Bernard NWR (prairie and marshes) would decrease both mechanical and chemical treatments to approximately 50 acres annually where it cannot employ fire as the primary management tool. There would be an increase in prescribed fire to burn approximately 4,200 acres annually.

Farming
Under Alternative C, the Refuge would reduce the cooperative farming program at Brazoria NWR to 500 acres, and only farm 150–200 annually. The Complex would eliminate farming at San Bernard and Big Boggy NWRs.

Water Management
Water management would be the same as Alternative B.

Water Delivery Canals
Management would be the same as Alternative B.

Water Purchases
Management would be the same as alternative B; however, Brazoria NWR would explore the options to purchase water rights so that we would not have to rely heavily on purchases and decrease water purchase from Gulf Coast Water Authority to approximately $10,000 annually. Brazoria NWR would also increase partnerships with Ducks Unlimited and Velasco Drainage District to increase freshwater availability.

Irrigation Wells
Management would be the same as Alternative B.

Ponds, Reservoirs, Moist Soil Units
Management would be the same as Alternative B.

Bottomland Hardwood Forest
Management would be the same as Alternative A.

Dune and Beach
Management would be the same as Alternative B.

2.4.3.3 Wildlife Management

Threatened and Endangered Species
Management would be the same as Alternative B.

Management of Invasive Species (Fauna)

Feral Hog
Management would be the same as Alternative A; however, the Brazoria and San Bernard NWRs would open refuges to general feral hog hunt. Portions of both refuges (including bottomland units) would be open on three weekends during the late winter/early spring. An estimated 210 hunter days would occur annually.

Red Imported Fire Ants and Rasberry Crazy Ants
Under this alternative, the Complex would implement broad scale treatment using methoprene (insect growth regulator) bait like Extinguish®.

2.4.3.4 Visitor Services

Hunting
Management of hunting would be the same as Alternative B; however, San Bernard NWR would offer a deer hunt to reduce populations once population data is available.

Wildlife Observation
Management of these activities would be the same as Alternative B.

Wildlife Photography
Management of these activities would be the same as Alternative B.

Environmental Education
Management of these activities would be the same as Alternative B.

Interpretation
Management of these activities would be the same as Alternative B.

Entrance Fee
In this management alternative, the Complex would make the current voluntary moneybox visible and more secure. Brazoria NWR would add a donation box at the fishing pier and San Bernard NWR would add donation boxes to public use areas.

2.4.3.5 Facilities/Infrastructure Management

Visitor Use Infrastructure

Visitor Orientation Facilities
Management under this alternative would establish a standalone and manned visitor contact station at San Bernard NWR Headquarters.

Trails
Management of trails would be the same as Alternative B.

Non-motorized Boat Launches
Management of these launches would be the same as Alternative B; however, San Bernard NWR would work with partners to establish additional launch sites, one on Brazos River, one on Oyster Creek, and one on the San Bernard River.

Signs/Exhibits
Management of signs and exhibits would be the same as Alternative B.

Administrative Infrastructure

Volunteer Facilities

Under this alternative Brazoria NWR would keep the same facilities outlined in Alternative A, but the refuge would construct a larger laundry/community building to support volunteers. Management of these facilities for San Bernard NWR would be the same as Alternative B.

Administrative Facilities
Management of these facilities would be the same as Alternative B.

2.5 Comparison of Alternatives

Table EA 2-3. Comparison of Alternatives

Issue	Alternative A: Current Management (No Action)	Alternative B	Alternative C
Ecoregion Management			
Climate Change	Supplement natural forest regeneration with restoration efforts; monitor carbon sequestration; conduct education programs; and use "green" technologies and building products on all new construction	Same as Alternative A plus increase restoration efforts; utilize exchange of carbon credits; gather baseline data on habitat composition/wildlife diversity; update refuge displays; and increase use of "green" technologies	Same as Alternative B plus increase restoration efforts above described levels
Erosion / Saltwater Intrusion	Construct/Use a variety of structural and some restoration techniques at various locations	Same as Alternative A plus increase the types and amounts of structural and restoration techniques used	Same as Alternative B but diversify the types of structural and restorative techniques used
Wildland Fire Use	Follow direction of current FMP	Same as Alternative A	Same as Alternative A
Petroleum Development	Work cooperatively with companies to minimize impacts to refuge resources	Same as Alternative A	Same as Alternative A
Land Conservation	The Complex will continue to acquire lands under the 1997 Austin's Woods Conservation Plan until the 28,000 cap is reached	The Complex will acquire lands under the new (see Appendix) Land Protection Plan up to 70,000 acres	Same as Alternative B
Habitat Management			

Gulf Coast Prairies and Marshes			
Prairie/Grassland Restoration and Management	Cooperative haying conducted; wetland and farmland rehabilitation. Native prairie restoration	Same as Alternative A, plus increase acreage of haying, and increase number of rehabilitation projects. Increase prairie restoration	Same as Alternative B plus develop seed bank on prairie restoration areas.
Management of Invasive Species (Flora)	Mechanical, chemical, and prescribed fire use allowed; grazing not allowed	Same as Alternative A plus increase the types and amounts of management prescriptions used including limited livestock grazing	Same as Alternative B but diversity the types of management prescriptions used including bison grazing
Prescribed Fire Use	Allowed Complex-wide to improve habitats and reduce hazardous fuels	Same as Alternative A	Same as Alternative A
Farming Program	Cooperative farming and force account farming occur on all three refuges	Same as A, plus incorporate additional moist soil units into farming rotation at Brazoria NWR	Reduce cooperative farming acres at Brazoria NWR and eliminate farming at Big Boggy and San Bernard NWRs
Water Management	Restore prairie pothole hydrology as opportunity arises; use established wells to provide freshwater to moist soil units during drought periods; and purchase water from various water authorities annually	Same as Alternative A plus drill additional wells, and develop new / rehabilitate existing water control structures	Same as Alternative B plus increase water availability through the development of partnerships and purchase of water rights; expand wetlands; and rehabilitate marshes
Bottomland Hardwood Forest			
Forest Restoration	Allow natural regeneration, where appropriate add supplemental planting of hardwood species; treat invasive species	Same as Alternative A	Same as Alternative A
Water Management	Restore previously drained wetlands	Same as Alternative A	Same as Alternative A
Dune and Beach			

	Management of beach resources have not been clearly defined due to recent silting in of Cedar Lakes Cut and trespass across upland vegetation on private land to access the Cut.	Cooperatively work with County and General Land Office (GLO) to provide additional protection on San Bernard Beach restricting type of access and activities by visitors that would be compatible with Refuge Purpose.	Same as Alternative B
Wildlife Management			
Threatened and Endangered Species	Implement the Sea Turtle Recovery Plan	Same as A, plus if reintroduction of APC and whooping crane occur, implement APC and whooping crane recovery plans	Same as Alternative B
Migratory Bird Species and Species of Special Management Concern	Manage a variety of habitats for resting, feeding, and reproductive purposes	Same as Alternative A	Same as Alternative A
Management of Invasive Species (Fauna)	Baiting and broad scale treatments to control ants	Same as Alternative A plus release natural predators to control ants	Same as Alternative A but diversify the types of management prescriptions used for each invasive
Visitor Services			
Hunting	Allowed in designated areas for waterfowl, youth deer/feral hog hunt on San Bernard NWR, and a youth feral hog hunt One permit area and ATV use allowed in designated area for disable hunters	Same as Alternative A plus provide a youth waterfowl hunt; and revise the hunting schedule at two locations	Same as Alternative B plus provide a population reduction deer hunt
Fishing	Allowed on all navigable waters and from designated locations	Same as Alternative A	Same as Alternative A
Wildlife Observation	Brazoria and San Bernard NWRs open to wildlife observation;	Same as Alternative A plus construct additional photo	Same as Alternative B

	visitors directed to designated public use areas	blinds, new trails, a boardwalk, and road pull-offs to provide for additional opportunity	
Wildlife Photography	Photo blind at Hudson Woods	Same as Alternative A plus develop additional photography opportunities	Same as Alternative B
Environmental Education	Various programs and events conducted	Same as Alternative A plus increase number of programs conducted and expand programs into additional school districts at San Bernard NWR	Same as Alternative B
Interpretation	One annual 3-day event	Same as Alternative A plus expand organized interpretive programs at a variety of Refuge venues on a monthly basis.	Same as Alternative B
Preservation of Historic Sites	Historical sites are identified and interpreted in public use areas when appropriate	Same as Alternative A	Same as Alternative A
Entrance Fee	No entrance fee required	Require entrance fee	Provide donation boxes at various public use areas
Facilities/ Infrastructure Management			
Visitor Use Infrastructure:			
Visitor Orientation Facilities	Visitor contact station located at Brazoria NWR Discovery Center	Same as Alternative A plus additional Visitor Contact Station at San Bernard NWR	Same as Alternative A plus construct stand-alone Visitor Center at San Bernard NWR Field Office.
Trails	Hiking trail provided at Brazoria and San Bernard NWRs	Same as Alternative A plus construct a new trail at Brazoria NWR Field Office; provide bicycle access at Dow Woods Unit.	Same as Alternative B

Non-Motorized Boat Launches	Canoe / Kayak launches provided at San Bernard and Brazoria NWRs	Same as Alternative A plus construct one additional launch	Same as Alternative B plus construct two additional launches
Signs/Exhibits	Signs and exhibits at Brazoria and San Bernard NWRs	Construct new exhibits and signs and improve quality and content of existing exhibits and signs	Same as Alternative B
Roadways	Vehicular access allowed on designated refuge roads	Same as Alternative A	Same as Alternative A
Administrative Infrastructure:			
Volunteer Facilities	Recreation vehicle pads provided at Brazoria and San Bernard NWRs	Construct new recreation vehicle site at Brazoria NWR, and expand recreation vehicle sites at San Bernard NWR; include additional facilities at both locations	Same as A, plus construct additional facilities at Brazoria NWR
Administrative Facilities	A variety of administrative / maintenance facilities available at various Refuges	Construct new administrative / maintenance facilities at various refuges	Same as Alternative B
Budget	Base Funding: $2.9M Fire Funding: $788,000 Other: $ 410,000 (Project Specific Funding)	In addition to Alt. A: $1.7M Project Funding: $213,000 Staff Salaries: $200,000	Addition to Alt. A: $1.7M Project Funding: $220,000. Staff Salaries: $200,000.
Staff	26 FTEs	In addition to Alt A: 7 FTEs	In addition to Alt. A: 7 FTEs

Table EA 2-4. Mitigation Measures and Monitoring

Mitigation Measure and Monitoring Description	Alternatives
General	
Gather updated resource baseline data to form a current analytical base from which to judge future management impacts and effects.	A, B, & C
Develop and implement an extensive and ongoing monitoring program to judge management action effectiveness and provide alternative solutions that would decrease any short-term or long-term negative impacts on fish and wildlife resources and other environmental elements.	A, B, & C

Mitigation Measure and Monitoring Description	Alternatives
Regulate management actions to address any potential impacts. For example, activities would be conducted during times of the year and in areas where breeding and nesting activities are at a minimum.	A, B, & C
Prohibit or restrict activities in areas where listed species occur. The potential effects of CCP implementation on federally-listed species has been reviewed per an Intra-Service Section 7 Consultation (See Appendix F).	A, B, & C
Seek public input in future planning for any management actions that are considered major federal actions, as per NEPA requirements.	A, B, & C
Air Quality	
For prescribed burning the following precautions would be in place: habitat management involving prescribed burning will occur only under ideal weather conditions and smoke management practices will be implemented during all burning events; an approved Prescribed Burn Plan, favorable weather conditions, and adequate firefighting resources all work together to prevent pervasive air pollution or from affecting air quality.	A, B, & C
Water Management and Quality	
Avoids spraying during or immediately before a rainfall event to reduce the chances of run-off and herbicide delivery to water resources.	A, B, & C
Agency-approved application practices and guidelines will be implemented during all prescription events and under an approved plan to prevent or minimize effects to water quality.	A, B, & C
Conduct water sampling on all potable waters on the Complex. Multiple water quality sampling and analysis occurs in the surface waters on and around the Complex.	A, B, & C
Soils	
Erosion fences will be established on construction sites when erosion is a concern. If heavy sediment deposits occur in water, maintenance workers will use excavators to pull sediment and move it back into place.	A, B, & C
Habitats	
Take a proactive approach to working with information provided through biological surveys, inventories, and monitoring including monitoring of invasive species and prescribed burning to determine changing conditions and vegetation associated with climate change or other potential impacts.	A, B, & C
Wildlife	
The Complex will coordinate with Coastal Prairie Conservation Initiative and others to maximize outcomes and success of prairie restoration efforts.	A,B, & C
The Complex will continue to monitor area beaches for nesting sea turtles in coordination with Padre Island National Seashore.	A, B, &C
The refuge management methods would not result in direct take of any species of conservation concern and vegetation clearing activities would not occur during general bird nesting season, March through August.	A, B, & C
Oil and Gas Activities	

Mitigation Measure and Monitoring Description	Alternatives
Each refuge will work with oil and gas companies to ensure that to the greatest extent practicable, all exploration, development, and production operations are conducted in such a manner as to prevent the damage, erosion, pollution, or contamination to the lands, waters, facilities, and vegetation of the area.	A, B, & C
The Complex will continue restoring marshland by planting smooth cordgrass in areas impacted by oil and gas activities.	A, B, & C

3.0 AFFECTED ENVIRONMENT

Refer to Chapter 3 of the Comprehensive Conservation Plan.

4.0 ENVIRONMENTAL CONSEQUENCES

This section analyzes and discusses the potential environmental effects or consequences reasonably expected by the implementation of each of the three alternatives described in Chapter 2 of this EA. The 15-year life of the CCP will portray each alternative and the expected outcomes.

This chapter identifies, describes, and compares the impacts of implementing the three alternatives proposed in this EA on the Complex's physical, biological, and socio-economic environment. Current management (Alternative A, the No Action Alternative) provides the basis for comparing the effects of the action alternatives (Alternatives B and C). This chapter analyzes the direct, indirect, and cumulative effects of each alternative as defined below in section 4.1.

The Complex conducted an analysis of the effects of management actions on the physical environment for air quality, water quality/quantity, and soils. It also conducted an analysis of the effects of management actions on the biological environment for vegetation/habitat, wildlife, and species of special concern (e.g., threatened and endangered species). Although all plant, animal, and fish species on the Complex are important, many species are not expected to experience any change—or at most, a negligible one—as a result of implementing any of the alternatives. For that reason, this chapter does not discuss all Refuge species.

An analysis of the effects of management actions on the socio-economic environment has been conducted for local populations and economy, recreational uses and facilities, scenery, oil and gas activities, natural and cultural prehistoric and historic resources, and land acquisition. This chapter describes potential impacts in terms of type, duration, intensity, and context (scale). General definitions are as follows:

4.1 Definition of Terms

Effects

Direct effects are the impacts that would be caused by the alternative at the same time and place as the action.

Indirect effects are impacts that occur later in time or distance from the triggering action.

Cumulative effects are incremental impacts resulting from other past, present, and reasonably foreseeable future actions, including those taken by federal and non-federal agencies, as well as undertaken by private individuals. Cumulative impacts may result from singularly minor but collectively significant actions taking place over a period of time.

Impact Type

Beneficial impacts are those resulting from management actions that maintain or enhance the quality and/or quality of identified refuge resources or recreational opportunities.

Adverse impacts are those resulting from management actions that degrade the quality and/or quantity of identified refuge resources or recreational opportunities.

Duration of Impacts

Short-term impacts affect identified refuge resources or recreational opportunities; they occur during implementation of the management action but last no longer.

Medium-term impacts affect identified refuge resources or recreational opportunities that occur during implementation of the management action; they are expected to persist for some time into the future though not throughout the life of the CCP.

Long-term impacts affect identified refuge resources or recreation opportunities; they occur during implementation of the management action and are expected to persist throughout the life of the CCP and possibly longer.

Intensity of Impact

Negligible impacts result from management actions that cannot be reasonably expected to alter identified refuge resources or recreational opportunities at the identified scale; impacts are so small that they would not be measurable.

Minor impacts result from a specified management action that can be reasonably expected to have detectable though limited effect on identified refuge resources or recreation opportunities at the identified scale; impacts are detectable but would affect a small area.

Moderate impacts result from a specified management action that can be reasonably expected to have apparent and detectable effects on identified refuge resources or recreation opportunities at the identified scale; effects would be readily apparent and would occur over a relatively large area but are not extreme or excessive.

Major impacts result from a specified management action that can be reasonably expected to have readily apparent and substantial effects on identified refuge resources and recreation

opportunities at the identified scale; effects would be readily apparent and would substantially change the characteristics of the resource.

Scale of Impact

Site-specific effects are those impacts that occur solely within the project area (i.e., construction site or treatment area).

Localized impacts are those that would occur within and immediately surrounding the project area.

Refuge/Complex-wide impacts are those that would occur across the entire Refuge/Complex landscape.

Widespread impacts are those that would occur beyond the Complex landscape.

4.2 Effects Common to all Alternatives

Several potential effects will be very similar under each alternative, and they are summarized in this section.

Climate Change

The Complex considers carbon sequestration, a climate-related phenomenon, in planning. Vegetated land is a tremendous factor in carbon sequestration. Terrestrial biomes of all sorts—grasslands, forests, wetlands, tundra, and desert—are effective in both preventing carbon emission and acting as biological "scrubber" of atmospheric CO2.

In terms of climate change, conserving natural habitat for the Complex is the primary management focus for the CCP. The actions proposed in this CCP would conserve or restore land and habitat, and would thus retain existing carbon sequestration on the Complex. Additional conserved lands would ensure that development and loss of current carbon sequestration ability does not occur in the future. This in turn contributes positively to efforts to mitigate human-induced global climate change.

One Complex activity in particular, prescribed burning, releases CO_2 directly into the atmosphere from the biomass consumed during combustion. However, there is actually no net loss of carbon, since new vegetation quickly germinates and sprouts to replace the burned-up biomass and over time sequesters or assimilates an approximately equal amount of carbon as was lost to the air (Dai et al. 2006). Overall, there should be little or no net change in the quantity of carbon sequestered at the Complex from any of the proposed management alternatives. The use of green technology and products would reduce the Complex's carbon footprint.

Regional modeling of how long-term global warming patterns might emerge in the U.S. suggests that future climates along the Texas Gulf Coast could be very different from those of the past. Climate researchers used unique state-of-the art high resolution nested climate simulation models

to explore the importance of fine scale processes in determining climate change hotspots in the continental U.S. and Mexico (Texas Climate Initiative).

The occurrence of climate change hotspots in the U.S. was generally persistent in the southwestern U.S., including Texas. Northern Mexico was also a region of persistent, intense climate changes. Interestingly, the observed pattern of responsiveness was largely consistent between low and high-end emissions scenarios and throughout the 21st century. The persistence of the hotspot patterns observed in these regional climate modeling experiments suggest that the broad patterns of responsiveness observed may be robust to climate system variability. Changes in inter-annual variability, particularly of precipitation, were the primary drivers of peak climate changes in these modeling studies (Texas Climate Initiative).

The Service undertook an investigation of wetland trends and future conditions in response to a changing climate across three coastal units of the Complex.

The Complex assessed future wetland conditions spatially by modeling sea level inundation rates resulting from predicted sSLR from 2010 to 2100. Researchers derived low and high estimates of SLR used in the inundation model by combining two SLR prediction models for the region. Results of the sea level inundation model were stored in a GIS database and used to quantify potential impacts to existing wetlands at decadal intervals from 2010 to 2100. Results of the 1938/44–2008 trends analysis showed a significant increase of in-flow through (tidally influenced) wetland acres across the Complex. Results of the future conditions analysis predict that sea level rise will significantly alter or displace the majority of wetlands across the Complex between 2020 (71.03 percent of current wetland acres) and 2050 (87.10 percent of current wetland acres) (USFWS 2009). This will occur equally under all three proposed management alternatives evaluated in this EA.

Results of the 1938/44 to 2008 wetlands trends analysis tends to indicate subsidence and/or SLR had been occurring across the Complex prior to the significant impacts of climate change predicted today. The increase in the area of flow through wetland basins from 2872.79 (1938/44) acres to 4593.34 (2008) acres is an indication that the coastal wetlands of TMC have already been impacted by SLR to some degree. In addition to SLR, many climate change studies predict changes to tropical storm events, precipitation rates, and temperature levels at rates that can affect habitat conditions and distributions along the Gulf Coast. Combined with SLR, it is likely that tropical storm events will accelerate wetland impacts across the Complex by increasing wave action and erosion rates that will compound the conversion of coastal salt marsh to open bays. Changes in precipitation amounts and runoff may also impact wetlands. A decrease in freshwater inputs to coastal wetland systems resulting from reduced rainfall and increased upstream water usage from agriculture, urban, and industrial use may increase salinity rates and reduce sediment inputs to coastal wetland systems. Compounding this likelihood is a predicted temperature increase of >3˚F (HadCM2) to >7˚F (CGCM2), which could increase the annual surface water evaporation rates by more than a foot (Fang and Stefan 1999), further decreasing freshwater inputs and increasing salinity rates.

In response to past episodes of SLR, coastal wetlands have responded by migrating to adjacent uplands or building additional substrate to account for changes in water depth. Were this to

happen, it is unlikely that impacts to coastal wetland systems would be significant in a period of accelerated climate change. However, where migration of wetlands to higher ground is not possible because of existing human developments and land uses, coastal wetlands are likely to be diminished in extent or eliminated (Cahoon et al.1998). Using the results of the high inundation model, the Complex is predicted to lose 37,926 acres (36 percent of its total area) to open bay (seawater) conversion by 2100. This will eliminate 90 percent of the current wetlands on the Complex. While San Bernard and Brazoria NWRs will still contain a substantial portion of the upland land mass, it is not known if these areas are suitable for future wetland migration and formation or if the wetlands formed there would function at a level 24 of long-term productivity to offset predicted losses. The Complex may need to purchase additional lands suitable for inland wetland development to offset predicted wetland loss.

Again, these predicted long-term, climate-change-related impacts would occur regardless of which of the management alternatives under consideration here the Service ultimately selects. Over the 15-year life of the CCP, impacts associated with climate change are likely to be adverse, minor to moderate, and widespread.

Herbicide Application

Chemical herbicides are one of the methods the Service uses to control invasive plants on national wildlife refuges. Herbicides can efficiently and effectively suppress or kill unwanted plants and the Service uses them in such a manner as to minimize adverse effects on non-target resources. An herbicide suppresses or kills plants by decreasing their growth, seed production, and competitiveness (USFWS 2009b).

The Complex must weigh the benefits of herbicides in controlling invasive plants against the potential for exposure and impacts to human health, non-target organisms, and the environment. The federal and state governments regulate herbicides to ensure that they do not pose unreasonable risks. The EPA requires extensive test data from herbicide producers to show that their products are safe to use. EPA scientists and analysts carefully review these data to determine whether to register (license) an herbicide and whether certain restrictions on use are needed (USFWS 2009b).

EPA evaluates both exposure and toxicity to determine the risk associated with use of a given herbicide. Applications and subsequent movement may expose people, non-target flora and fauna, water, and soil directly or indirectly to herbicides; the refuge can minimize or avoid this exposure by following proper instructions and labels. For wildlife and humans, herbicides may enter the body through the skin, by swallowing, and by breathing. Once the refuge applies herbicides, the many biotic (living) and abiotic (non-living) processes that affect the fate of herbicides in the environment further influence the potential for exposure.

Herbicide use on national wildlife refuges must comply with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and other federal laws and authorities. The use of herbicides and other pesticides on refuges is governed by the U.S. Department of Interior Integrated Pest Management Policy (517 DM 1), the Service Pest Management Policy and Responsibilities (30 AM 12), and the Service Refuge Manual (7 RM 14).

The Service policies and Refuge Manual state that we will use herbicides only after full consideration of management alternatives including chemical, biological, physical, and no action. If after considering all of these factors managers determine that we must use herbicides to meet invasive plant management objectives, then we will use the least hazardous, most effective herbicides to meet those objectives (USFWS 2009b).

Refuge staff must complete a Pesticide Use Proposal (PUP) whenever we use a pesticide or herbicide on a refuge, including applications by staff, volunteers, contractors, or in association with a right-of-way easement or Special Use Permit. Individuals with duties related to plant management and knowledge and experience with herbicides typically complete and submit the PUP. An online PUPs database enables staff to complete and submit PUPs electronically at https://systems.fws.gov/PUPS/. Depending on the pesticide and other conditions listed in the PUP, the PUP may need Regional Office review and approval, and under some circumstances, the Regional Office may need to submit the PUP for Washington Office review and approval. PUPS that are part of an approved integrated pest management plan may receive five-year approvals. The Director periodically issues specific guidance that includes details about PUP approval authority and which herbicides and application scenarios require review beyond the field station.

Refuge managers or the project leader ensures that:

- Pest management decisions are consistent with all applicable policies, laws, and regulations.
- Anyone applying pesticides, releasing biological control agents, and conducting other Integrated Pest Management activities has the appropriate training and equipment necessary to protect their safety and health.
- We apply pesticides only after the appropriate reviewer approves the PUP.
- We establish threshold levels of damage or pest populations according to Service or refuge goals and objectives and applicable laws.
- Staff store, handle, and dispose of pesticides and pesticide containers in accordance with the label and in a manner that safeguards human, fish, and wildlife health and prevents soil and water contamination.
- Submit annual reports documenting pesticide use and efficacy into the online PUPs database (USFWS 2009b).

Each of the alternatives would follow the above procedures and each would use the same herbicides and have approximately similar rates of application. Environmental impact associated with herbicide use on the Complex would be both adverse and beneficial. Adverse impacts may occur from localized toxicity of non-target organisms (plant and animal), and would be short-term to long-term (short-term for any given application, but long-term if the applications are repeated regularly). Herbicides would also have negligible, short-term adverse impacts on water quality. They may potentially leach into and pollute groundwater and may flush into surface water if improperly applied. However, proper application under conditions specified on product labels and the use of best management practices minimizes movement of herbicides from their intended targets.

Beneficial impacts from herbicide application would also occur under each alternative. Benefits would result from control of invasive plants that threaten to infest large areas, displacing native species of flora and fauna; these beneficial effects would be long-term, Complex-wide, and of moderate intensity.

Petroleum Development Impacts

As noted in Section 2.3 of this EA, oil and gas exploration is occurring on four locations on the Complex. Operators are required to prevent, to the maximum extent possible, releases of hazardous materials and substances, crude oil, and produced water. Each operator and/or facility operator must have a current Oil Discharge Prevention and Contingency Plan outlining procedures for accidental releases. Sampling, remediation, and restoration of contaminated sites would be the responsibility of the operator and/or facility operator and would occur in consultation with the Service and the appropriate state agency. All sites no longer in use must be sampled for contaminants at the operator's expense to ensure proper disposal of material and that refuge staff and/or the visiting public are not exposed to contaminants. The Service may request that wells, roads, pipelines, and associated infrastructure and facilities not needed to support ongoing operations be removed and the sites restored to the satisfaction of the Refuge Manager.

Reasonable restrictions include restriction on time of year (October 15–March 15) for operations designed to minimize wildlife disturbance during the winter months; restriction on equipment to include low-pressure terra-tired vehicles or tracked equipment in the marshes and small "Bumble Bee" drillers in the bottomlands; and restriction of ATV use in marsh habitats. The Refuge Manager will negotiate the locations of production lines prior to drilling. Operators will generally place such lines along roadways, and directionally drill under wetlands or other sensitive environments. The Complex only permits closed loop drilling operations. All seismic operations must hire an environmental monitor, who is selected by the Refuge Manager and who reports to the Refuge Manager, to monitor all seismic operations and ensure minimal habitat damage. In Texas, the refuges may accept payment for restoration work required after the seismic operations. The refuges will then conduct restoration and monitoring efforts using those funds.

Petroleum exploration and extraction activities and facilities would impact each alternative equally. In summary, these impacts would be adverse, long-term, site-specific, and of negligible to minor intensity.

Cultural Resources

The Service is responsible for managing archeological and historic sites found on national wildlife refuges. Undertakings accomplished on the Complex have the potential to impact cultural resources. The consequences for cultural resources would be the same under each management alternative.

Although the presence of cultural resources, including historic properties, cannot stop a federal undertaking, the undertakings are subject to Section 106 of the National Historic Preservation Act. Thus, Refuge Managers and the Project Leader, during early planning, provide the Regional Historic Preservation Officer (RHPO) with: 1) a description and location of all projects, activities, routine maintenance and operations that affect ground and structures; 2) requests for permitted uses; and 3) alternatives being considered. The RHPO analyzes these undertakings for

potential to affect historic properties and enters into consultation with the State Historic Preservation Officer (SHPO) and other parties as appropriate. The Refuge Manager and/or Project Leader ask the public and local government officials to identify concerns about impacts caused by the undertaking in a notification that is at least equal to, and preferably with, the public notification carried out for NEPA and compatibility.

Impacts on cultural resources associated with each alternative would at most be negligible to minor, site-specific, and long-term.

Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" was signed by President Clinton on February 11, 1994, to focus federal attention on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities. The Order directs federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. Another intent of the Order is to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low-income communities with access to public information and opportunities for participation in matters relating to human health or the environment.

None of the three management alternatives described in this EA would disproportionately place any adverse environmental, economic, social, or health impacts on minority and low-income populations. The Complex anticipates that implementation of any alternative that includes public use and environmental education will provide a benefit to the residents residing in the surrounding communities.

Feral Hog Management

The detrimental impacts of feral hogs are well documented (West et. al. 2009). They damage native habitat by rooting and trampling. These activities result in compaction of soils, which influence plant regeneration, community structure, soil properties, nutrient cycling, and water infiltration. Feral hogs induce the spread of invasive plant species because invasive exotics typically favor disturbed areas and colonize more quickly than many native plants. Feral hogs compete with native wildlife for resources and cause direct wildlife mortality through nest predation and opportunistic consumption of birds, reptiles and amphibians. Feral hogs also vector many diseases that can be contracted by other animal species. Any increase in population would lead to adverse impacts on other wildlife species. Feral hogs increase the overall harvest yield losses incurred by farmers both on and off the refuges. Additionally, feral hogs cause damage to roads, levees, and public use areas by means of rooting, thus leading to equipment and vehicle damage used to maintain and travel these areas. They also pose health and safety risks due to disease and potential for vehicle accidents.

The management activities conducted on the Complex, (as described in the Feral Hog Management Plan), are necessary to reduce the impacts mentioned above. Activities that require use of vehicles or equipment may increase impacts to air quality due to emission. Impacts to

soils and vegetation would be expected from foot and vehicular traffic. However, these direct impacts to air, soil and vegetation would be negligible and short-term impacts. No impacts to water quality or quantity are expected from the proposed management activities. There would likely be some short-term impacts to non-target wildlife species (short-term disturbance and displacement) as a result of the activities involving vehicles, foot traffic and aerial shooting. These impacts, however, would be short-term, only lasting through the duration of the management activity.

Hogs that are killed by staff (i.e., law enforcement officers or professional sharpshooters) are quickly and humanely killed by an accurate shot to the neck/shoulder area. Special Use Permits and staff removal are outside of public view. Coyotes, vultures, and other wildlife, normally consume carcasses that are left where shot in remote areas, within one to two days. Carcasses near public use facilities are removed from public view.

The indirectly long-term impacts of feral hog management are expected to be beneficial to soil, water, vegetation, and wildlife as feral hog numbers are reduced. In addition, many predators and scavengers would benefit from the carcasses left in the field.

Fishing

Forty percent of the visitation on the Refuge Complex is for saltwater fishing. Visiting anglers enjoy some of the best fishing for redfish, spotted sea trout, black drum, sheepshead, and flounder in Texas. Brazoria NWR has three public fishing areas that allow land access to saltwater fishing. One boat ramp is located on the west bank of Bastrop Bayou, off CR 227, and another ramp is located off CR 257 on the refuge's southwestern boundary. San Bernard NWR has one fishing area—Cedar Lake Public Fishing Area offers an accessible fishing pier, a fishing trail that offers bank fishing and a public boat ramp that gives visitors access to Cedar Lake Creek. The Refuge allows saltwater fishing and crabbing in designated areas in accordance with applicable state and federal regulations. At Big Boggy NWR, public fishing is limited to the navigable waters of Boggy Creek and Lake and the portion of the Refuge bordering the GIWW.

Under each of the alternatives, the refuge would continue to allow fishing on all navigable waters from designated locations. The effects of each alternative would be identical. The effects of fishing and associated boating activities on migratory and shore birds include noise, harassment, and displacement. Compaction of vegetation may occur along the shores and along creeks from fisherman accessing fishing points. With the stipulations outlined below disturbances caused by fishing, including associated boating activities is not having an adverse impact on wildlife resources. Refuge staff monitor shorelines for erosion. Trash is the single greatest impact on the refuges associated with this use.

Under each, the impacts on Complex fishing opportunities would be beneficial, long-term, widespread, and of moderate intensity.

Refuge Revenue Sharing

Annual Refuge revenue-sharing payments to Brazoria, Matagorda, and Fort Bend counties, Texas, would continue at similar rates under each alternative. If the Complex acquires and adds lands to the refuges, the payments would increase accordingly.

Indian Trust Assets
The Complex has identified no Indian Trust Assets on its lands. There are no reservations or ceded lands present. Because the Complex does not believe resources are present, it does not anticipate impacts to result from implementation of either alternative described in the EA.

Other Common Effects
None of the alternatives would have more than negligible or at most minor effects on geology, topography, noise levels, transportation, waste management, or human health and safety.

4.3 Physical Environment

4.3.1 Impacts on Air Quality

Each of the alternatives would implement the following mitigation measure to protect air quality: For prescribed burning, the following precautions would be in place: habitat management involving prescribed burning will occur only under ideal weather conditions and smoke management practices will be implemented during all burning events; an approved prescribed burn plan, favorable weather conditions, and adequate firefighting resources all work together to prevent pervasive air pollution or unnecessary effects on air quality.

The analysis below assumes implementation of this mitigation measure to protect air quality.

Alternative A—No Action Alternative
Existing conserved lands provide important beneficial impacts on regional air quality by providing open space and vegetated habitats. The forests, wetlands and prairies serve as air filters, filtering out particulates, aerosols, and other pollutants, thus improving air quality in the region. Mature bottomland forests sequester carbon in the leaves, stems, trunks and roots of woody plants. It has been estimated that an acre of maturing Columbia Bottomland forest will sequester 131 tons of carbon. Conservation of existing refuge units is beneficial, long-term, minor to moderate, and widespread.

Management actions and activities associated with Alternative A that could potentially affect air quality include prescribed fire, farming operations, equipment and vehicle operation, and landscape conservation.

Refuge staff would use prescribed fire Complex-wide to manage, enhance, or restore habitats and reduce hazardous fuels. Table 2-1 shows the prescribed fire schedule for the Complex. Annually, Brazoria NWR would burn on average about 10,600 acres, San Bernard NWR about 8,200 acres, and Big Boggy NWR about 1,900 acres. Prescribed fire would have generally minor, sometimes moderate, adverse impacts that are short-term in duration at the local to widespread scales due to smoke emitted from burning vegetation. Smoke consists of particulate matter, aerosols, soot, and a variety of gases, all of which degrade air quality when they are present. In brush and grass vegetation types, smoke would dissipate rapidly and smoke should disappear shortly after the fire burns down; long-lasting smoldering would not be a problem. Generally, whenever weather conditions allow for prescribed burns, air masses are not stagnant,

and smoke will rise and disperse, minimizing impacts on ground level air quality, visibility, and human health.

Brazoria NWR would continue to use cooperative farming on 10 farm fields comprising 1,000 acres; of these 1,000 acres, the Refuge farms three fields of approximately 220–350 acres in a given year with the remaining seven units left fallow. San Bernard NWR would continue to farm a single 10-acre plot. Big Boggy NWR would farm a total of 90 acres of rye grass for winter browse for waterfowl through force account at Mathis Field. Exhaust from farm equipment and fugitive dust produced by the use of agricultural machinery (e.g., tractors and plows) during discing and harvest may both produce negative short-term direct effects to air quality. These farming operations would continue to result in some negligible short-term negative impacts on air quality at the local scale since the refuge only farms up to 350 acres and the total Complex is approximately 44,044 acres. In preparation and harvest of all farming operations, the use of two tractors for less than two months out of the year will have negligible impact on air quality within the Complex.

Dust and emissions produced by equipment and vehicle operation associated with construction such as road maintenance would be minor and localized. Performing work during times of low to no wind would abate blowing dust. Furthermore, most construction occurs as maintenance to already existing facilities or infrastructure that is small scale and localized. During extremely dry periods, the Complex would water down heavily used unpaved roads to reduce fugitive dust emissions.

Herbicides are an important management tool used to gain an upper hand on the war against the many aggressive non-native flora. Table 2-2 identifies chemicals and target species. Brazoria NWR would continue to treat 1,600–2,500 acres with Grazon P+D and Grazon Next Generation through aerial application. San Bernard NWR would use the same chemicals as Brazoria NWR and treat approximately 100 acres annually. The Complex conducted no chemical treatments on Big Boggy NWR, but the option to use them if deemed necessary would still be available in the event of a Chinese tallow outbreak. The majority of these treatments would be aerial application, but the Complex may use hand, backpack, and boom sprayers on a variety of target species. Performing work during times of low wind would abate non-target species and maximize chemical efficiency. Spraying chemicals to treat target fauna may produce negative short-term direct effects to air quality.

The Complex does not anticipate any other Refuge management activities or public uses to adversely affect air quality to any appreciable degree.

Important beneficial impacts from Alternative A on regional air quality would accrue from the Complex's continuing management of tens of thousands of acres of open space and vegetated habitats. The forests, fields, and marshes on these conservation lands serve as air filters, filtering out particulates, aerosols, and other pollutants, thus improving air quality in the region.
In summary, Alternative A would entail both adverse and beneficial impacts on air quality on the Complex. Impacts from prescribed fire would be adverse, short-term, minor to moderate, and localized to widespread. Impacts from farming and vehicular operation would be adverse, short-

term, negligible to minor, and localized. Overall impacts from habitat conservation and management would be beneficial, long-term, minor to moderate, and widespread.

Alternative B—Proposed Action

Alternative B would conserve and restore additional habitat acreage, with a focus on bottomland hardwood forests and prairies. By conserving additional habitat and filtering foliage, this alternative would be more beneficial for air quality than Alternative A. These benefits would be long-term, moderate, and widespread.

Alternative B would have the same amount of prescribed fire but would have a slightly higher (from 1,000 acres to 1,200 acres) use of herbicides that would have short-term, localized air quality impacts. Although these adverse impacts would be slightly greater (from 1,000 acres to 1,200 acres) than Alternative A, they would still be considered adverse, short-term, minor to moderate, and localized to widespread.

Alternative B would conserve and restore additional habitat acreage, with a focus on bottomland hardwood forests and prairies. By conserving more habitats and filtering foliage, this alternative would be slightly more beneficial for air quality than Alternative A.

Alternative C

This alternative would keep prescribed fire use the same and reduce farming, leading to lower air emissions from exhaust and fugitive dust. Overall, adverse impacts of Alternative C on air quality from the same actions and activities would still be approximately the same as Alternative B.

The beneficial impacts on air quality from habitat conservation, management, and restoration would be the same as Alternative B. These benefits would be long-term, moderate, and widespread.

4.3.2 Impacts on Water Resources

Each of the alternatives benefits water resources, both in terms of quality and quantity, simply by maintaining and conserving large areas of healthy, vegetated habitats that protect soils and waters. These vegetated habitats filter out contaminants, minimize erosion, turbidity, and sedimentation, and regulate water flows by serving as “sponges” that soak up rainfall and slowly release moisture over the following days and weeks.

Each of the alternatives would implement the following mitigation measures to protect water quality:

- Avoid spraying during or immediately before a rainfall event to reduce the chances of run-off and herbicide delivery to water resources.
- Implement agency-approved application practices and guidelines during all prescription events and under an approved plan to prevent or minimize effects to water quality.
- Conduct water sampling on all potable waters on the Complex. Multiple water quality sampling and analysis occurs in the surface waters on and around the Complex.

The analysis below assumes implementation of these mitigation measures to protect water quality.

Alternative A—No Action Alternative

The following activities would continue under Alternative A and could potentially have impacts on water quality: erosion prevention measures, farming, invasive species control, herbicide use, and oil and gas operations. Section 4.2 discussed herbicide use and oil and gas operations above in "Effects Common to All Alternatives."

The Complex would continue to engage in management activities and maintain facilities that reduce erosion and prevent saltwater intrusion on all three refuges. Such facilities would include bank armoring by use of concrete block/mats and large concrete slabs used as riprap.
The Complex would construct and use a variety of structural and some restoration techniques at various locations. Brazoria NWR projects include two miles of bank armoring by use of concrete block/mats along the GIWW and shoreline riprap along 2,000 feet of Cox Lake and 100 feet at Salt Lake. San Bernard NWR projects include large concrete slabs serving as riprap along the south end to protect 1,500 feet of levee from wind-driven wave action and to encourage sedimentation of the marsh and plugging small tidal channels. Big Boggy NWR would continue to install riprap to slow down erosion at Dressing Point Island. These activities would result in increased sedimentation and turbidity during construction, but these impacts would be minor and short-term; long-term benefits would outweigh these short-term adverse impacts. These efforts would help protect freshwater quality, present saltwater intrusion, and reduce erosion and sedimentation, and would thus represent a long-term, localized beneficial effect on the Complex's hydrology.

The cooperative farming operation and moist soil units on Brazoria NWR would continue to maintain 1,000 acres of farmland, of which only 220 to 350 acres would be farmed annually. This operation has the potential to cause short-term, negligible to minor, localized (only within and around specific farm units) to widespread adverse impacts to water quality. Ground-disturbing farming operations such as crop planting and discing using tractors may churn and expose bare soils to direct rainfall; they have the potential to increase erosion, thereby resulting in higher levels of sediments reaching area water bodies. This siltation could adversely affect water quality of these water bodies locally and downstream during and after storm events; however, the area's virtually flat topography reduces erosive potential, and the amount of soil matter reaching watercourses as suspended sediments is likely to be relatively small.

Overall, these adverse impacts on water quality from Alternative A are likely to be negligible to minor, localized, and short-term. The Complex's habitat conservation efforts and erosion control measures would have beneficial, moderate, long-term, and widespread effects on water quality (extending beyond the boundaries of individual refuges).

Alternative B—Proposed Action

Under Alternative B, there would be greater efforts to address erosion and saltwater intrusion than with Alternative A. Brazoria NWR would rehabilitate the Salt Lake weir and increase cooperation with ACOE to establish up to seven additional beneficial dredge projects and approximately 10 miles of bank armoring along the GIWW. This refuge would also explore the

option of planting smooth cordgrass to reduce erosion. San Bernard NWR would also increase cooperation with ACOE to identify and implement two beneficial dredge sites and approximately six miles of bank armoring or installation of break waters along the GIWW with breakwaters preferred. Big Boggy NWR would install reef domes and/or geotubes to stabilize erosion of Dressing Point Island. There would be minor short-term adverse impacts (increased sedimentation and turbidity) during project construction; however, these actions would expand water resource benefits provided by Alternative A.

Increasing cooperative farming and moist soil acreage at Brazoria NWR to 350-400 acres annually has the potential to increase short-term, localized to widespread adverse impacts to water quality from increased erosion, turbidity (suspended sediments), and sedimentation. However, as noted above, the area is flat topography tends to minimize erosion and sedimentation; therefore, the intensity of these impacts would still be negligible to minor. Since Alternative B would eventually protect more riparian lands and conserve their bottomland hardwood forests which filter surface and ground water, than Alternative A, its long-term beneficial impacts on water quality and resources would be greater than Alternative A's.

Overall, Alternative B, like Alternative A, would cause both adverse and beneficial impacts. Its adverse impacts would be greater than Alternative A's. Its beneficial impacts would be greater than Alternative A's.

Alternative C

Alternative C would maintain and develop structures like Alternative B, but would diversify the types of structural and restorative techniques used. Brazoria NWR would construct a breakwater structure made of riprap, reef domes, or geotubes) to Lost Lake to increase sedimentation behind the structure and prevent further erosion. San Bernard NWR would increase bank armoring or installation of breakwaters along the GIWW to 10 miles of shoreline protected.
Big Boggy NWR would expand Dressing Point Island using geotubes, beneficial dredges, and breakwaters, as well as working with ACOE to implement two beneficial dredge sites off-refuge on the opposite side of the GIWW and install approximately two miles of bank armoring or breakwater. There would be adverse, short-term direct impacts during construction. However, the long-term effects would be beneficial for water resources and quality, as engineers design these structures to restore and protect areas from further erosion.

Under Alternative C, Brazoria NWR would reduce the cooperative farming program to 500 acres, and only farm 150–200 acres annually, restoring the remaining acres to coastal prairie. San Bernard and Big Boggy NWRs would eliminate agricultural activities altogether. These actions could potentially further reduce the erosion and localized water pollution from siltation and turbidity associated with agriculture in this flat area.

Overall, Alternative C would have fewer adverse impacts on water quality than Alternative B due to reduced farming. Adverse impacts would be negligible to minor, localized, and short-term. Alternative C's beneficial impacts on water quality would be greater than Alternative A and B's due to the increased land conservation (Alt. B & C) and a greater level of effort to reduce erosion and saltwater intrusion.

4.3.3 Impacts on Soils

Each of the alternatives would implement the following mitigation measure to protect soils:

- Establish erosion fences on construction sites when erosion is a concern. If heavy sediment deposits occur during construction in water, maintenance workers will use excavators to pull sediment and move it back into place.

The analysis below assumes implementation of this mitigation measure to protect soils.

Alternative A—No Action Alternative

Habitat conservation (of bottomland hardwood forest and other habitat) has beneficial effect on soils. Vegetation catches rainfall before it strikes the ground and roots hold the soils in place. Impacts from conserving natural habitats, which protect the soil surface and prevents erosion, would be largely beneficial, long-term, minor to moderate, and widespread. Over considerable time, conserving the protective cover provided by vegetation gives soils a chance to develop, improving both fertility and depth.

The following management activities, which would continue under Alternative A, could potentially have impacts on the Complex's soils: construction activities, road maintenance, prescribed fire and fire suppression, farming, public use facilities, wildlife foraging such as geese eat-outs and feral hog foraging, and habitat conservation. All but the last of these activities would have adverse effects on soils; the final (habitat conservation) would have a beneficial effect.

Construction activities (including excavation), road maintenance, farming, as well as some fire suppression and prescribed fire activities all have the potential to disturb, compact, or disrupt and move soils. This can happen by means of bulldozer blades, front-end loader buckets, tractor discs, or by means of treads or tires. These activities expose soils to potential wind and water erosion; however, the flat topography of the three refuges minimizes the risk of erosion and soil loss.

Geese eat-outs and feral hog foraging can disturb soils as well. Geese eat-outs happen when a large flock of wintering geese eats most or all of the vegetation in a confined area, exposing the soils beneath. A secondary factor is that their fecal matter would fertilize these same soils, and if not over-fertilized or "burned," this could assist in the recovery of vegetation on the site. The high feral hog population foraging across the refuges in many habitats causes widespread soil disturbance due to their particular feeding habits, namely their aggressive rooting behavior, which rips up extensive areas. While this is certainly damaging to vegetation and native plants, the amount of damage it causes to soils proper is unclear, because once more, the area's flat topography does not facilitate soils erosion and transport offsite. The Complex's ongoing efforts to control feral hog populations helps keep this potential damage in check.

Impacts from conserving Complex habitats and ground cover, which protects the soil surface and prevents erosion, would be largely beneficial, long-term, minor to moderate, and widespread. Over considerable time, conserving the protective cover provided by vegetation gives soils a chance to develop, improving in both fertility and depth.

Overall, Alternative A would lead to both adverse and beneficial effects on the Refuges' soils. Adverse effects would tend to be negligible to minor, localized to Complex-wide, and mostly short-term. Beneficial effects would be minor to moderate, Complexe-wide, and long-term.

Alternative B—Proposed Action
Under this alternative, a larger amount of land would be conserved, which would result in beneficial impacts to soils over a larger area.

Impacts that result from implementing refuge management activities would be similar those discussed under Alternative A; the type of impacts would be the same with varying degrees of soil disturbance depending on the amount and location of management actions. Overall, the impacts would be adverse and beneficial, negligible to minor, localized, and short term.

Alternative C
Impacts from implementing Alternative C would be similar but not identical to Alternatives A and B. The reduction in farming acreage at Brazoria NWR and elimination of farming at San Bernard and Big Boggy NWRs would reduce the amount of soils subjected to the repeated stresses of discing, disturbance, exposure, fertilizers, and herbicide. Over time, subjecting soils to intensive agriculture tends to degrade them by reducing fertility, nutrient availability, and depth, and increasing compaction and possible contamination. The farming acreage is a small fraction of the total acreage of soils on the three refuges, but this would still constitute a reduced adverse impact on soils from the other two alternatives.

In general, under Alternative C, adverse effects (from reducing in farming acreage) would be less than Alternatives A and B, and beneficial effects (from habitat conservation) would be about the same. In summary, Alternative C is more beneficial than Alternatives A and B.

4.4 Biological Environment:

4.4.1 Impacts on Prairie Habitats

Alternative A—No Action Alternative
Under Alternative A, impacts on prairie habitats would result from the use of habitat management and restoration techniques (including prescribed fire and cooperative haying), mechanical and chemical treatments of invasive species, feral hog control, visitor and facilities use and management, and oil and gas development. Section 4.2 above describes impacts of oil and gas development.

The Complex would continue to prohibit grazing on all three refuges. The Complex would also continue to use mechanical, chemical, and prescribed fire treatments to control salt cedar, Chinese tallow, deep-rooted sedge, trifoliate orange and Japanese honeysuckle, and any additional invasive species on an as-needed basis. The Complex would conduct cooperative haying. Native prairie restoration activities would occur on Brazoria and San Bernard NWRs. These refuges would actively restore old fields and coastal prairie through a combination of chemical, mechanical, fire, and planting of native prairie seed. Once restored, they would use

fire to maintain the habitat, mimicking natural fire regimes. Regular fires every few years can prevent the encroachment of woody plants that could eventually take over a prairie and replace it with scrub or woodland. The Complex would continue to control feral hogs through a variety of means including issue special use permits for feral hog hunting with the aid of hounds or trapping, collaborative youth hunts and aerial shooting . While this would not be enough to eradicate feral hogs from the Complex, it would help control their numbers and thus adverse impacts to native prairie habitats from the hogs' rooting behavior, which damages and destroys native prairie fauna.

Existing visitor use facilities and management/administrative infrastructure, including buildings, parking lots, trails, and over 50 miles of roads occupy land surface area. These developed lands represent a small fraction of the total area of the three refuges. Fragmentation and loss of coastal prairie habitat due to development is an issue in and around the refuges. The Complex addresses this issue through its acquisition and restoration programs, which provides unfragmented habitat for wildlife.

Overall effects from Alternative A on prairie habitats at the Complex would be both adverse and beneficial. However, the beneficial effects greatly exceed the adverse effects. Adverse effects would be minor, long-term, and localized to refuge-wide. Beneficial effects would be moderate, long-term, and refuge-wide.

Alternative B—Proposed Action

Under Alternative B, impacts on prairie habitat would result from the same actions and activities listed under Alternative A. However, Alternative B would be more beneficial than Alternative A as described below.

This management alternative would incorporate limited livestock grazing throughout the Complex as a management tool for specific issues, such as invasive species management (of both exotic species and aggressive native plants). San Bernard NWR would increase mechanical treatment to approximately 100 acres annually and increase use of prescribed fire to approximately 1,000 acres per year. Chemical application would continue to be the same as Alternative A. Feral hog management would continue as described in Alternative A. Brazoria NWR would increase the cooperative haying program up to 75 total acres to increase the wildland urban interface buffer area where it cannot implement prescribed fire due to the presence of houses adjacent to the refuge boundary.

The Complex would establish a one-mile long trail across from the Brazoria NWR Field Office to support other wildlife dependent recreational activities and would result in direct loss of less than an acre of prairie habitat. Other prairie restoration activities would be the same as Alternative A; however, Brazoria NWR would establish partnerships for native prairie seed harvest. Seeds would be collected from refuge prairies and used to restore other coastal prairie habitats on the refuge; approximately 600–800 acres of prairie annually.

San Bernard NWR would also implement monitoring on prairie restoration areas listed in Alternative A.

Overall, Alternative B would be more beneficial for prairie habitat than Alternative A.

Alternative C

Under Alternative C, impacts on prairie habitat would result from the same actions and activities listed under Alternatives A and B. However, Alternative C would be more beneficial for native prairies than either Alternative A or Alternative B, as described below.

The refuge would manage invasive species under Alternative C the same as Alternative B, but Brazoria NWR would allow limited bison grazing under Alternative C instead of livestock as a management tool for specific issues, such as invasive species or controlling aggressive natives. The refuge would manage grazing with bison on a year-round basis across the larger coastal prairies rather than seasonally as with livestock. Bison may be moved into a small part of a larger pasture using an electric fence to obtain the desired habitat outcome, for instance in a moist soil unit to control phragmites. Management of feral hogs would be the same as Alternative A; however, Brazoria and San Bernard NWRs would open refuges to a general feral hog hunt. Cooperative haying and prairie restoration would be the same as Alternative B. However, Brazoria NWR would develop a seed bank on 500 acres of native prairie to collect and distribute native prairie seed to increase restoration efforts across the ecosystem to include off-refuge locations.

Overall, Alternative C would be more beneficial for prairie habitat than either Alternative A or Alternative B.

4.4.2 Impacts on Wetland and Aquatic Habitats

Alternative A—No Action Alternative

Many ongoing refuge management activities that would continue under Alternative A—including prescribed fire, restoration, management of invasive species, and provision of additional water—have beneficial and adverse impacts on wetland and aquatic habitats as described below.

The Complex would continue to use mechanical, chemical, and prescribed fire treatments to control salt cedar, Chinese tallow, deep-rooted sedge, and any additional species on an as needed basis. The Complex would continue to control feral hogs with various means, particularly aerial shooting in marsh and prairie habitats in and around wetlands. Brazoria NWR would continue to restore the wetland component of wet prairie mostly by reshaping and building up ditch borrows material. The refuge would install water control structures to manipulate water levels in the prairie. In addition, it would rebuild water delivery canals and levees around farm field/moist soil units to improve water management and movement capability across the units.

Brazoria and Big Boggy NWRs would continue to maintain irrigation canals on the refuges for water delivery and movement. They would capture freshwater from rice fields and provide wetland habitat below the rice fields. Brazoria NWR would continue to manage three irrigation wells. During drought situations, the small 4-inch pump at Teal Pond may provide the only freshwater in the Big Slough area. The Complex can also divert water from this pump to Teal, Olney, or Crosstrails Ponds. San Bernard NWR would continue to use two large irrigation wells

regularly. The 8-inch well at Wolfweed is a backup to the Cedar Lake Creek diversion pump and the Refuge would use it when Cedar Lake Creek is salty. The refuge would use a 10-inch pump at Sargent to provide fresh water in the moist-soil units in the Pentagon Marsh, which is essential to providing freshwater in this salt marsh habitat.

All refuges on the Complex would continue to manage moist soil units and fields with a combination of draining and summer discing, using a stubble roller while flooded. The reservoirs are generally self-sustaining but may be drained and refilled with saltwater to control encroaching vegetation. Brazoria NWR would continue to manage 23 fields/ponds for freshwater habitats. San Bernard NWR would continue to maintain two reservoirs, eight moist soil units, and two ponds. Big Boggy NWR would continue to manage four moist soil units.

Existing administrative and public use roads and trails occupy a small fraction of the total area of wetlands across the three refuges. The Complex conserves additional wetlands and aquatic habitats through the acquisition program in addition to forested habitat.

Overall, Alternative A would result in both adverse and beneficial impacts on wetland and aquatic habitats. Adverse effects would be minor, long-term, and localized to refuge-wide. Beneficial effects from the actions described above would be moderate, long-term, and refuge-wide to widespread.

Alternative B—Proposed Action

Under Alternative B, both adverse and beneficial impacts on wetland and aquatic habitats would occur from the same actions and activities as under Alternative A. However, Alternative B would be more beneficial for wetlands and aquatic habitats than Alternative A due to the additional actions described below.

San Bernard NWR would increase mechanical treatment in salty prairie from 50 to approximately 100 acres annually and increase use of prescribed fire from 400 acres to approximately 1,000 acres per year. Chemical application would continue to be the same as Alternative A, which is less than 200 acres annually. Feral hog management would be the same as Alternative A. Water management would be the same as Alternative A; however, there would be drilling of additional wells and development of new/rehabilitated existing water control structures. The Complex would continue to purchase water on an as-needed basis, as described in Alternative A. Brazoria NWR would drill an additional well in Farm Fields. San Bernard NWR would rehabilitate two existing irrigation wells. Rehabilitation of these wells would involve clearing out the well and determining the reason for low water flow. The refuge would add one additional well for Mocassin and Rail Pond while Big Boggy NWR would add an irrigation well at McCoach Unit.

Big Boggy NWR would rehabilitate levee and water control structures at Matthes Pond and Mallard Pond. San Bernard NWR would rehabilitate levees and level the west and middle units of Wolfweed Wetlands to improve management capability. San Bernard NWR would explore expansion of Wolfweed Wetlands and increase management capabilities at Sargent Pentagon Marsh by establishing two additional moist-soil units totaling 120 acres and water canals. Brazoria NWR would construct water diversions along ditches and canals to capture more runoff

water. The refuge would install lift pumps and check dams in drainage ditches. Big Boggy NWR would clean out existing water delivery canals and drainage ditches to increase freshwater availability.

Land conservation would benefit wetland and aquatic habitats. Many conserved tracts include conservation of waterways, and seasonally flooded swales. Bottomland forests filter surface and ground water, which improves water quality in waterways and basins, including the Bays and estuaries.

Impacts to wetlands and aquatic habitats would also include construction of a 600-foot boardwalk across from Brazoria NWR Field Office. Overall, Alternative B would be more beneficial for wetlands and aquatic habitats than Alternative A.

Alternative C

Alternative C includes the same management actions and activities that may affect wetlands and aquatic habitats both adversely and beneficially as Alternatives A and B.

Under Alternative C, management of water purchases, irrigation wells, ponds, reservoirs, moist soil units, and water delivery canals would be the same as Alternative B; however, Brazoria NWR would explore the option of purchasing water rights so that we would not have to rely heavily on annual water purchases from the water authority to flood seasonal wetlands. Brazoria NWR would also increase partnerships with Ducks Unlimited and Velasco Drainage District to increase freshwater availability through canal improvements. This will improve the Refuge's ability to manage wetlands for the benefits of waterfowl.

Overall, Alternative C would be more beneficial for wetlands and aquatic habitats than Alternatives A and B.

4.4.3 Impacts on Bottomland Hardwood Forests

Alternative A—No Action Alternative

Under Alternative A, the current levels and type of management activities for bottomland hardwood forests would continue. Current management includes restoring hydrology, planting of native hardwood species, allowing natural regeneration, and controlling invasive species. Restoring hydrology would ensure that bottomland hardwood forests have the levels of standing, flowing, and groundwater they need, and during the right seasons. Planting of native hardwood species would emphasize native species that offer benefits to wildlife, such as oaks. The Complex would continue to allow natural regeneration in those instances where staff judge that native species will predominate. Staff would also control invasive species to prevent them from displacing and outcompeting natives. Trail maintenance supporting public use (hunting, wildlife observation, wildlife photography, hiking) through bottomland hardwood forests result in minor, site-specific impacts.

The Complex maintains thousands of acres of bottomland hardwood forests, a disappearing habitat on the Texas Gulf Coast due to extensive urban, suburban, industrial, and agricultural development. Existing visitor use facilities and management/administrative infrastructure,

including buildings, parking lots, and trails occupy land surface area. These developed lands represent a small fraction of the total area of bottomland forest.

Currently, emphasis in land acquisition focuses on bottomland hardwood forest and associated wetlands and prairie habitats. The Complex is currently working on updating the LPP to expand the acreage within the acquisition boundary from 28,000 to 70,000 acres. These additional acres would have a long-term beneficial impact to the bottomland hardwood ecosystem.

Overall, Alternative A's effects on bottomland hardwood forests would include both adverse and beneficial impacts, though the latter would far outweigh the former. Adverse impacts would be minor, long-term, and localized to refuge-wide. Beneficial impacts would be moderate, long-term, and widespread.

Alternative B—Proposed Action
Under Alternative B, the acreage of conserved bottomland forest would increase and therefore ensure that natural diversity is sustained across the ecoregion. The overall benefit of conserving additional bottomland habitat will ensure its preservation into the future. The hydrology is preserved to the extent possible insuring future diversity of plants and animals. Overall, Alternative B's effects on bottomland hardwood forests would include both adverse and beneficial impacts, though again the latter would far outweigh the former. Overall, the net benefits for migratory birds associated with Alternative B would greatly exceed those of Alternative A.

The same management actions and activities that occur on existing bottomland hardwood forests under Alternative A would likely occur under Alternative B. Due to the costs and personnel required to maintain public use programs, these programs are limited to only a few tracts, where the use is at such a level that the benefit to the public to have trails, and other opportunities. Invasive species management is required to some level on all bottomland tracts. Nearly all tracts are intersected by pipeline, road, electrical line and other right-of-way easements. These are all conduits for invasive species and non-native species that threaten natural bottomland diversity.

Overall, Alternative B would be more beneficial, moderate, long-term and widespread than Alternative A.

Alternative C
Same as Alternative B.

4.4.4 Impacts on Migratory Birds

Alternative A—No Action Alternative
Alternative A would manage a variety of habitats for resting, feeding, and reproductive purposes for the benefit of migratory birds. Tools and techniques used on behalf of migratory birds would include prescribed fire, moist soil management, farming, research (primarily on mottled ducks, yellow and black rails, wintering and migratory songbirds), water management, and rookery management. These habitat management activities result in short-term adverse impacts (temporary disturbance and displacement) to resident wildlife; however, these impacts would be

of short duration and the benefits of the resulting habitat improvements would outweigh these adverse impacts. Each of these management tools/techniques would be used explicitly to maintain and restore habitats that would benefit migratory waterfowl, neotropical migrants, and other migratory birds. Prescribed fire would maintain open habitats and encourage vigorous growth that foraging birds use. The Complex manages moist soil management and farming specifically to provide carbohydrate and protein-rich foods for wild birds, which are important in helping them gain weight and strength while they are wintering on the Complex. Water management provides water to habitats and makes them more beneficial to migratory birds, both as sources of food and places to loaf, rest, and breed. Research helps generate knowledge and information that would lead to better resource management and decision-making on behalf of migratory birds. Rookery management protects known and active rookery sites for colonial nesting water birds from disturbance during the nesting season.

Under this alternative, there would also be certain adverse impacts from disturbance associated with public use programs, including hunting. The presence of hunters and other humans may agitate and disturb flocks of birds, placing them under energetic and psychological stress. Hunting will remove waterfowl from the population both directly through take and indirectly through wounding. Even wildlife watchers may inadvertently scare off large flocks of wintering geese, ducks, and other water-associated birds, causing them to use energy unnecessarily when they need to be feeding, resting, adding weight, and strengthening themselves for their long journeys northward to breeding grounds. These adverse impacts would be short-term to long-term, negligible to minor, localized but also potentially widespread throughout the central flyway.

Overall, Alternative A would have both beneficial and adverse effects. The beneficial effects from many different management efforts and actions would be moderate, long-term, and widespread. The adverse effects would be short-term to long-term, negligible to minor, localized but also potentially widespread.

Alternative B—Proposed Action

Like Alternative A, Alternative B would also manage a variety of habitats for resting, feeding, and reproductive purposes for the benefit of migratory birds, using the same tools and techniques discussed above.

Alternative B would also carry out additional actions that would affect migratory birds beneficially including the conservation of additional lands. To reduce erosion and saltwater intrusion, Alternative B would increase the types and amounts of structural and restoration techniques used. This alternative would increase the acreage of haying, increase the number of rehabilitation projects, and increase prairie restoration. It would incorporate additional moist soil units into the farming rotation at Brazoria NWR. Alternative B would drill additional wells on the Complex; these would provide additional water for irrigation and increase water management capacity on moist units and wetlands. This alternative would also develop new and rehabilitate existing water control structures. In order to manage invasive flora, it would increase the types and amounts of management prescriptions used, including limited and targeted livestock grazing. These combined habitat conservation, management, and restoration actions would have short-term adverse impacts (disturbance and displacement) during project implementation, but would

generally benefit a wide variety of migratory birds, from waterfowl to shorebirds and wading birds in the long-term.

Adverse impacts from hunting and other public uses would be the same as Alternative A: short-term to long-term, negligible to minor, localized but also potentially widespread.

Overall, the net benefits for migratory birds associated with Alternative B would exceed those of Alternative A.

Alternative C

As Alternatives A and B, Alternative C would also manage a variety of habitats for resting, feeding, and reproductive purposes, are benefiting migratory birds. Alternative C would use the same tools and techniques as the other two alternatives. However, it reduces the acreage dedicated to farming from 1,000 to 500 acres. Alternative C converts the reduction of 500 acres in farming back to prairie habitat, which would in turn reduce the amount of food and forage production for migratory and wintering waterfowl, and thus, the ability of the Complex to support the same large waterfowl numbers for extended periods. This would represent a minor to moderate, long-term, widespread adverse impact for migratory birds.

Overall, Alternative C would generate both adverse and beneficial impacts on migratory birds. Adverse impacts would result from both public use disturbance as well as a reduction in farming acreage and would be minor to moderate, long-term, and widespread. Beneficial impacts would result from prescribed fire, moist soil management, some farming, research, water management, and rookery management. These benefits, like those of Alternatives A and B, would be moderate, long-term, and widespread.

4.4.4 Impacts on Resident, Native Wildlife

Alternative A—No Action Alternative

Existing habitat management practices that support current populations and diversity of resident native wildlife would continue under Alternative A. These management practices include: constructing and using a variety of structural and some restoration techniques at various locations to decrease erosion and saltwater intrusion; controlling invasive plant species with mechanical, chemical, and prescribed fire treatments; hunting and trapping to control feral hogs; baiting and broad scale treatments to control non-native fire ants; rehabilitating wetlands and farm lands; restoring native prairie habitat; haying and farming (both cooperative and force account); restoring prairie pothole hydrology as opportunity arises; using established wells to provide freshwater to moist soil units during drought periods; purchasing water from various water authorities annually; and restoring previously drained wetlands. Since all of these actions would continue under this alternative, current levels of wildlife diversity and abundance should also continue through the life of the CCP.

Implementation of these management actions can result in minor short-term adverse impacts such as temporary disturbance and displacement of native wildlife; however, management specifically designed these actions to improve habitat conditions for the benefit of wildlife. Reducing erosion and saltwater intrusion would protect freshwater areas and marshes from conversion to brackish and salt marshes. A variety of vertebrates and invertebrates depend on

the maintenance of fresh water areas. Controlling invasive flora and fauna precludes or minimizes the displacement of native species. Cooperative haying helps maintain grasslands and stimulates growth of edible, nutritious shoots. Many native species forage on the Complex's farmlands. Restoring pothole hydrology would provide water and valuable edge habitat for a number of prairie and wetlands species. Irrigating moist soil units during drought periods would maintain their usefulness as important foraging grounds for many species of waterfowl, wading birds, marsh birds, and shorebirds.

Under Alternative A, no appreciable changes in populations or species diversity are expected. Wildlife population and habitat management on the Complex already renders considerable benefits for resident, indigenous wildlife, and these benefits would continue under this alternative. The adverse impacts from disturbance associated with public use programs such as wildlife observation, wildlife photography, and hunting (including direct mortality of white-tailed deer), all of which bring people into relatively close proximity to wildlife, which would be negligible to minor, short-term to long-term, localized to widespread.

Overall net impacts on resident, native wildlife from Complex management under Alternative A would continue to be moderate beneficial, long-term, and widespread.

Alternative B—Proposed Action

Under Alternative B, the Complex would implement the same management activities as those described under Alternative A, except at different levels and intensities. Additional conservation of lands, increased habitat management and restoration efforts would result in greater short-term adverse impacts (disturbance and displacement during project implementation). However, by increasing invasive species control, reducing erosion, restoring habitat, and improving hydrology on the Complex, it would tend to provide for greater benefits to resident, native wildlife than those of Alternative A. Adverse impacts from public use-related disturbance would be negligible to minor, short-term to long-term, localized to widespread, as they are with Alternative A.

Overall, Alternative B's net impacts on resident, native wildlife would be more beneficial than Alternative A's.

Alternative C

Under Alternative C, management of invasive species would use more diverse strategies and perhaps be more effective, to the benefit of native wildlife. In this alternative, increasing water availability through the development of partnerships and purchase of water rights, expanding wetlands, and rehabilitating marshes would all tend to benefit wildlife more than in Alternative B. Adverse impacts from disturbance associated with public use would be negligible to minor, short-term to long-term, localized to widespread, as they are with Alternative A.

Overall, Alternative C's net effects on resident, native wildlife would be more beneficial than Alternative B. These impacts would be moderate, beneficial, long-term, and widespread.

4.4.5 Impacts on Threatened and Endangered Species

Alternative A—No Action Alternative

Table 3-8 in Chapter 3 of the CCP is a list of federal and state threatened and endangered species, as well as species of concern, that are expected to occur within Brazoria, Matagorda, Fort Bend, and Wharton Counties. Within the Complex, the only federally listed species known to occur are the piping plovers, green sea turtle, and Kemps ridley sea turtle. In addition, the Complex has found loggerhead, hawksbill, and leatherback-stranded sea turtles on area beaches. The Complex would continue to implement the Sea Turtle Recovery Plan and would support all sea turtle recovery efforts by patrolling area beaches for stranding and nests. The Complex would continue to restrict refuge beaches from vehicular traffic to protect these species. The Complex will continue to excavate all nests and transfer them to the incubation site at Padre Island National Seashore, and live turtles would be transferred to the NOAA recovery facility in Galveston.

The San Bernard beach is designated critical habitat for piping plovers. The Complex will continue to conduct plover surveys on area beaches and protect designated critical habitat.

The Complex provides potential habitat for Attwater's prairie chicken and the whooping crane, but do not currently occur in the Complex. All the federally listed species would continue to be protected under the Endangered Species Act and any projects that could potentially impact listed species would undergo Section 7 Consultation prior to any ground disturbing activities. Overall, the effects of Alternative A on federally threatened and endangered species would be beneficial, moderate to major, long-term, and widespread.

Alternative B—Proposed Action

Each of the actions and impacts for listed species anticipated for Alternative A would also occur with Alternative B. In addition, under Alternative B, there would be potential benefits to the federally endangered whooping crane and the APC, if these species re-establish populations on the Complex. Both of these species occur on refuges nearby and are the focus of major sustained federal recovery programs. If these reintroductions occur, the Complex would then implement APC and whooping crane recovery plans.

The Complex would begin monitoring for the potential reintroduction of APC and whooping crane. In preparation for a potential APC reintroduction, the Complex would monitor habitat conditions; conduct research on burning regimes, grazing, and cooperative haying; and collect baseline data on insect populations. The Complex is listed a potential reintroduction site for whooping crane, but since the Complex is outside of the whooping crane flyway, the Complex would play only a small role in this recovery effort. Monitoring would include baseline data on freshwater availability and blue crab populations.

Overall, the effects of Alternative B on federally threatened and endangered species would also be beneficial, moderate to major, long-term, and widespread. With additional efforts on behalf of two other endangered species—the APC and the whooping crane—this alternative would be more beneficial than Alternative A.

Alternative C
Alternative C's actions and effects on threatened and endangered species would be the same as Alternative B: beneficial, moderate to major, long-term, and widespread.

4.5 Human Environment

4.5.1 Impacts on Local Population and/or Economy

Alternative A—No Action Alternative
The Complex would continue to implement current management programs and no change in refuge staff would be required. The economic and social condition of the area would remain the same. The presence and operation of the refuges provides economic benefits to the surrounding communities within a 30-mile radius in several ways. The Complex attracts local, national, and some international visitors and by attracting visitors to the area, the refuges generates revenue for the local economy. Much of the Complex's annual budget is recycled into local businesses through Complex staff salaries and purchases of equipment and supplies, as well as contracts for local labor to accomplish refuge projects. The annual Complex budget is roughly 2.8 million dollars. The Complex provides full-time employment for 28 individuals and up to 12 temporary or part-time staff (primarily high school and college students), that live in nearby communities. Special project funds for restoration through grants, private and corporate donations add an additional $500,000 to the economy annually as projects to restore and enhance refuge habitats are implemented by the refuge and partners on refuge lands.

Although the refuge does not pay taxes to the counties, Revenue Sharing does provide some off-set for the loss of taxes. These represent important contributions to the coffers of local governments. As such, expenditures and profits associated with these programs are important inputs to the economy of the local community.

Spending by approximately 75,000 annual visitors to the Complex generates economic activity throughout the local economy in terms of income, jobs, and tax revenue (Carver and Caudill, 2007). Extrapolating from economic studies conducted for other Region 2 national wildlife refuges, total expenditures related to Complex visitation could reach some two million dollars annually, with up to several dozen jobs generated by and dependent on these expenditures. This is a positive and important contribution to the local economy, but it is quite small in comparison with the total annual income, employment, and tax bases of Brazoria, Matagorda, and Fort Bend counties, in which the three refuges of the Complex are located.

Under Alternative A, the economic benefits would continue at current levels. The impact of Complex operation and visitation on the local economy would be beneficial, minor, long-term, and widespread.

Alternative B—Proposed Action
Economic impacts of Alternative B would be greater than Alternative A, commensurate with the proposed increase in Complex programs, actions, staffing, budget, and spending under this alternative. In addition, the populations of the Texas Gulf Coast and Houston metro areas are

projected to continue growing for the near future. This would likely result in an increase in visitation to the Complex and associated visitor spending, which is a stimulus for the local economy, contributing jobs, income, and tax revenues. Relative to the enormous local economy, these socioeconomic benefits would be small, but still tangible and appreciated.

The loss in tax revenue to the counties would occur with additional land acquisition. Prior to 2010, the counties on average received 43 percent of what the maximum payment could be through the Refuge Revenue Sharing Program. This percentage decreased significantly in 2010 due to the decision not to supplement revenue funds with general tax revenue funds by Congress, through their efforts to reduce the Federal Budget.

Under Alternative B, the impact of Complex operations and visitation on the local economy would be beneficial, minor, long-term, and widespread.

Alternative C

Economic impacts of Alternative C would also be beneficial, and exceed those of Alternative A, due to the increased staffing, budget, and visitation at the Complex. The elimination of cooperative farming would reduce economic benefits to one individual farmer but impacts to the local economy from this reduction would be negligible. The Complex expects the proposed addition of grazing to offset this effect. In addition, under this alternative the Complex would have greater short-term expenditures on larger projects to reduce erosion and saltwater intrusion. Like Alternative A and B, the net effect of Alternative C on the local economy would be would be beneficial, minor, long-term, and widespread under this alternative as well.

4.5.2 Impacts on Aesthetic and Visual Resources

Alternative A—No Action Alternative

Habitat management actions that remove vegetation, disturb soils, and use heavy equipment (prescribed burning, invasive species control, habitat restoration, etc.) can be visually unattractive in the short-term (during project implementation); however, in the long-term these actions restore and improve habitat quality and should result in a more aesthetically pleasing landscape.

Under Alternative A, the Complex would continue to protect tens of thousands of acres of open space, including scenic habitats such as bottomland hardwood forests, coastal marshes, prairies, and farmland. In an area of the state and the Gulf Coast that is developing rapidly and that already has substantial industrial, commercial, and residential footprints, the maintenance of this aesthetically pleasing open space is a great benefit of the Complex.

Proposed maintenance (no new construction planned) of infrastructure under Alternative A is on a small scale and would not have more than negligible, short-term, localized adverse effects on visual resources within the Complex. Long-term impacts will depend on the design, location, and context of the new facilities. Overall, the Complex expects the impacts of its facilities, operations, and visitation on aesthetic and visual resources to be beneficial, moderate, long-term, and widespread.

Alternative B—Proposed Action
Under Alternative B, the same actions that take place under Alternative A would also occur, but to different extents. There would be an increase in prairie restoration and management activities such as mechanical treatments and prescribed fire, as well as construction of one new trail, a new office at San Bernard NWR, and construction of new maintenance and storage buildings at Brazoria and San Bernard NWRs. Short-term impacts would be the same as Alternative A, but long-term impacts would be more beneficial than Alternative A due to increased restoration and management and the augmented effort to acquire and protect more riparian corridors and bottomland hardwood forest.

Alternative C
Under Alternative C, the San Bernard will construct an office and visitor center instead of the office/visitor contact station proposed under Alternative B on San Bernard NWR. The impacts will be the same (same location and project footprint) as described under Alternative B.

4.5.3 Impacts on Public Use Opportunities

Alternative A—No Action Alternative
Under Alternative A, current opportunities for hunting, fishing, wildlife observation and photography, environmental education and interpretation on the Complex would all remain the same. The Complex identified these six wildlife-dependent activities as priority public uses of national wildlife refuge in accordance with the Improvement Act.

Section 4.2 discusses fishing; each of the alternatives would have the same effect on fishing opportunities on the Complex.

Alternative A would maintain existing hunting opportunities, including waterfowl and feral hog and white-tailed deer. The Complex would allow waterfowl hunting in designated areas of all three refuges. One permit area and ATV use is allowed for disabled hunters at the Sargent Unit of San Bernard NWR. There would also be a youth-only hunt allowed for feral hogs on Brazoria and San Bernard NWRs in cooperation with TYHP. Feral hogs/white-tailed deer hunting opportunities for youth will continue at San Bernard NWR in cooperation with TPWD-Stringfellow WMA. Maintaining existing public hunting opportunities on the Complex would continue to be a benefit to the public. The impact of Alternative A on hunting opportunities would be beneficial, moderate, long-term, and localized.

Alternative A would maintain current wildlife observation and photography opportunities and facilities. Brazoria and San Bernard NWRs would remain open to wildlife observation; visitors would be directed to designated public use areas. Bird watching is the most popular form of wildlife observation and would likely remain so in the future. Most birders visit during the cooler months of November through March when large concentrations of waterfowl are present and readily observable. The spring and fall bird migrations are also popular for viewing neo-tropical songbirds. Brazoria NWR would maintain its auto-tour route through the Big Slough Recreation Area, which contains a number of wildlife viewing areas and stations as well as a couple of nature trails. San Bernard NWR would also maintain its wildlife drive, trails, and observation platforms, which offer outstanding views of geese, ducks, shorebirds, marsh birds,

and wading birds. San Bernard NWR would also maintain a photo blind at Hudson Woods. Wildlife observation and photography are two of the big six wildlife-dependent public uses identified in the Improvement Act as being generally compatible with the purposes of national wildlife refuges. Alternative A would maintain existing wildlife observation and photography opportunities on the Complex, which would be a benefit. Thus, impacts of Alternative A on wildlife observation and photography would be beneficial, moderate, long-term, and widespread.

Under Alternative A, the environmental program on the Complex would continue to provide opportunities for both children and adults to learn about the Complex and natural habitats of the Texas Gulf Coast. The education programs improve the quality of the visitor's experience and provide them with a better understanding of the benefits, issues, and challenges of natural resource conservation in the coastal ecosystem. The program meets local and State of Texas education standards, allows professional development for teachers, provides community-based service organization programs, meets youth group merit badge requirements, and instills a sense of stewardship and understanding of conservation issues.

The Discovery Center at Brazoria NWR is the focus of the Complex's active environmental education program. Its classroom/lab, outfitted with stereomicroscopes and a video microscope projector, is a highlight for visiting students and adults. The DEEP currently serves approximately 3,000 students annually. A partnership exists between the Friends of Brazoria NWR and area school districts to help with the financial impacts of the program expansion. The Complex has an MOU with the Brazosport Independent School District for this program. To help accommodate increases in demand for the program, workshops would be available to train teachers to lead their students through a high quality outdoor experience.

At San Bernard NWR, DEEP currently serves approximately 500 students, and this alternative would maintain this level. Activities would continue to occur primarily at the Hudson Woods Unit, making use of a small building (Discovery Outpost), the entrance road, and various trails. Habitats studied are bottomland hardwood forest and freshwater marsh.

Alternative A would maintain existing opportunities for interpretation on the Complex. The Complex would continue to hold one annual 3-day event (Migration Celebration). Other interpretive opportunities are present and would continue along wildlife drives, at observation points, and at the Brazoria NWR visitor contact station.

The Complex would continue to tailor messages and delivery methods to specific audiences and present them at the Discovery Center and other locations. Interpretation enhances opportunities for a quality visitor experience on the refuges and promotes visitor understanding for America's natural resources. Visitors would continue to make their own connection with natural resources through talks, publications, brochures, fact sheets, species lists, signs, interpretive panels, and exhibits. Exhibits would continue to be easy to read, understand, and accessible.

Current levels of wildlife observation, photography, environmental education, and interpretation would continue and the Complex would maintain facilities that support these activities. The impacts of continuing these activities throughout the Complex would be beneficial, moderate, long-term, and widespread.

Alternative B—Proposed Action

In general, under Alternative B, the Complex would augment wildlife-dependent recreation opportunities.

Alternative B would provide a new youth waterfowl hunt and revise the schedule at two locations. Potentially opening Eagle Nest Lake on San Bernard NWR to waterfowl hunting would be an additional benefit. Alternative B would offer more hunting opportunities than Alternative A. Overall benefits of Alternative B for hunting would be moderate, long-term, and localized.

Under this alternative, the Complex would increase wildlife observation opportunities by constructing new wildlife observation facilities. Brazoria NWR would provide a viewing area on Otter Slough (possibly a boardwalk across the slough) and establish pull off points along FM2004, at the Farm Fields, and on CR 227. San Bernard NWR would add photo blinds at the Dow Woods Unit and Brazoria NWR would add photo blinds to the Big Slough area. Because of these new facilities for both wildlife observation and photography, Alternative B would be more beneficial than Alternative A, but overall impacts would be basically the same (moderate, long-term, and widespread).

Alternative B would expand the environmental education program into additional school districts. Brazoria NWR and San Bernard NWR would expand outreach by contacting local media outlets, radio, and Web sites to provide information on the DEEP program, events, and refuge purposes. We would provide a one week day camp focused on the "at-risk" group of kids (Boys and Girls Club, etc.). The DEEP program at Brazoria NWR would expand to include one additional school district (Angleton/Danbury school district).

The DEEP program at San Bernard NWR would expand to include two additional school districts (Van Vleck/Bay City and Columbia). San Bernard NWR would also like to develop a partnership with Brazosport College at the Dow Woods Unit, enabling them to use the area as an outdoor classroom. Overall then, with respect to environmental education, Alternative B would be more beneficial than Alternative A, but overall impacts would be basically the same (moderate, long-term, and widespread).

Alternative B would expand the interpretive program at a variety of refuge venues on a monthly basis. Across the Complex, interpretive activities would include day and night naturalist walks and audio/visual presentations conducted by staff and volunteers. Brazoria NWR would also construct an information kiosk along FM2004. Due to this expanded program, Alternative B would be more beneficial than Alternative A, but overall impacts on interpretation would be the same (moderate, long-term, and widespread).

Alternative C

In general, public uses under Alternative C tend to be similar to or more expansive than those of Alternative B.

Alternative C proposes a new hunt for white-tailed deer on bottomland units (San Bernard NWR). This alternative would also change the Sargent Unit waterfowl lottery hunt to an open, walk-in hunt and modify the timing of the hunt by decreasing the hours of allowed hunting (morning hunt instead of all-day hunt). Overall effects of Alternative C with respect to hunting opportunities on the Complex would be more beneficial than those of Alternative B. Alternative C would be beneficial, moderate, long-term, and localized.

Proposed facilities and opportunities for wildlife observation and photography, as well as expansion of environmental education, under Alternative C would be the same as Alternative B. Therefore, the effects on these activities would be the same as well (beneficial, moderate, long-term, and widespread).

Under Alternative C, interpretation would be the same as in Alternative B. The effects would also be very similar: beneficial, moderate, long-term, and widespread.

4.5.4 Impacts on Visitor Use Facilities:

Alternative A—No Action Alternative
All visitor use facilities and related infrastructure, including roads, kiosks, trails, boardwalks, observation decks, and visitor centers/contact stations would be maintained. The impact of Alternative A on visitor use facilities would be moderate, beneficial, long-term, and widespread.
Alternative B—Proposed Action
There would be additional benefits under Alternative B from expanded visitor use facilities such as signs, trails, a visitor contact station, and a new kayak and canoe launch on Cedar Lake Creek at San Bernard NWR, additional photo blinds, trails, and a boardwalk on Brazoria NWR.

Alternative C
There would be even more additional benefits from those of Alternative B due to a new visitor center at San Bernard NWR and a new kayak and canoe launch.

4.6 Assessment of Cumulative Impacts:

A cumulative impact is defined as an impact on the environment that results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future action regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can “accumulate” spatially, when different actions affect different areas of the same resource. They can also accumulate over the course of time, from actions in the past, the present, and the future. Occasionally, different actions counterbalance one another, partially cancelling out each other’s effects on a resource. But more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource. Accurately summarizing cumulative effects is difficult in that while one action increases or improves a resource in an area, other unrelated actions may decrease or degrade that resource in another area.

As stated in the Service Manual (550 FW 1 and 2), in an EA, a cumulative impact assessment should be conducted if it is determined necessary through scoping to make a determination of significance of the proposed action. When a cumulative effects analysis is included in an EA, the analysis need only be sufficient for the decision maker to reach a conclusion on the significance of the impact in order to determine if the preparation of an EIS is required.

This section addresses the potential cumulative effects for all the alternatives and is intended to consider the activities on the Complex in the context of other actions on a larger spatial and temporal scale. The current resource conditions (Affected Environment) reflect the impacts of past and present actions that have taken place on the Complex as described in Chapter 3 of the Draft CCP. Earlier parts of this EA discuss the impacts of proposed future actions (for all alternatives). The adverse direct and indirect effects of current refuge management and the proposed actions (all alternatives) on air, water, soil, habitat, wildlife, the local economy and population, and aesthetic/visual resources are expected to be mostly negligible to moderate and short-term to long-term. The benefits to habitat, wildlife, and public use that the proposed action would achieve greatly outweigh any of the adverse impacts discussed in this document. The Service also considered past, present, and future planned actions on other state, federal, and private lands surrounding the Complex. The section below provides an analysis area for potential cumulative effects on each resource and a summary of those potential impacts.

Cumulative Impacts on Physical Resources

Air Quality

A substantial amount of heavy industrial activity is present within the multi-county region south of Houston. Both permitted and unpermitted releases of a wide variety of pollutants and contaminants have a substantial impact on air quality in the region. These organic and inorganic chemicals would have an adverse impact on air quality and ecosystems within the Complex, but these precise effects have not been extensively studied or documented. Barge and boat traffic along the GIWW, pipelines, Houston airports, and the traffic of millions of residents in the metropolitan area all have substantial negative impacts on air quality. While the Complex's implementation of periodic prescribed fires during times when this is permitted would temporarily add smoke to the regional air shed; overall, the presence of the Complex's nearly 100,000 acres of natural habitat would help serve to ameliorate adverse effects on air quality of hundreds of other human activities and processes in the region.

Air quality is always a concern on the Complex, which is located within 60 miles of one of the most industrialized and populated areas in the United States. Hundreds of refineries and chemical plants occur in surrounding counties as well as the Freeport/Clute industrial center. Approximately 60 natural gas and coal power plants, some of the nation's largest shipping ports, two major airports several regional airports, and one military base also surround the Complex. The Houston area has nearly 5 million inhabitants as well as a sprawling urban commuter population in one of the largest industrial complexes in the country.

Projects on the refuge that affect air quality would be consistent with the minimal effects produced in the past (as described in section 4.3.1 of this draft EA). When compared to the magnitude of industrialization occurring in areas surrounding the Complex, the effects of refuge

management actions are negligible. In all alternatives, the prescribed burning program, construction, and maintenance activities and increased visitor use would essentially have the same adverse effects to refuge air quality, while the preservation of native bottomland hardwood habitat would have long-term benefits to air quality by limiting local development and increasing carbon sequestration. These adverse and beneficial impacts, however, would not be cumulatively significant.

Water Management and Quality

Increasing population in the region, along with greater urban, commercial, and industrial development would all tend to increase the extent of adverse effects on water quality in and around the Complex by increasing discharges from point and non-point sources of water pollutants and contaminants.

As the area has grown and developed, the increasing diversion and drainage of water from shallow channels and bayous upstream of the Complex have occurred as flood control measures. This has cumulatively reduced the amount of water flowing into the Complex refuges and is a long-term threat to both aquatic and wetland habitats.

The GIWW is a major source of erosion, leading to saltwater intrusion and the subsequent degradation of freshwater marshes. This project affects all three refuges in the Complex.

E. coli (fecal coliform bacteria) from untreated wastewater, whether from an increase in ranching activity or improperly controlled septic system releases, affects both primary (contact) and secondary recreational activities involving contact with the water. This affects both the Brazoria and San Bernard NWRs. It has led to periodic closures of both boating and fishing activities along the San Bernard River.

All of the above activities, actions, and trends have had adverse implications for water quality and quantity in the area. These large detrimental influences work against and offset the refuges' largely beneficial impacts on water quality and quantity, from conserving more than 100,000 acres of marsh, prairie, riparian, and bottomland hardwood forest. In view of these increasing adverse pressures on water quality and quantity, which are likely to continue to increase in the near future, the Complex's positive effects on water resources become even more important. However, the net cumulative effect on water resources in the coming decades would probably be more negative than positive. At the end of the 15-year planning period, the overall condition of water resources on the Complex as a result of cumulative effects is likely to be less than at present, with less water and lower water quality. These impacts, however, would not be cumulatively significant.

Soils

Rapid population growth and associated development in the multi-county region cause the development and covering of soils in the greater Houston area and Texas Gulf Coast at a rapid rate. As the population of an area grows, it converts soils that formerly supported agriculture and natural habitats to roads and streets, residential, commercial, institutional, and industrial areas. Instead of supporting biologically productive ecosystems, the soils beneath all these

developments support buildings and structures. In this regional context, the soils of the Complex have an even greater importance.

Past, present, and reasonably foreseeable future impacts to soils on the Complex would stem mostly from activities on the Complex itself, rather than from activities occurring outside of the three refuges. Refuge management activities would result in effects on soils as discussed in earlier parts of this EA, including ground disturbance from crop cultivation, prescribed fires and wildlife suppression, and construction, which can result in erosion and sedimentation. Over years of farming a site, its soils are also subject to nutrient loss and declining soil fertility, which the Complex can compensate for to some extent by extensive application of nitrogen and phosphate fertilizers (See Table 3-7, Applications for Invasive Target Species Applications).

While there would be some application of herbicides, both to agricultural soils and other sites, currently, herbicides tend not to be persistent or accumulate in the environment. However, continuous use of these chemical compounds would mean that residues of a number of herbicides would continue to occur in soils throughout the lifetime of the CCP.

Effects from other ground disturbance activities off-refuge are likely to remain at roughly the same level as they are currently. The Complex implements farming under organic practices, which allow for maintaining soil nutrients without the use of fertilizers, pesticides, herbicides, and constant crop propagation and harvesting. Alternatives A, B, and C, which propose similar amounts of construction and other management activities, would have similar effects to soils. Oil and gas operations vary seasonally depending on the industry. The refuge has some facilities on the south unit and there are a number of facilities and pipelines outside the refuge boundaries. The refuge does not own the mineral rights; therefore, the potential for additional oil and gas operations is always possible. There could be potential cumulative impacts on soil quality if oil and gas operations increase in the future.

Overall, cumulative effects on soils (from all alternatives) would be a mix of minor adverse and minor to moderate, beneficial. Adverse cumulative effects would probably occur to those soils that are regularly or continually subjected to some form of disturbance. The Complex does not anticipate these adverse effects to be major. Minor to moderate, beneficial effects on soils would be expected to occur at those sites constituting the great majority of the area of the refuges, whereupon undisturbed soils would continue to develop (slowly increasing in depth as well as fertility) as a result of nearly continuous vegetative cover. These adverse and beneficial impacts, however, would not be cumulatively significant.

Cumulative Impacts on Biological Resources

In general, the area considered for the cumulative impacts on biological resources is the Gulf Coast Prairies and Marshes Ecoregion, unless otherwise specified below. Chapter one of this EA discussed ecoregion issues such as fragmentation, commercialization, urbanization, disturbance, and habitat conversion, which influence, impact, and threaten biological resources on the Complex.

Prairie Habitats

Impacts on prairie habitats from the management actions under all three alternatives would be generally beneficial, long-term, moderate, and widespread. There would also be some adverse impacts from implementation of refuge management activities, construction and maintenance of refuge infrastructure, and visitor use, but these adverse impacts would be minor in comparison to the beneficial effects.

Other private and public prairie conservation and restoration efforts in the region contribute to long-term beneficial cumulative impacts on prairie habitats. The Katy Prairie Conservancy (KPC) was established in 1992 to conserve Katy Prairie west of Houston. This prairie encompasses more than 1,000 square miles and is bordered by the Brazos River on the southwest, pine-hardwood forest on the north, and Houston on the east. Historically, Katy Prairie was a poorly drained tall-grass prairie subject to periodic fires; it also included a substantial area of wetlands. The aim of the KPC is to protect between 30,000–60,000 acres of Katy Prairie both in its current agricultural state, with portions enhanced as wetlands and restored prairie habitat.

The Nature Conservancy owns Nash Prairie, north of West Columbia; this will be the Complex's biggest partner in prairie conservation and restoration. Nash Prairie is a 300-acre parcel of native Texas Coastal Prairie. Nash Prairie has never been grazed or farmed. Except for the encroachment of invasive species (notably Chinese tallow), it represents the Texas Coastal Prairie as it existed centuries ago at the time of European contact. To date, the Service has identified almost 300 plant species at Nash Prairie, with 14 considered rare.

There is also the Pierce Ranch west of Wharton, partnering with Texas RICE, restoring and constructing wetlands and prairies. TPWD has a prairie initiative as well; its action plan calls for identifying critical habitats of Texas Coastal Prairie.

In combination, these and other initiatives will have a generally beneficial, cumulative effect on restoration of prairie habitats in the wider region. The Complex would be contributing to these positive impacts. When compared to the magnitude of impacts on prairie habitats occurring outside of the Complex, these beneficial impacts would not be cumulatively significant.

Wetland and Aquatic Habitats

Continuing development in and around the refuges will continue to adversely affect the Complex's wetland and aquatic habitats through alteration of the hydrologic regime. In general, there will be less water flow to the refuges in the future, which could subject wetland and aquatic habitats to moisture stress.

Long-term cumulative impacts from the Complex's proposed management actions on wetlands and aquatic habitats would be moderate, beneficial, and widespread across the Complex. Adverse cumulative impacts from habitat fragmentation due to visitor use and management infrastructure would be minor and localized to widespread. When compared to the magnitude of impacts on wetland and aquatic habitats occurring outside of the Complex, the impacts from proposed management activities (all alternatives) would not be cumulatively significant.

Bottomland Hardwood Forests

The Complex partners with the NRCS on conservation easements that include management, conservation, and restoration of bottomland hardwood forests, as part of the Wetlands Reserve Program. The TPWD is acquiring bottomland hardwood forest in these counties as well. In addition, there are two WMAs and one state park in Complex counties and one state park, Columbia Bottomlands. In combination, all of these joint efforts will increase the acreage and quality of protected bottomland forests along the Texas mid-coast. Against these positive conservation trends is the general population growth and residential, commercial, and industrial development occurring in the wider region between the Gulf Coast and Houston.

The Complex maintains thousands of acres of bottomland hardwood forests, which is disappearing due to extensive urban, suburban, industrial, and agricultural development. The impacts from management of bottomland hardwood forests (under all alternatives) would be both beneficial (due to land acquisition and protection) and adverse (due to development, use, and maintenance of visitor use and administrative infrastructure) as described in section 4.4.3. These impacts, however, when compared to impacts on bottomland hardwood forest outside of the Complex, would not be cumulatively significant.

Migratory Birds

Under each of the alternatives, effects on migratory birds from proposed management actions would be beneficial, long-term, moderate to major, and widespread. Under this alternative, there would also be certain adverse impacts from disturbance associated with public use programs, including hunting. Adverse impacts from the disturbance of visitor use activities would be short-term to long-term, negligible to minor, localized but also potentially widespread. None of these impacts would be cumulatively significant.

These actions on the Complex are a small part of a number of integrated efforts to manage migratory birds on the flyway, continental, and hemispheric scales, as described in Chapter 1 of the CCP. The Complex contributes to and collaborates with waterfowl management efforts by the Service and a number of states and Canadian provinces in the Central Flyway. The North American Waterfowl Management Plan (NAWMP) seeks to restore waterfowl populations in Canada, the United States, and Mexico to levels recorded in the 1970s. This international partnership has worked to identify priority habitats for waterfowl and has established goals and objectives for waterfowl populations and habitats. Regional partnerships, called joint ventures, are the implementing mechanisms of the NAWMP. The Texas Mid-coast Complex is situated within the Gulf Coast Joint Venture.

The North American Bird Conservation Initiative (NABCI) seeks to ensure the long-term health of North America's native bird populations by increasing the effectiveness of existing and new bird conservation initiatives, enhancing coordination among the initiatives, and fostering greater cooperation among the continent's three national governments and their people. In 1999, the U.S. NABCI approved a framework for delineating ecologically-based planning, implementation, and evaluation units for cooperative bird conservation in the U.S. and Canada known as Bird Conservation Regions (BCRs). BCRs are ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues.

Partners in Flight (PIF) is a cooperative effort involving partnerships among numerous governments and NGOs concerned about neotropical migrants and other birds. Partners in Flight was created in 1990 in response to growing concerns about declining populations of many land bird species and to emphasize the conservation of birds not covered by existing conservation initiatives. Bird conservation plans, are developed in each region to identify species and habitats most in need of conservation, to establish objectives and strategies to provide needed conservation, to establish objectives and strategies to provide needed conservation activities, and to implement and monitor progress on the plans. This North American Landbird Conservation Plan summarizes the conservation status of landbirds across North America, illustrating broad patterns based on a comprehensive, biologically-based species assessment. The Texas Mid-coast NWR is within PIF Physiographic Area #6, the Coastal Prairies.

PIF Landbird Conservation Plan-Gulf Coastal Prairie (2008) covers the BCR #37, the Gulf Coastal Prairie. This plan selected and developed conservation recommendations for four species of concern, and one suite of species, with expectations that actions proposed would benefit a number of species with similar habitat requirements. The selected species are seaside sparrow, northern bobwhite, loggerhead shrike, Le Conte's sparrow, and a suite of warblers (Cerulean, Swainson's, and goldenwinged) which represent neotropical migrants that use Gulf Coast stopover habitat.

The U. S. Shorebird Conservation Plan, adopted in 2001, seeks to stabilize populations of all shorebirds that are in decline because of factors affecting habitat in the United States. At a regional level, the plan's goal is to ensure that shorebird habitat is available in adequate quantity and quality to support shorebird populations in each region. This plan considers 53 species of shorebirds. Twenty of these species at risk listed in this plan occur on the Complex.
In addition to these continent-wide and international plans, Texas has a number of initiatives. At the state level, there are a number of initiatives in Texas that have positive cumulative consequences for migratory birds, including the Texas Comprehensive Wildlife Conservation Strategy (2005), Land and Water Resources Conservation and Recreation Plan (2005), Texas Wetlands Conservation Plan (1997), Austin's Woods Conservation Plan (1997), and Seagrass Conservation Plan for Texas (1999). While these do not focus primarily on migratory birds, their implementation would still provide long-term, cumulative benefits for them.

Finally, the Complex is located within the Service-designated Gulf Coast Prairies and Marshes Ecoregion, which is the subject of intra-Service collaborative conservation efforts.
In combination, all of the foregoing efforts should improve the prospects for many migratory birds species at all scales, from local to hemispheric. However, these efforts confront a wide variety of threats to migratory birds at all scales. Most of these are threats to habitats where the birds breed in the spring and summer months (in more northerly areas) and where they winter (in more southerly areas), as well as crucial stopover habitats that migratory birds need when they are in transit between summer and winter ranges. Habitat conversion, degradation, and fragmentation from diverse human activities, including urbanization, agriculture, logging and forestry, mining, and hydroelectric development, all on a vast scale, threaten populations of migratory birds species. Whether long-term cumulative impacts trend negative or positive varies by species, and there are hundreds of migratory bird species in question.

Resident, Native Wildlife
Regionally, the Complex anticipates increased habitat loss and fragmentation to occur in the coming 15 years from the general, long-term increase in population and development within the central Gulf Coast region of Texas. In general, such habitat loss and fragmentation would be detrimental to populations of most, but not all, species of resident, native wildlife. Reduced populations of wildlife outside of the Complex may or may not affect the size and viability of populations on the Complex.

Under all alternatives, there would be long-term benefits to resident native wildlife due to the habitat protection provided by the Complex. Overall, cumulative impacts on resident, native wildlife from Complex management under the three alternatives would be moderate, beneficial, long-term, and widespread. There would also be adverse impacts from disturbance associated with public use programs, but these impacts would be negligible to minor, short-term to long-term, localized to widespread. None of these impacts, however, would be cumulatively significant.

Threatened and Endangered Species
The protection of habitat provided by the Complex would result in a benefit to long-term conservation of threatened and endangered species. All alternatives would beneficially impact federally threatened and endangered species known to occur on Complex (piping plovers, green sea turtle, and Kemps ridley sea turtle) due to habitat protection, species surveys, and monitoring. These beneficial impacts would be moderate to major, long-term, and widespread. Alternatives B and C would provide greater benefits to additional species than Alternative A, with the potential reintroduction of the whooping crane and the APC. These impacts, however, would not be cumulatively significant.

Recent years have witnessed a slow trend toward the overall recovery of populations of both piping plovers and sea turtles. The Complex expects this cumulative trend to continue over the coming 15 years, and the Complex will continue contributing to the recovery of these species. Neither the APC nor the whooping crane now occur on the Complex, but if generally positive trends continue with regard to their recovery, they may possibly occur, or relocation efforts may be focused inside the boundaries of the Complex, within the timeframe of this CCP. With regard to the whooping crane, the Complex would therefore participate in continuing efforts to re-establish other flocks, migratory and non-migratory, of this highly endangered bird.

Cumulative Impacts on the Human Environment
Based on the analysis presented earlier in this chapter, the Service has concluded that there would be no significant cumulative impacts on the human environment from proposed refuge management actions, when considered in context with other state, federal, and private actions (as summarized below), all management alternatives have similar impacts and conclusions.

Local Population and/or Economy
As a result of projected population and economic growth in the region over the coming 15 years, overall cumulative economic impacts would continue to be beneficial. The Complex would continue to contribute positive, if relatively minor, economic effects on the region.

Aesthetic and Visual Resources
Aesthetic and visual resources in the region surrounding the Complex are rapidly diminishing due to residential development, urbanization, and other ecoregional issues. The Complex has an overall beneficial effect on aesthetic and visual resource in this area where open space and natural beauty are diminishing.

Hunting
As in most states, there is a long-term, generalized decline in hunting participation in Texas, even as the state's population (and thus the number of potential hunters) continues to grow very rapidly. While a number of factors undoubtedly contribute to this, the rising cost of hunting on private land may be growing prohibitively expensive for much of the public, decreasing its ability to actually participate in hunting, if not the desire or demand to hunt. Under these circumstances, the importance of public lands and wildlife habitat to hunters, such as those available on the Complex, cannot be understated. However, if hunting demand or participation on the Complex were to increase greatly, as a result of declining opportunities elsewhere, this excessive competition could eventually decrease the quality of the hunting experience available on the Complex.

Wildlife Observation and Wildlife Photography
There are a growing number of other formal and informal opportunities for wildlife observation in the region. The City of Freeport is developing wildlife observation areas in marsh habitats alongside Hwy 36. Two county parks offer additional opportunities for both observation and photography. The Gulf Coast Bird Observatory, outside of Lake Jackson and Quintana, encourages wildlife observation. TPWD has established the Coastal Birding Trail. Brazos Bend State Park, west of Rosharon, covers roughly 5,000 acres, with an eastern boundary fronting on the Brazos River. Visitors may view and photograph wildlife from a nature trail and hike bike/foot trails. The City of Lake Jackson has a wilderness park. The Complex will contribute to these long-term, cumulatively beneficial effects related to wildlife observation opportunities in the region. However, even as these formal facilities and opportunities increase, an expected decrease in the amount of overall wildlife habitat present due to the area's continuing growth and development (and associated habitat conversion) may reduce the amount of wildlife actually available for viewing and photography.

Environmental Education
Environmental Education (EE) is also taking place at other sites in the region, so that the Complex contributes to a beneficial cumulative effect from all of these combined efforts. The Texas Master Naturalists Chapter does EE programs out of the INEOS facility, east of Brazoria NWR; it focuses on marsh ecology. The Chevron/Phillips plant provides EE opportunities at Flag Pond, north of Sweeney. TPWD does EE focused on fisheries at Sea Center Texas, located in Lake Jackson.

Interpretation
Within the larger region, each of the sites mentioned above under "Wildlife Observation and Wildlife Photography" also offers interpretive opportunities. Thus, the Complex would be playing an integral role in growing opportunities for nature and wildlife interpretation around the region.

Visitor Use Facilities
No outside forces or factors would cause or contribute to cumulative effects on these facilities.

4.7 Short-Term Uses versus Long-Term Productivity

The Complex dedicates the habitat protection and management actions under the proposed alternative to maintaining the long-term productivity of refuge habitats. The benefits of this plan for long-term productivity far outweigh any impacts from short-term actions, such as the construction of observation towers and a visitor center, or creation of new trails. While these activities would cause short-term negative impacts, the educational values and associated public support gained from the improved visitor experience would produce long-term benefits for the Complex's entire ecosystem.

The key to protecting and ensuring the refuges' long-term productivity is to find the threshold where public uses do not degrade or interfere with the refuges' natural resources. The Complex has carefully conceived plans proposed to achieve that threshold. Therefore, implementing the proposed alternative would lead to long-term benefits for wildlife protection and land conservation that far outweigh any short-term impacts.

4.8 Unavoidable Adverse Effects and Mitigation Measures

All action alternatives may have some unavoidable adverse impacts. The Complex expects these impacts to be minor and/or short-term in duration. The Complexe would attempt to minimize these impacts wherever possible. The following sections describe the measures the Complex would employ to mitigate and minimize the potential impacts that could result from implementation of the proposed action.

Water Quality from Soil Disturbance and Use of Herbicides
The Complex expects foot traffic on new foot trails to have a negligible impact on soil erosion. To minimize the impacts from public use, the Complex would include informational signs that request trail users to remain on the trails, in order to avoid causing potential erosion problems.

Long-term herbicide use for exotic plant control could result in a slight decrease in water quality in areas prone to exotic plant infestation. Through the proper application of herbicides, however, the Complex expects this to have a minor impact on the environment, with the benefit of reducing or eliminating exotic plant infestations.

Wildlife Disturbance
Disturbance to wildlife is an unavoidable consequence of any public use program, regardless of the activity involved. The Complex would design all of the public use activities proposed under the proposed alternative to minimize levels of impact.

Vegetation Disturbance
Negative impacts could result from the creation and maintenance of trails that require the

clearing of non-sensitive vegetation along their length. The Complex expects this to be a minor short-term impact. The Complex would minimize this impact by installing informational signs that request users to stay on the trails.

Other Unavoidable and Adverse Impacts
Potential development of the Complex's buildings, trails, and other improvements could lead to minor short-term negative impacts on vegetation, soils, and some wildlife species. When building the administrative facilities, the Complex would make efforts to use recycled products and environmentally sensitive products and would build the facility in the same footprint as the current administrative offices. Projects to remove man-made impoundments and other infrastructure would be done using best management practices and areas would be restored through planting of native prairie grasses. All construction activities would comply with the requirements of Section 404 of the Clean Water Act; the National Historic Preservation Act; Executive Order 11988, Floodplain Management; and other applicable regulatory requirements.

4.9 Irreversible and Irretrievable Commitment of Resources:

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that this use could have on future generations. Irreversible effects primarily result from the use or destruction of specific resources that cannot be replaced within a reasonable period, such as energy or minerals. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action, such as extinction of a threatened or endangered species or the disturbance of a cultural resource.
None of the alternatives would result in a large commitment of nonrenewable resources. Project implementation would require the irretrievable commitment of fossil fuels (diesel and gasoline), oils, and lubricants used by heavy equipment and vehicles. In addition, management actions in this document will require a commitment of funds that would then be unavailable for use on any other Service projects. At some point, commitment of funds to these projects would be irreversible, and once used, these funds would be irretrievable. The Proposed Action would result in some unavoidable harm or harassment to some wildlife. The Service would implement best management practices to minimize potential impacts.

Table EA 4-2. Summary of Environmental Effects by Alternative

Environmental Resource	Alternative A: Current Management/ No Action Alternative	Alternative B: Proposed Action Alternative	Alternative C
Impacts on Air Quality	• Impacts from prescribed fire would be adverse, short-term, minor to moderate, and localized to widespread • Impacts from farming and vehicular operation would be adverse, short-term, negligible to minor,	• Adverse impacts greater than Alternative A, but still considered adverse, short-term, minor to moderate, and localized to widespread. • Impacts from additional habitat conservation and management would be	• Adverse impacts from the same actions are approximately the same as Alternative B. • Impacts from additional habitat conservation and management would be greater than Alternative A & B, long term,

	and localized • Impacts from habitat conservation and management would be beneficial, long-term, minor to moderate, and widespread.	more beneficial than Alternative A, long-term, moderate, and widespread.	moderate, and widespread
Impacts on Water Resources	• Adverse impacts on water quality from farming and invasive control using herbicides are likely to be negligible to minor, localized, and short-term. • Habitat conservation efforts and erosion control measures would be beneficial, moderate, long-term, and widespread.	• Adverse impacts greater than Alternative A's, negligible to minor, localized and short-term. • Beneficial impacts would greater than Alternative A's, due to increased habitat conservation.	• Fewer adverse impacts on water quality than Alternative B due to reduced farming. • Overall adverse impacts would be negligible to minor, localized, and short-term. • Beneficial impacts would be greater than Alternative A's due to the habitat conservation and a greater level of effort to reduce erosion and saltwater intrusion.
Impacts on Soils	• Both adverse and beneficial effects. • Adverse effects would tend to be negligible to minor, localized to Refuge-wide, and mostly short-term. • Beneficial effects would be minor to moderate, Refuge-wide, and long-term.	• Same as Alternative A.	• Better than Alternatives A and B due to reduced impacts on soils from farming.
Impacts on Prairie Habitats	• Both adverse and beneficial effects but beneficial effects exceed adverse. • Adverse effects would be minor, long-term, and localized to Refuge-wide. • Beneficial effects would be moderate, long-term, and Refuge-wide.	• More beneficial than Alternative A.	• More beneficial than Alternatives A and B.
Impacts on Wetland	• Both adverse and	• More beneficial than	• More beneficial than

and Aquatic Habitats	beneficial impacts on wetland and aquatic habitats. • Adverse effects would be minor, long-term, and localized to Refuge-wide. • Beneficial effects from the actions described above would be moderate, long-term, and Refuge-wide to widespread.	Alternative A.	Alternative A and probably more beneficial than Alternative B.
Impacts on Bottomland Hardwood Forests	• Effects would be both adverse and beneficial with beneficial impacts outweigh the adverse impacts. • Adverse impacts would be minor, long-term and localized to Refuge-wide. • Beneficial impacts would be moderate, long-term, and widespread.	• Same as Alternative A.	• Same as Alternative A.
Impacts on Migratory Birds	• Both beneficial and adverse effects. • Beneficial effects from many different management efforts and actions would be moderate, long-term, and widespread. • Adverse effects would be short-term to long-term, negligible to minor, localized but also potentially widespread.	• More beneficial than Alternative A.	• Both adverse and beneficial impacts. • Adverse impacts would result both from public use disturbance as well as a reduction in farming acreage and would be minor to moderate, long-term, and widespread. • Beneficial impacts would result from prescribed fire, moist soil management, some farming, research, water management, and rookery management and would be moderate, long-term, an widespread.
Impacts on Resident, Native Wildlife	• Net impacts would be beneficial, moderate, long-term, and widespread.	• Net impacts would be more beneficial than Alternative A's.	• Net effects would be more beneficial than Alternative B.

			• These impacts would be moderate, beneficial, long-term, and widespread.
Impacts on Threatened and Endangered Species	• Net impacts would be beneficial, moderate to major, long-term, and widespread.	• More beneficial than Alternative A.	• Same as Alternative B.
Impacts on Cultural Resources	• Continue to protect cultural resources under NHPA and Section 106 consultations with TX SHPO. • Impacts would be beneficial, minor to moderate, long-term and localized to widespread.	• Same as Alternative A.	• Same as Alternative A.
Socioeconomic Impacts	• Impact of Complex operations and visitation on the local economy would be beneficial, negligible to minor, long-term, and widespread.	• Likely greater than Alternative A.	• Likely greater than Alternative B.
Impacts on Aesthetic and Visual Resources	• Impacts would be moderate, beneficial, long-term, and widespread.	• Short-term impacts would be the same as Alternative A • Long-term impacts would be more beneficial than Alternative A due to stepped-up restoration and management and the augmented effort to acquire and protect more riparian corridors and bottomland hardwood forest.	• The impacts will the same (same location and project footprint) as described under Alternative B.
Impacts on Hunting	• Impact would be beneficial, moderate, long-term, and localized.	• More beneficial than Alternative A.	• Overall benefits same as Alternative B. • New hunt for white-tailed deer on bottomland units (San Bernard NWR) would increase public benefits of this alternative. • Change Sargent Unit

			waterfowl lottery hunt to open, walk-in hunt and modify timing.
Impacts on Fishing	• Impact would be moderate, beneficial, long-term, and widespread.	• Same as Alternative A.	• Same as Alternative A.
Impacts on Wildlife Observation	• Impact would be beneficial, moderate, long-term, and widespread	• Slightly more beneficial than Alternative A because of new facilities development.	• Same as Alternative B.
Impacts on Wildlife Photography	• Impact would be moderate, beneficial, long-term, and widespread.	• Slightly more beneficial than Alternative A because of new photography opportunities (e.g., photo blinds).	• Same as Alternative B.
Impacts on Environmental Education	• Impact would be moderate, beneficial, long-term, and widespread.	• More beneficial than Alternative A due to expansion into additional school districts.	• Same as Alternative B.
Impacts on Interpretation	• Impact would be moderate, beneficial, long-term, and widespread.	• More beneficial than Alternative A due to expanded program.	• Same as Alternative B.
Impacts on Visitor Use Facilities	• Impact would be moderate, beneficial, long-term, and widespread.	• Additional benefits from expanded visitor use facilities such as signs, trails, visitor contact station, and boat launches.	• Additional benefits from those of Alternative B from new visitor center at San Bernard NWR and boat launches.

5.0 CONSULTATION, COORDINATION, AND DOCUMENT PREPARATION

5.1 Document prepared by:

Please refer to Appendix I in the Plan

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