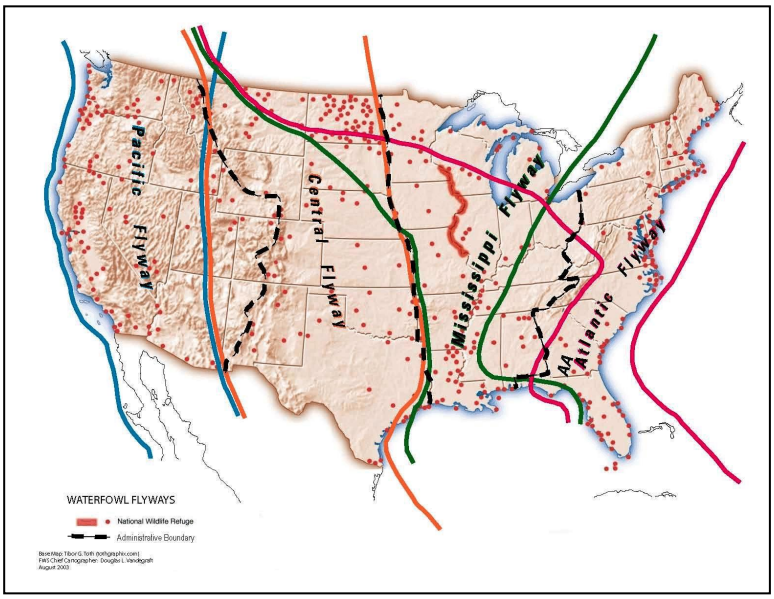
3.0 Refuge Resources and Current Management

This chapter provides a detailed description of the Refuge, its habitats, the species that occur, how habitat and species are managed, and the recreational opportunities it offers. It is divided into six major sections: Landscape Setting; Physical Environment; Biological Environment; Socioeconomic Environment; Archeological, Cultural, and Historical Resources; and Current Management.

3.1 Landscape Setting

To effectively achieve the Refuge System mission of conserving fish, wildlife, and their habitats, the Buffalo Lake NWR took a landscape-scale approach to identifying refuge resources, issues, and management direction. The refuge is one small portion of land within a larger landscape, and as such, the landscape beyond its boundaries should be taken into consideration to determine its role in the larger conservation effort. This section describes the landscape setting in which the Buffalo Lake NWR is located. These "landscapes" are defined by many different characteristics and zones dependent upon which government or non-government organization (NGO) is delineating them. The different landscapes (Central Flyway, Landscape Conservation Cooperative, Bird Conservation Regions, The Nature Conservancy Ecoregion, and Hydrologic Unit) are discussed in the following text (see Map 3-1).

3.1.1 Central Flyway



Bird migration is the seasonal movement of birds between summer nesting habitat in Canada and the northern United States and wintering habitat in the southern United States, Central and South America. These movements generally follow regular routes called flyways. There are four administrative flyways in North America: the Atlantic, Mississippi, Central and Pacific. It is along these four flyways that tens of millions of migrating birds travel seasonally. The Service established national wildlife refuges along these flyways to provide resting and nesting habitat for migrating birds.

Buffalo Lake NWR is located within the Central Flyway which spans the Canadian Northwest Territory, two Canadian provinces (Alberta and Saskatchewan), numerous countries in Central

and South America, and ten U.S. states: Montana, North Dakota, South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, and Texas.

3.1.2 Strategic Habitat Conservation and the Great Plains Landscape Conservation Cooperative

Strategic Habitat Conservation

Strategic Habitat Conservation (SHC) is an adaptive management approach to habitat conservation (USFWS 2006). Adaptive management refers to a management style in which the effectiveness of management actions is monitored and evaluated, and future management is modified as needed, based on the results of this evaluation or other relevant information that becomes available. This approach will protect and enhance wildlife populations and ecological functions that sustain them. Additionally, it will direct our limited resources to achieve conservation for priority species.

The Service believes that SHC is a more effective strategic approach to conservation than the largely opportunity-driven approach that has been taken in the past. It is a scientific method that is integral for our science-based organization and will help us and our partners meet common conservation objectives through more efficient uses of resources. Rarely will single organizational divisions of the Service have the capacity to perform all elements of SHC. Conservation success will be achieved through cooperation between divisions of the Service, interagency collaboration, and partnerships. SHC is a framework of four functional elements that must occur in an adaptive management loop. The four elements are: 1) Biological Planning; 2) Conservation Design; 3) Program Delivery; and 4) Outcome-based Monitoring.

Some programs within the Service already use the framework of SHC, notably Joint Venture and the National Fish Habitat Action Plan. Many of our conservation partners, such as The Nature Conservancy, World Wildlife Fund, and state wildlife departments in their State Action Plans, use a similar approach. This approach provides a framework for setting conservation objectives based on the best available information. Underlying assumptions will be monitored and tested to improve our knowledge and any necessary changes will be made to our implementation strategies and techniques.

The Implementation Team for SHC developed a Strategic Habitat Conservation Handbook in 2008. This handbook is a guide to implementing the technical elements of strategic habitat conservation. Efforts are underway to take the first steps of biological planning at a regional scale and at more local scales. The framework the planning team took to conduct landscape level planning in association with development of this Plan is described more fully in Chapter 3.1, Landscape Setting.

Landscape Conservation Cooperative

The Service is using the framework as a base geography to locate the first, as well as future, Landscape Conservation Cooperatives (LCCs; See Figure 3-2). LCCs are conservation-science partnerships between the Service, Federal agencies, states, tribes, NGOs, universities, and other entities. The Service uses LCCs, the fundamental units that function within the geographic framework, to carry out the functional elements of SHC. The geographic framework provides a Service-wide network of scientifically credible analytical units for optimizing conservation efficiency for priority species that can be compared fairly across the network. By providing a visual context for conservation at the landscape scale (the entire range of a priority species or suite of species), the framework helps ensure that resource managers have the information and tools needed to make decisions to conserve natural resources using the most efficient and effective methods possible.

LCCs guide resource management decisions to address landscape-scale stressors, including habitat fragmentation, genetic isolation, spread of invasive species, and water scarcity, all of which are accelerated by climate change. LCCs are developed on the foundation of SHC. The national geographic framework consists of twenty-two areas which were developed by aggregating Joint Venture's Bird Conservation Regions (biologically-based units representing long-standing partnerships that facilitate conservation planning and design at the landscape-scale) with Freshwater Ecoregions of the World (as a standard unit for aquatic species considerations) and Omernick's ecological units (to account for a variety of terrestrial species' needs).

The Buffalo Lake NWR is located in the Great Plains LCC (GPLCC). The geographic area of the GPLCC encompasses and parts of eight states: New Mexico, Texas, Oklahoma, Colorado, Kansas, Nebraska, South Dakota and Wyoming. The boundary of the Great Plains LCC falls along the boundaries of Bird Conservation Region 18 (Shortgrass Prairie) and 19 (Central Mixed-grass Prairie). This boundary also corresponds with the administrative boundaries of the Playa Lakes and Rainwater Basin Joint Ventures. The administrative boundary of the Rainwater basin Joint Venture is restricted to the BCR 19 portion of Nebraska while the remaining areas within BCR 18 and 19 are within the administrative boundary of the Playa Lakes Joint Venture. The GPLCC area also encompasses three formally recognized partnerships as part of the National Fish Habitat Action Plan (NFHAP). The northern half of the GPLCC geography encompasses the Great Plains Fish Habitat Partnership (GPFHP) in the states of CO, NE, KS, SD and WY. The southern half of the GPLCC encompasses the Southeast Aquatic Resources Partnership (SARP) within the states of Oklahoma and Texas. Multiple reservoirs in all states within the GPLCC area will be included in the Reservoir Fisheries Habitat Partnership.

Federal lands within the GPLCC area include:

- Bureau of Land Management public lands in southeastern New Mexico

- 11 Fish and Wildlife Service National Wildlife Refuges
- USDA Forest Service National Grasslands and Forests in New Mexico, Oklahoma, Texas, Colorado, Kansas and Nebraska
- Lands managed by the Department of Defense, Bureau of Reclamation and National Park Service

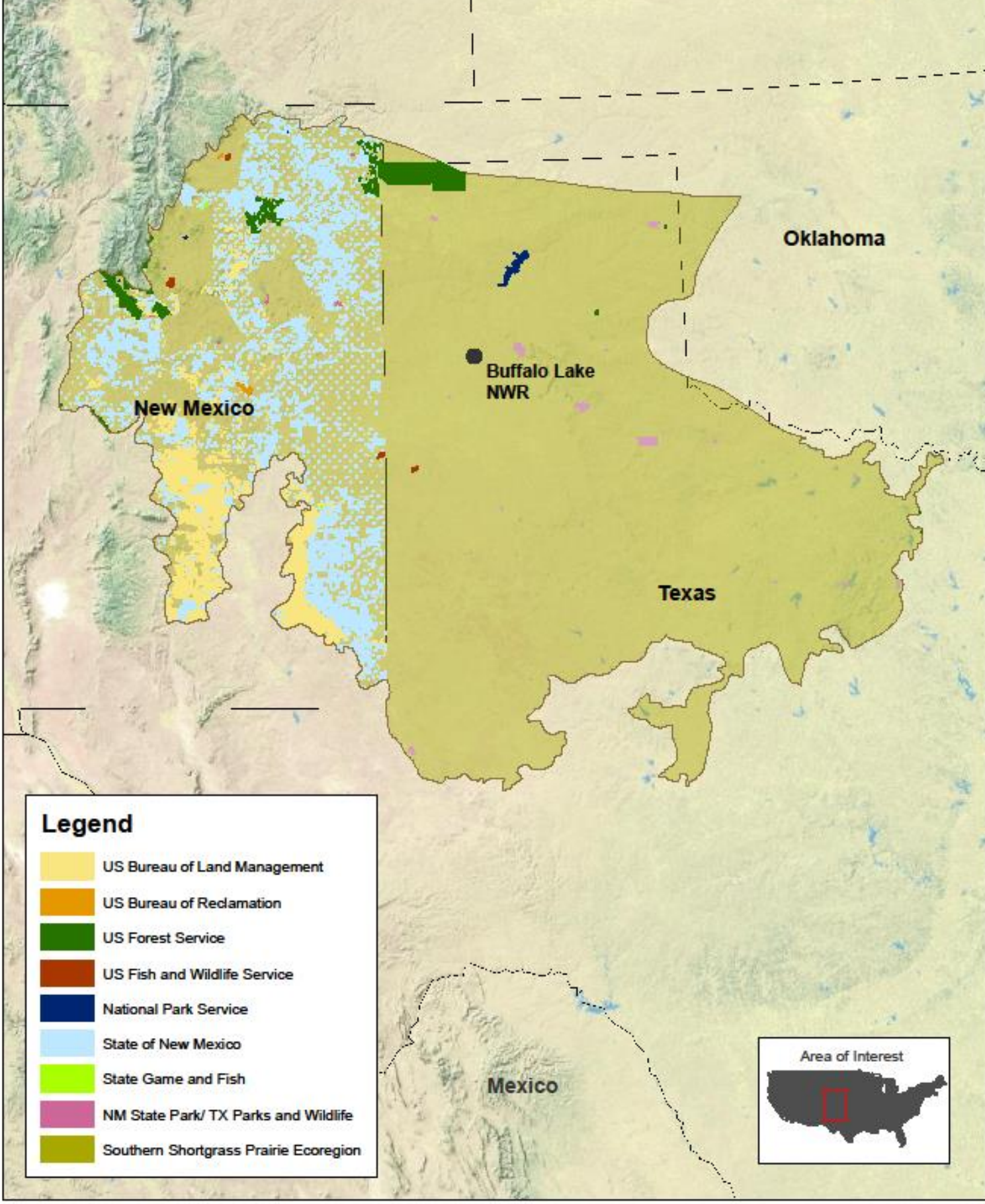
State owned lands are expected to be an important component of the GPLCC area and many contribute habitats necessary to support priority species. The majority of the GPLCC area is under private ownership. Incentives that encourage private landowners to manage their lands in ways that contribute to wildlife habitat values and providing tools that help strategically target those incentives are important considerations of the GPLCC.

Texas Conservation Action Plan:
The Texas Conservation Action Plan's (TCAP) purpose is to provide a statewide "roadmap" for research, restoration, management, and recovery projects addressing Species of Greatest Conservation Need (SGCN) and important habitats. SGCN include terrestrial, freshwater, and marine birds, mammals, reptiles, amphibians, invertebrates, fishes, plants and plant communities. The goal of the plan is ultimately to conserve and improve the status of these species and, as possible, prevent listings under the Endangered Species Act. Buffalo Lake NWR falls within the High Plains Ecoregion of Texas.

3.1.3 Ecoregion Setting

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance. These general purpose regions are critical for structuring and implementing ecosystem management strategies across federal agencies, state agencies, and nongovernment organizations that are responsible for different types of resources within the same geographical areas (EPA, http://www.epa.gov/wed/pages/ecoregions.htm).

The Nature Conservancy's (TNC) ecoregion planning approach divides the nation into natural areas as the foundation for identifying and protecting unique natural areas and features. TNC ecoregions were based on original work by Robert Bailey, and were modified by TNC in cooperation with the network of Natural Heritage Programs.



PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: April, 2010
BASEMAP: N/A
MERIDIAN: N/A
FILE: R_mapfile

0 40 80 160 Miles

0 60 120 240 Kilometers

UTM ZONE
NAD

3.1.3.1 Terrestrial Description

The Southern Short-grass Prairie Ecoregion occupies more than 107,000 square miles of northeastern New Mexico, northern Texas, and small portions of western Oklahoma and southern Colorado. The Southern Short-grass Prairie Ecoregion lies within the Southwest Plateau and Plains Dry Steppe and Shrub Province described by Bailey (1995). It is bordered on the north by the Central Short-grass Prairie Ecoregion, on the south by the Edwards Plateau and Chihuahuan Desert ecoregions, on the east by the Central Mixed-grass Prairie and Cross-timbers and Southern Tall-grass Prairie ecoregions, and on the west by the Southern Rocky Mountains and Arizona/New Mexico Mountains ecoregions. This large ecoregion harbors a varied landscape but is typified by flat to rolling plains, dissected on the east and west by canyons and caprock escarpments. Elevations range from less than 250 meters (above mean sea level) to an altitude of more than 2,500 meters on isolated volcanic peaks.

Photo 3-1 Buffalo Lake NWR Dry Lakebed USFWS

The western portion of the ecoregion is characterized by plateaus of the High Plains, punctuated by escarpments, while the eastern portion harbors the Rolling Plains. Soils range from dry aridisols to rich, deep mollisols. Surficial geology ranges from the Permian red clay and sand beds of the Western Rolling Plains, to the Tertiary Ogallala Formation underlying much of the southern High Plains, to the Quaternary basalt flows of the Capulin High Plains and Quaternary sand and loess deposits overlying much of the Llano Estacado. Average annual rainfall amounts

decrease from a high of about 900 millimeters in the east to about 300 millimeters in the southwestern part of the ecoregion. Annual mean daily average temperature varies between 10°C (50°F) and 17°C (63°F). Portions of the Pecos, Canadian, Red, Colorado and Brazos Rivers are located within the ecoregion. This generally rural region has few large cities; the largest are Amarillo, Lubbock, Abilene, Odessa-Midland, and Wichita Falls in Texas, and Clovis and Las Vegas in New Mexico.

Perhaps the most striking geologic features of the ecoregion are the canyon breaks and wide floodplains formed by the large rivers of the southern Great Plains. The Canadian, Red, Brazos, Colorado and Pecos rivers have wide, shallow sandy-bedded channels containing unique aquatic fauna adapted to the harsh climate. The ecoregion also includes a diversity of other aquatic habitats, from high gradient snowmelt-fed streams in the Southern Rocky Mountain foothills, to intermittent streams in the arid Pecos River valley and Llano Estacado, to medium-sized groundwater-fed perennial streams in the rolling plains and prairies in the east. The geology of the region, which contributes to the diversity of substrates of the aquatic systems, ranges from Precambrian granites of fairly restricted distribution, to the more extensive sands of the Ogallala Formation of Tertiary age, and the limestone, shale and sandstones of Permian age.

Over 25,000 round depressional basins, known as playas, are found throughout the relatively flat regions and represent a significant resource for migratory waterfowl, shorebirds, and other species; they also function as recharge features for the Ogallala Aquifer (Smith 2003). Other features important to some wetland dependent species are saline lakes, which are characterized by freshwater springs and high salinity in the basins. More than 40 saline lakes are found within the ecoregion. These wetlands contribute disproportionately to the biodiversity of this semi-arid region.

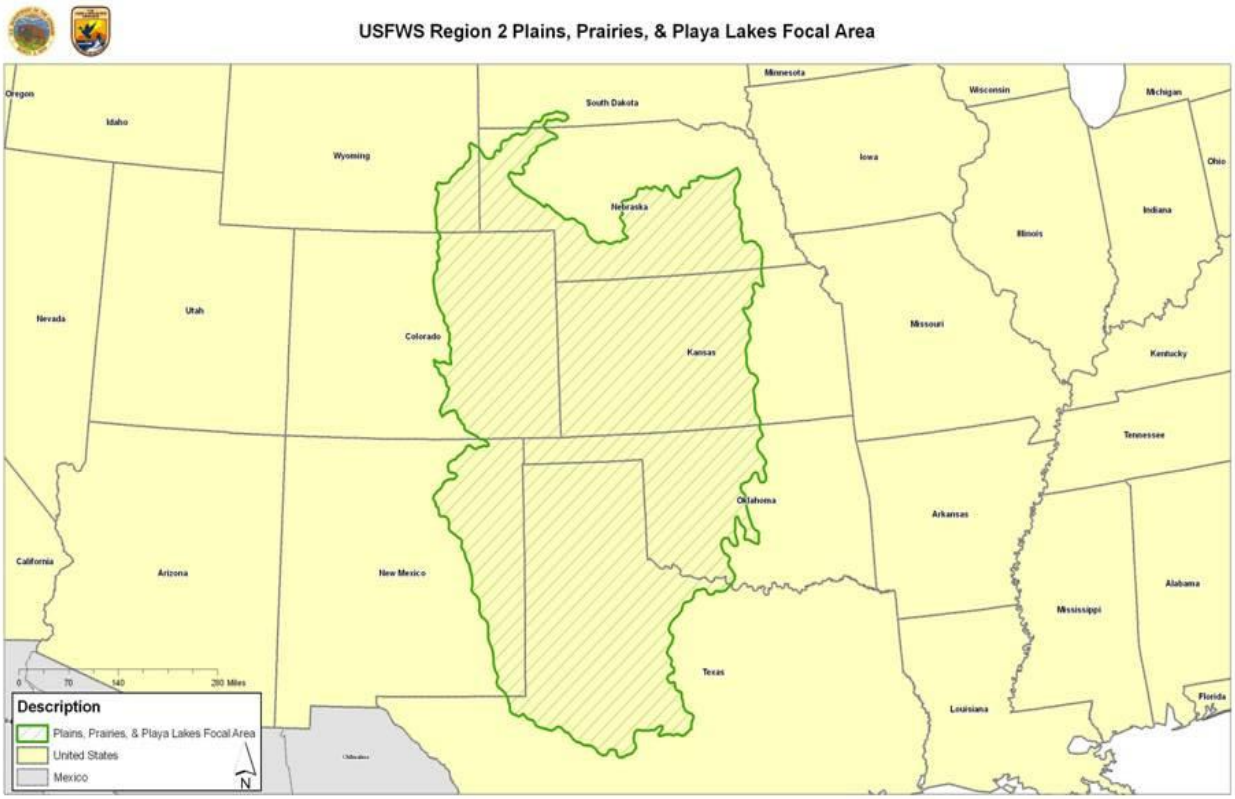
Temperate grasslands represent one of the most altered and least conserved habitat types on Earth, with more than 40 percent of their total area worldwide converted to agriculture. The biodiversity and ecological processes of the Southern Short-grass Prairie face serious threats, habitat loss and degradation being two of the most significant. Agricultural production (primarily of cotton, wheat and grain sorghum) has replaced much of the historical short-grass and mixed-grass prairie. This is especially evident on the Llano Estacado of Texas, noted as one of the most intensively cultivated region in the Western Hemisphere (Bolen and Guthery 1982). Analyses using the National Land Cover Dataset (Vogelmann et al. 2001) indicate that approximately 28% of the ecoregion is currently in agricultural production. Most of this agricultural production relies on irrigation water extracted from the Ogallala Aquifer. As a result, excessive groundwater withdrawal for agricultural and municipal use currently vastly exceeds recharge in this aquifer (Terrell et al. 2002), resulting in reduced stream and river flow in many areas. Land conversion, water-use patterns, modifications of natural fire regime, and exotic species introductions have all

had major impacts. Climate change is a concern in the region, though the exact nature of impacts remains unclear.

The Nature Conservancy and other conservation-minded landowners and organizations recognize the implications of these changes to the ecological and cultural landscape of the Short-grass Prairie. This assessment represents The Nature Conservancy's initial effort to identify intact areas of biodiversity significance and summarize the critical conservation threats faced by biodiversity in these areas.

Plains, Prairies and Playa Lakes Focal Area

The Plains, Prairies and Playa Lakes Focal Area (PPPFA) is one of three focal areas identified in March 2007 (USFWS 2007) by Region 2 in response to a decision by the U.S. Fish and Wildlife Service (Service) Directorate in January 2007 to implement SHC on a landscape-level scale. The PPPFA encompasses portions of eight states in two Service regions. The focal area provides habitat for a myriad of native plants and fish and wildlife species, including continentally important populations of waterfowl, shorebirds, and many other migratory and resident species. It is the home of several keystone species which inhabit the short and mixed-grass prairies of this area, some of the most imperiled habitats in the United States. Also of concern in the PPPFA are threats to playa wetlands and prairie riverine ecosystems. These ecosystems provide vital habitat to numerous resident and migratory species, many of which are recognized as endangered, threatened, or species of concern by Federal and State fish and wildlife agencies and conservation organizations.



The geographic extent of the PPPFA is defined by the boundaries of Omernick's (1987) "Ecoregions of the Conterminous United States," and includes the Western High Plains (25), Southwestern Tablelands (26) and Central Great Plains (27) regions. The PPPFA boundaries also closely approximate those defined by Bailey (1976) in his "Ecoregions of the United States," including the Grama-Buffalo Grass (3113), Bluestem-Grama Prairie (2533) and Mesquite-Buffalo Grass (2521) regions. Further refinements of Bailey's work have been utilized in a number of planning efforts, both relative to the PPPFA and other geographic areas, as well as nationwide.

Throughout the PPPFA, priority fish and wildlife resources have been identified in a number of efforts through federal and state listings of threatened and endangered species, analysis of habitat losses, documentation of invasive species-related issues, reports on the status of species and landscapes and numerous related activities. In the remainder of this document, the species and ecosystem priorities identified by the Service and the states, through their comprehensive wildlife conservation strategies, are used as the bases of our analysis and formulation of recommendations for conservation action throughout the focal area. Both priority habitats (i.e., conservation landscapes) and lists of priority species are provided for each of the two broad ecosystems contained in the PPPFA as a synthesis of information gleaned from the state strategy documents. Specific habitat descriptions may be obtained from the state strategy documents as well.

The conservation landscapes listed below for each ecoregion are compilations and syntheses of those listed in the state strategies, modified in some cases where conflicting terminologies were encountered. The priority species lists include only those designated by the states as high priority. Every attempt was made to confirm these lists with the respective state agencies given time constraints inherent in the preparation of this document.

3.1.3.2 Aquatic Description

Tierra Blanca Creek begins in flat to rolling terrain with local escarpments where soils are mostly deep, fine sandy loams and the vegetation comprises hardwood forest, brush, and grasses. It flows through flat areas with local shallow depressions where water-tolerant conifers and grasses cover clay loam and sandy loam soils. Tierra Blanca Creek rises in Curry County, New Mexico and enters Texas in southwestern Deaf Smith County. Then it flows east-northeast for 75 miles, across southern Deaf Smith and Randall counties, to join Palo Duro Creek east of Canyon. The junction of the two streams forms the Prairie Dog Town Fork of the Red River, although in the upper course it is often called Palo Duro Creek.

Because of a cartographic error, the land between the north and south forks was claimed by both the state of Texas and the federal government. Originally called Greer County, Texas, the U.S. Supreme Court ruled that it belonged to the federal government, which at the time oversaw the Oklahoma Territory. That territory was later incorporated into the state of Oklahoma, whose southern border now follows the south fork.

That southern fork, which is about 120 miles, is generally called the Prairie Dog Town Fork. It is formed in Randall County, Texas near the county seat of Canyon, by the confluence of intermittent Palo Duro Creek and Tierra Blanca Creek. It flows east-southeast; through Palo Duro Canyon in Palo Duro Canyon State Park, then past Newlin, Texas, to meet the Oklahoma state line. From there eastward, it is usually referred to as the Red River, even before meeting the north fork.

The Red River is one of several rivers with that name. It rises in two branches in the Texas Panhandle and flows east forming the border between Texas and Oklahoma, and briefly between Texas and Arkansas. At Fulton, Arkansas, the river turns south into Louisiana to empty into the Atchafalaya and Mississippi Rivers. The total length of this journey is 1,360 miles. The river gains its name from the red-clay farmland of its watershed. Since 1943 the Red River has been dammed by Denison Dam to form Lake Texoma, a large reservoir of 89,000 acres, some 70 miles north of Dallas. Other reservoirs serve as flood control on the river's tributaries. The Red River has a mean flow of over 7,000 ft^3/s.

Much of the river's length in Louisiana was un-navigable in the early 19th century because of a collection of fallen trees that formed a "Great Raft" over 160 miles long. Captain Henry Miller Shreve cleared the logjam in 1839. The river was thereafter navigable only for small craft north

of Natchitoches. The Red River Valley Association was formed to lobby the United States Congress to make the river fully navigable between Alexandria and Shreveport, Louisiana. This project has been completed, and a lock system now allows navigation of barge traffic as far north as Shreveport.

3.1.4 Protected Areas in the Southern Shortgrass Prairie Ecoregion

The International Union for Conservation of Nature (IUCN) defines a protected area as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008). Protected areas serve a variety of purposes for society. They are an expression of our community's goals to maintain the value of biodiversity and to ensure these values are passed on to future generations. They represent the diversity of the earth's history and the current natural processes, and provide many environmental services such as clean air, water, and nutrients. They are treasured landscapes reflecting the inherited cultures of many generations and they hold spiritual values for many societies (IUCN 2005).

Protected areas cover over 13% of the earth's land surface (IUCN 2005). In the United States, over 10,480 protected areas, including state level protected areas, account for 27% of the land area (1,006,619 sq mi) (UNEP 2008). Within the Southern Short-grass Prairie Ecoregion there are 46 federal, state, or privately owned/managed conservation and recreation units including the Buffalo Lake National Wildlife Refuge (see Table 3.1.4.) These protected areas total almost 6 million acres (approximately 30%) of the entire Southern Short-grass Prairie Ecoregion.

3.1.5 Conservation Corridors

Conservation corridors are physical connections between disconnected fragments of plant and animal habitat. Without such connections some species would be unable to reach necessary resources like food, water, mates and shelter. Working with partners to identify key conservation corridors and crucial habitats is needed to conserve the habitat and wildlife species that depend on it. Wildlife corridors in the Texas Panhandle are essentially the watershed areas of local creeks and tributary systems as well as playa lakes; this is no exception for Buffalo Lake NWR.

Drainages within watersheds provide a variety of habitat types such as flat to rolling terrain and escarpments. Vegetation is composed of hardwood forest, brush and grasses along the canal. Frio Draw, which originates near the Texas-New Mexico border gives rise to the Tierra Blanca Creek. Tierra Blanca Creek is located in Deaf Smith and Randall Counties, Texas. The Tierra Blanca and Palo Duro Creeks join together to form the Prairie Dog Town Fork of the Red River. In contrast, playa lakes provide important stop over for migratory birds as well as provide food and habitat for wildlife in the area.

3.1.6 Refuge Location

Buffalo Lake NWR is located Randall County, in the central part of the High Plains area of the

Texas Panhandle. The refuge is 1.5 miles south of the small community of Umbarger, which is 10 miles west of Canyon, 15 miles east of Hereford, and approximately 30 miles southwest of Amarillo.

This area, which the southern end of the Great Plains, is a relatively level, high plateau separated from the Rolling Plains by the Caprock Escarpment. Features of the region are the dramatic Caprock Canyons and Palo Duro Canyon. On the tabletop expanse of the Texas High Plains, a branch of the Red River has carved the incredible spires and pinnacles of Palo Duro. Walls plunge a thousand feet to the canyon floor, exposing brilliant multicolored strata. One of the State's largest state parks, 15,103 acres is located here amid the scenic landscape of Palo Duro Canyon.

Situated astride a canyon carved by Tierra Blanca Creek into the highlands of the Panhandle region of northwest Texas, Buffalo Lake NWR provides diverse habitats that are important to many migratory and resident wildlife species. The primary purpose of the refuge is to provide quality habitats for these species and protect and enhance wildlife populations that depend on these areas.

3.1.7 Surrounding Land Uses

The conservation land status of Buffalo Lake National Wildlife Refuge is just one of a variety of land uses found across the larger landscape. Industrial/urban/suburban/rural developments and agricultural/livestock land uses exist which offer an array of threats to fish, wildlife, and their habitats including invasive plants, feral animals, crop monocultures, habitat fragmentation, pathogens, and pollutants. Buffalo Lake NWR is surrounded almost completely by rangeland used primarily for cattle grazing and dairy operations; the next closest conservation area, Palo Duro Canyon State Park, is located almost fifty miles to the east of Buffalo Lake NWR.

3.2 Physical Environment

This section describes the physical environment in which the Buffalo Lake National Wildlife Refuge is found. It includes a description of the climate, geology and soils, aquifers and groundwater, oil and gas occurrences and potential, environmental contaminants, and water and air quality found at the Refuge; and concludes with a short discussion about the Service's concerns pertaining to those physical resources.

3.2.1 Climate

The refuge is situated in the dry leeward rain-shadow of the Sangre de Cristo Range of the Rocky Mountains, which are located approximately 300 miles to the west. The dry climate of this area is classified as a middle-latitude steppe. Characteristically, temperature and precipitation are extremely variable. Climate data indicates that the average monthly temperatures fluctuate through a combination of high elevation (3727.28 feet above sea level), seasonal dry air masses, and abundance of solar radiation. Precipitation, like temperature, is extremely variable. The average annual rainfall total for the Texas Panhandle is approximately

20 inches per year (Lutgen and Tarbuck, 2001). Most rainfall occurs as a result of thunderstorms during the spring and summer months.

On the refuge, the climate is considered cool temperate. Rainfall occurs as thunderstoms more than general rains. This kind of rainfall is spotty and accounts for variability in precipitation. Rainfall is greatest during May through June and September through October. Dry spells of several weeks or more are common, and there are monthly periods without measurable rain. These periods have occurred in all months except April, May, July, and August. Over the last 20 years, the average annual precipitation has been 18 inches per year.

During winter, frequent cold fronts block moisture from the Gulf of Mexico, and precipitation is limited. When cold fronts occur, snowfall is generally light, remaining on the ground for only a short time. Heavy snowfalls are infrequent and occur when moisture from the Gulf is carried into low pressure centers over the Texas Panhandle. Because much of the snow is driven by wind into high drifts, distribution of moisture is uneven when the snow melts.

Like rainfall, temperature is extremely variable, ranging from -24° C in the winter to well over 38° C in the summer. Average low and high temperatures are 2° C (January) and 25° C (July), respectively. Summer temperatures are hot with rapid cooling at night. Winters are generally mild, but cold air masses from the north may cause brief periods of colder weather. Cold fronts from the northern Rocky Mountains and the Plains sweep across the Panhandle at speeds of 20 to 40 miles per hour. Cold spells usually last two or three days before southwesterly winds from the high plateaus in New Mexico cause rapid warming. Temperatures commonly drop 50 to 60 degrees within 12 hours.

The average recorded wind speed at Buffalo Lake NWR is 11.22 mph with gusts up to 60 mph. Strong continuous winds, common in March and April, cause blowing soil and dust storms. The prevailing winds are usually southerly from May through September and southwesterly during the rest of the year. Winds, in short gusts, are strongest during intense thunderstorms.

Hail may accompany almost any thunderstorm, but damaging hailstorms are infrequent and cover small areas. Hail is most frequent in late spring and early summer. The refuge is located in “Tornado Alley” and numerous watches and warnings occur each year.

Relative humidity is low throughout the year, winds are predominantly southerly, and evaporation rates are high to moderate. Humidity averages 72% at 6:00 a.m. and 38% at 6:00 p.m. The most cloudiness occurs in the months of January through May. The last freeze, on average, usually occurs on April 15. The average date for the first freeze in the fall is November. On average, one out of every five years the first freeze will be before October 16 and/or the last freeze will be after April 23.

3.2.2 Air Quality

Pursuant to the Clean Air Act, as amended in 1977, the Service has an affirmative responsibility to protect air quality related values on national wildlife refuges, with special emphasis on Class I Wilderness Areas (areas in excess of 5,000 acres formally designated as Wilderness prior to August, 1977). Congress gave the U. S. Fish and Wildlife Service (FWS), a Federal Land Manager (FLM) of Wilderness Areas, the responsibility to protect the air quality and natural resources, including visibility, of the area from manmade pollution. Polluted air injures wildlife and vegetation, causes acidification of water, degrades habitats, accelerates weathering of buildings and other facilities, and impairs visibility.

Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has established primary air quality standards to protect public health. The EPA has also set secondary standards to protect public welfare. Secondary standards relate to protecting ecosystems, including plants and animals, from harm, as well as protecting against decreased visibility and damage to crops, vegetation, and buildings.

The EPA has developed National Ambient Air Quality Standards (NAAQS) for six principal air pollutants (also called "criteria pollutants"). They are ground-level ozone (O_3), particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and lead (Pb).

The ambient air quality within the boundaries of the refuge does not vary considerably. Neither the Buffalo Lake NWR or nearby Hereford, Texas has not recorded ambient criteria pollutant concentrations that approach the maximum concentration permitted by the NAAQS. As such, the refuge is not located in or near a nonattainment area and has continued to meet the air quality standards for all six pollutants.

3.2.3 Water Resources

Aquifers and Groundwater

The water saturated sand and gravel of the Ogallala Formation is a major regional aquifer that is the source of almost all of the irrigation water in the Texas Panhandle. Several millions of years ago, strata of the Ogallala Formation stretched from Texas to the Rocky Mountains. Subsequently, stream erosion removed large portions of the rock formation, resulting in the isolation of the High Plains Plateau. Today, the water that replenishes the Ogallala Aquifer originates entirely from rainfall and melting snow. The water table slopes gently to the southeast following the topography of the High Plains surface, and the natural rate of water movement in the aquifer is very slow, no more than one or two feet per day. Before irrigation, the water discharged at natural springs and seeps in the playa lakes and along the caprock escarpments. Today, water is being pumped for irrigation faster than it is being restored by recharge from rainfall. Some springs have dried up and playa lake levels are depressed due to depletion of the groundwater and lowering of the water table.

Direction of groundwater flow on Buffalo Lake NWR is to the south-southeast except where influenced by surface water. Tierra Blanca Creek and a draw entering the southeastern portion of the refuge (designated Southeastern Draw) represent the two viable surface water pathways which drain into the NWR. The watershed for Tierra Blanca Creek is composed of approximately 4403 square km and contains approximately 44 permitted concentrated animal feeding operations (CAFOs) representing approximately 830,000 animals. The former reservoir at the refuge was constructed as a flood control impoundment of Tierra Blanca Creek. Fish kills attributed to run-off from CAFOs located upstream of the refuge in the vicinity of the City of Hereford occurred in the reservoir in the 1960s and the 1970s. The reservoir has not contained water since the 1980s. A concrete flood control dam (Umbarger Dam) was constructed in the refuge at the site of the former reservoir in 1992; however, due to diminished flow in Tierra Blanca Creek attributed to modified land management strategies upstream of the refuge (ie., impoundments preventing CAFO run-off) and the lowering of the Ogallala Aquifer, it is highly unlikely that the reservoir site will sustain enough water to function as a viable lentic body.

Currently, the dry reservoir bed within the refuge is being used to cultivate winter wheat and milo. This area also contains four small perennial ponds that were constructed after the reservoir went dry. Approximately 40 acres of the dry reservoir bed in the far southern portion of the NWR are being utilized as a moist soil management unit (Stewart Marsh). Water for the moist soil management unit is obtained from the Santa Rosa Aquifer and supplemented by inflow from Tierra Blanca Creek. In Texas, CAFOs are not currently permitted to discharge waste from their waste management systems unless a rainfall occurs which is in excess of 24-hour, 25-year event. Individually, the 44 permitted CAFOs within the Tierra Blanca Creek watershed do not represent that much of concern to the refuge. In the event that a 24-hour, 25-year rainfall occurs, the refuge could receive inflow from multiple CAFOs. In addition to the CAFOs located within the Tierra Blanca Creek watershed, another viable contaminant source which could impact the refuge is the El Paso Natural Gas pipeline. This pipeline runs through the northwestern corner of the refuge.

Surface Water and Moist Soil Management

Construction on the 40 acre moist soil unit began in 1996 and was completed early fall of 1998. The unit was constructed upstream of Stewart Dike in the Tierra Blanca Creek floodway. The unit is composed a complex dike system that forms 10 individual 5 acre ponds that have a full depth of approximately 2 feet. Water for these ponds is drawn from a 600 foot well which is in the Santa Rosa Aquifer. This deep aquifer has poorer water quality than Ogallala Aquifer but does not have a strong demand at this time like the Ogallala Aquifer.

As indicated previously, moist-soil units are managed to produce food for ducks in late winter an early spring. Ponds; however, are specifically managed to enhance habitat conditions in late winter and early spring during spring migration. Water levels within each individual pond can

be manipulated to within one tenth of a foot to achieve the maximum vegetation growth and open water potential.

Vegetation within the units will be managed for a variety of moist-soil type vegetation such as barnyard grass, smartweeds, spikerush, and possibly yellownut sedge. Primarily, management of each individual unit will vary between years to discourage the establishment of non desirable plants (i.e. cocklebur) and to promote desirable species. Draw downs will be timed between April and June to promote valuable vegetation. To manage effectively desirable vegetation mowing may have to occur to make forage available to the birds as well as to broadcast seeds. These moist soil units, when wetted up by natural flooding events, has wintered large numbers of ducks often as many 60,000 at times. When naturally flooding occurs from Tierra Blanca Creek numerous species of ducks such as northern pintail, canvasback, ruddy duck, blue-winged teal, mallard, gadwall, and northern shovler nest on the moist soil units. Numerous shorebirds use these ponds as well during both fall and spring migration. However, natural flooding occurs only on rare occasions usually every 5 to 10 years. Therefore, it is imperative to manage this unit for waterfowl during the spring migration to provide much needed resources for their trip to northern breeding grounds.

Water Quality

Water quality is a measure of the suitability of water for a particular use based on physical, chemical, and biological characteristics. Natural water quality varies from place to place, with the seasons, with climate, and with the types of soils and rocks through which water moves. Water quality is also affected by human activities including, but not limited to, urban and industrial development, farming, mining, combustion of fossil fuels, and stream-channel alteration. (U.S. Geological Survey, 2001)

The Clean Water Act of 1977 (CWA) requires states to identify and prioritize waters that do not currently support designated uses. Water bodies that do not meet one or more applicable water quality standards and those that are threatened for a designated use by one or more pollutants are listed on each state's 303(d) list. The 303(d) list includes waters impaired by both point and non-point source pollution. Point source pollution occurs when contaminants enter the waterbody from a distinct localized source, such as a chemical plant or equipment exhaust. Non-point source pollution occurs when contaminants enter the water body from indirect sources, such as residential development or agricultural practices.

While Buffalo Lake NWR does not contain any impaired water bodies that are currently listed in the State of Texas' Commission on Environmental Quality March 19, 2008 303 (d) lists, it does have water quality concerns. A large number of feedlots varying in size and capacity are located within the Tierra Blanca Creek watershed, upstream of Buffalo Lake NWR. Feedlots have long been considered point sources of wastes which can pollute streams (Irwin et. al., 1991). Historically, Buffalo Lake has had increasing problems associated with inadequate inflows and

deteriorating water quality. During recent years, with the exception of major storms of unusual intensity, little or no water flows into the lake.

Water that reaches the refuge after a storm event has often been laden with nutrient rich runoff from the numerous cattle feedlots located within the watershed. Heavy rainfall in 1967 resulted in an almost total fish kill in the lake; fecal coliform bacteria levels were elevated to the point that Federal and State health officials temporarily closed the lake to water contact sports. Information in Service files indicate fish kills occurred in Buffalo Lake in 1959, 1964, 1967, 1968, 1969, 1970, 1971, and 1973.

The Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System regulations established under the Water Quality Act of 1987 dictate that no discharge of waste from cattle feedlots can flow into navigable waters. These regulations were developed to reduce or eliminate discharge of waste and or wastewater from concentrated animal feeding operations into the waters of the state. The Texas Water Commission issued regulations in 1989 regarding feedlots and surface water quality standards and required feedlots of over 1,000 head or dairy operations of 250 head or more to operate with specific permits. This requirement was met by utilizing detention lagoons, ditches, dikes, berms, terraces, or other structures which prevent feedlot runoff from reaching a lake, creek, or river during maximum rainfall, a "25-year 24-hour rainfall event" which is four and one-half to five inches of rain for Randall and Deaf Smith Counties (Irwin et. al., 1991). However, many feedlots are situated or operated such that some runoff drains into Tierra Blanca Creek on days when this rainfall criterion has been exceeded. Additionally, small feedlot operations not required to have a permit or water treatment systems contribute to the point source pollution of Tierra Blanca Creek during all rainfall events.

In 1987, the Service conducted a Phase 1 contaminant investigation of the refuge. The results of this investigation indicated that elevated concentrations of nutrients (nitrogen and phosphorous compounds), salts, copper, strontium, and zinc were found in and downstream of cattle feedlot waste retention lagoons; Tierra Blanca Creek, the major lotic contributor of the refuge, had degraded water quality, primarily attributed to runoff and discharges from cattle feedlots; and nutrient concentrations retained in soils in the dry lake bed in the refuge were elevated to the extent that inundation could create unacceptably high nutrient concentrations in the surface water. In 1993, a Phase II contaminants study was initiated at the refuge by the Service to evaluate the extent of contamination in storm water runoff entering the refuge via Tierra Blanca Creek; determine the extent of contamination in soils and vegetation within the refuge; evaluate the ability of crops grown in the refuge to reduce soil contaminant concentrations; and monitor contaminant levels in soils, surface water, and vegetation of moist soil management units constructed in the southern portion of the refuge. In general, surface water in Tierra Blanca Creek appeared to be not as contaminated in 1993 as it was in 1987. This may be attributed to the

timing of sampling, since rainfall events sampled were not of significant duration or intensity to cause discharges of waste from cattle feedlots in the runoff from upstream of the refuge. With the exception of Pond 2, surface water within the refuge was relatively un-impacted by contaminants. Pond 2 contained elevated metals which may be attributed to the high clay content within the sediments. No obvious trends of contaminant infiltration into the groundwater at the refuge were detected.

Significant surface water inflow into the refuge has not occurred since the Phase I study was conducted in 1987. Detected phosphorous levels in soils from the dry lake bed were lower in 1993 than in 1987; however, nitrogen soil levels were elevated in comparison to the 1987 data. Although elevated, these levels did not seem to cause adverse affects on wildlife feeding on the plants grown in these soils. Nutrient contaminants in runoff from the cattle feedlots that stimulated undesirable eutrophic conditions and caused fish kills in the lake now appear to function as fertilizer for crops. Metal concentrations detected in soils of the dry lake bed were not at levels considered detrimental to wildlife. Nitrogen levels detected in the soils of moist soil management units were more elevated then concentrations detected in the dry lake bed. This may be attributed to the moist soil management units functioning in the capacity of wetlands and acting as sinks for nutrient transport into the refuge from Tierra Blanca Creek. Total polychlorinated biphenyls and residual organochlorine pesticides did not appear to represent a concern within the refuge.

Based on the results of the later study, vegetation and wildlife currently at the refuge do not appear to be adversely impacted. As long as the dry lake within the refuge is managed as a grassland and not as a lake, there is no cause for concern. However, if the lake is filled again, eutrophication will likely occur resulting in situations similar to the 1960s and 1970s fish kills. The moist soil management units located in the southern portion of the refuge serve as limited buffers against contaminated storm water intrusion from Tierra Blanca Creek. However, it is suggested that regulatory agencies reevaluate permitting of so many large scale cattle feedlots in such a small watershed. The potential exists for the refuge to be impacted by millions of gallons of raw, untreated waste from these feedlots in the event of a rainfall of significant intensity and duration (Baker et al., 1998).

Water Rights

Water within the Tierra Blanca Creek watershed belongs to the State of Texas. The United States, in 1938, was issued Permit #1258 from the Texas State Board of Water Engineers granting the right to impound, divert, appropriate, and use appropriated water flow of Tierra Blanca Creek, a tributary of the Red River. At the time, authority was granted to construct an earthen dam with privilege's to impound up to 18,121 acre-feet of water per annum. The Board of Water Engineers of the State of Texas did not allow consumptive use of the lake water. The beneficial use was specifically for recreational purposes only. Included was a provision requiring release of normal creek flow waters to prior downstream appropriators on demand and

when the supply of the normal flow below the dam was insufficient for domestic use. Under the State of Texas, the water rights to impound water in Umbarger Reservoir, operated by the SCS impoundment was a prior appropriation. At the time of project development, the SCS negotiated personally with each landowner on downstream releases to regulate flow on an annual basis as a water conservation measure to assure water for downstream use and store water for recreational uses.

A decree in Civil Suit No. 121 of the United States District Court for the Northern District of Texas, Amarillo Division, stipulated the following:

- normal flow is 3 cfs at the dam site;
- the U.S. Government is permitted to impound floodwater in excess of 3cfs;
- the U.S. Government shall install, maintain, and operate water weirs with automatic recording and measuring devices to accurately judge water flow into Umbarger Reservoir and water flow released from the reservoir;
- the U.S. Government is required to make releases from the reservoir as required by Federal Court Decree, and during a flood period, the maximum required water release would not exceed 3 cfs;
- this decree stipulates that water in the reservoir can be used for recreational purposes only.

Water Management

Area land and water use methods, pumping of underground water supplies for urban and agricultural uses, and decreasing rainfall dried Tierra Blanca Creek and eventually Buffalo Lake. Since Buffalo Lake is normally operated as a dry, non-impounding reservoir, the gates of the dam are left open to pass minor flood water flows caused by rainfall throughout the drainage basin. The dam will detain and store major flood events up to the 100 year flood before overtopping. In October, 1998, the lake filled for the first time since 1978. It was estimated that the lake would be dry again by the summer of 2001.

Stewart Marsh is located at the south end of Buffalo Lake. It is separated from the lake by Stewart Dike. Forty acres of moist soil habitat is maintained by a well at Stewart Marsh. This acreage is separated into ten, four acre compartments which can be managed differently depending on management objectives. In general, management consists of two to three flooding or drawdown events during the growing season to maintain moist soil conditions for maximum plant growth and seed production. Units are flooded during migration and wintering periods to accommodate various populations of waterfowl and other wetland dependent wildlife. Each spring the well is turned on to pump water into the moist soil unit to initiate growth. In the past, when there is water left in the unit, it is released below Stewart Dike into Pond 1 and the marshy area below the dike to initiate moist soil growth in that area. Pumping continues until the unit is filled. This has proven to be successful in providing excellent waterfowl habitat.

Umbarger Dam was constructed under provisions of the Bankhead-Jones Farm Tenant Act of 1937, and conveyed to the Service as Buffalo Lake NWR to be managed for water conservation, recreation, and as a wildlife sanctuary. The lake water comes from Tierra Blanca Creek watershed in the form of rain runoff and natural springs. Approximately 500 square miles of the 15,000 square mile watershed contributes to the Tierra Blanca Creek flows.

3.2.4 Geology and Soils

Geology

About 250 million years ago, a shallow sea covered the area that is now west Texas. Marine mud and gypsum deposited at that time formed the Permian red beds. As sea level dropped, the Permian red beds were exposed and eroded. The climate was dry, and over time a series of rivers eroded the uplands and deposited extensive gravels and sands forming the Triassic red beds on top of the Permian rocks. Erosion continued in the region until about 120 million years ago during the Cretaceous period when sea levels rose and formed a seaway stretching south to north, flooding the continent from the Gulf of Mexico to the Arctic Ocean. Limestone-forming marine mud's accumulated on the floor of the shallow seaway, and dinosaurs lived along its shoreline. At the end of the Cretaceous period, the shallow seaway retreated and the region again was dry land. The Rocky Mountains began to be folded and pushed up at the end of the Cretaceous period, and rivers originating from the mountains and adjacent uplands eroded away many of the Cretaceous rocks that had formed on top of the Permian and Triassic red beds. Most of the Cretaceous rocks were washed away from the area; only a few remnants of Cretaceous rocks occur as outcrops along the edges of some of the large playa lakes.

The deeper basins of the area may have formed by collapse and subsidence over areas of subsurface dissolution of Permian evaporates. The Ogallala Formation and its caliche caprock are exposed in the collapse basins. The early Ice Age history of the basins is not known, but 20,000 years ago during the Late Wisconsin when continental glaciers had pushed south from Canada into the northern Great Plains and alpine glaciers were present in the southern Rockies, the playa basins were filled with water. Lake mud that accumulated in the High Plains lakes during the Late Wisconsin are named the Tahoka Formation and are mapped in numerous lake basins in west Texas and New Mexico. Overflow from the basins formed a river drainage system connecting the various basins on the High Plains surface and spilling out of canyons at the eastern edge of the cap-rock escarpment. The present day draws on the High Plains follow the route of the old river system. About 14,000 years ago the lakes began to dry. Tahoka lake deposits show that the vegetation of the High Plains during the late Ice Age was sagebrush grassland.

The primary physiographic feature of the High Plains is the gently sloping level surface lying at an elevation of about 3,600 feet above MSL. The surface, formed on the Ogallala Formation, is primarily alluvial outwash derived from the eroding Rocky Mountains. The outwash consists of gravels and sand several hundred feet thick deposited more than two million years ago by rivers

and wind. The weathering of the Ogallala Formation resulted in the development of a white calcareous material called caliche which today occurs in lenses only a few feet below the soils on the High Plains surface. On the eastern margin of the High Plains, erosion has exposed the Ogallala formation which is the cap-rock escarpment. The Ogallala formation is the largest freshwater aquifer in the world.

Buffalo Lake NWR is located in a shallow canyon cutting through the southern High Plains of Texas. The canyon was formed by the erosional forces of the intermittent Tierra Blanca Creek as it pursues its course by way of Palo Duro Creek and its famous canyon to the Red River. The underlying bedrock is covered by the Ogallala formation. The lake bed is covered by alluvial deposits of clay mixed with sand and silt. Upland areas are covered by windblown sediments.

Umbarger Dam is located across a narrow valley flanked by 150 foot high canyon walls with caliche cap-rocks. About a mile upstream from the dam the valley widens to form a wide basin bounded by rolling grassy hills. Bedrock at the damsite is of the Ogallala Formation and consists of sandstone, shales, and claystones. The sandstone varies from moderately hard, to friable, to crumbly. Shales and claystones are moderately hard. The colors range through pinks, reds, yellows, and greens. The limy cementation in the caliche cap-rock and along the canyon walls has increased with the rock as water evaporated. Less cementation would be found at a distance of perhaps 200 feet back from the exposed surfaces of the canyon walls. Some ledges of sandstone of a harder quality are found which have a siliceous cementation.

The valley floor, in general, is covered with overburden and plant growth. Bedrock is exposed along the highway cut on the right abutment. Some slumped formation was observed in which the voids have been filled with lime. Geologic data on the current spillway indicates that this structure rests upon the compact layers of claystones, shales, and sandstones of the Ogallala formation.

Soils

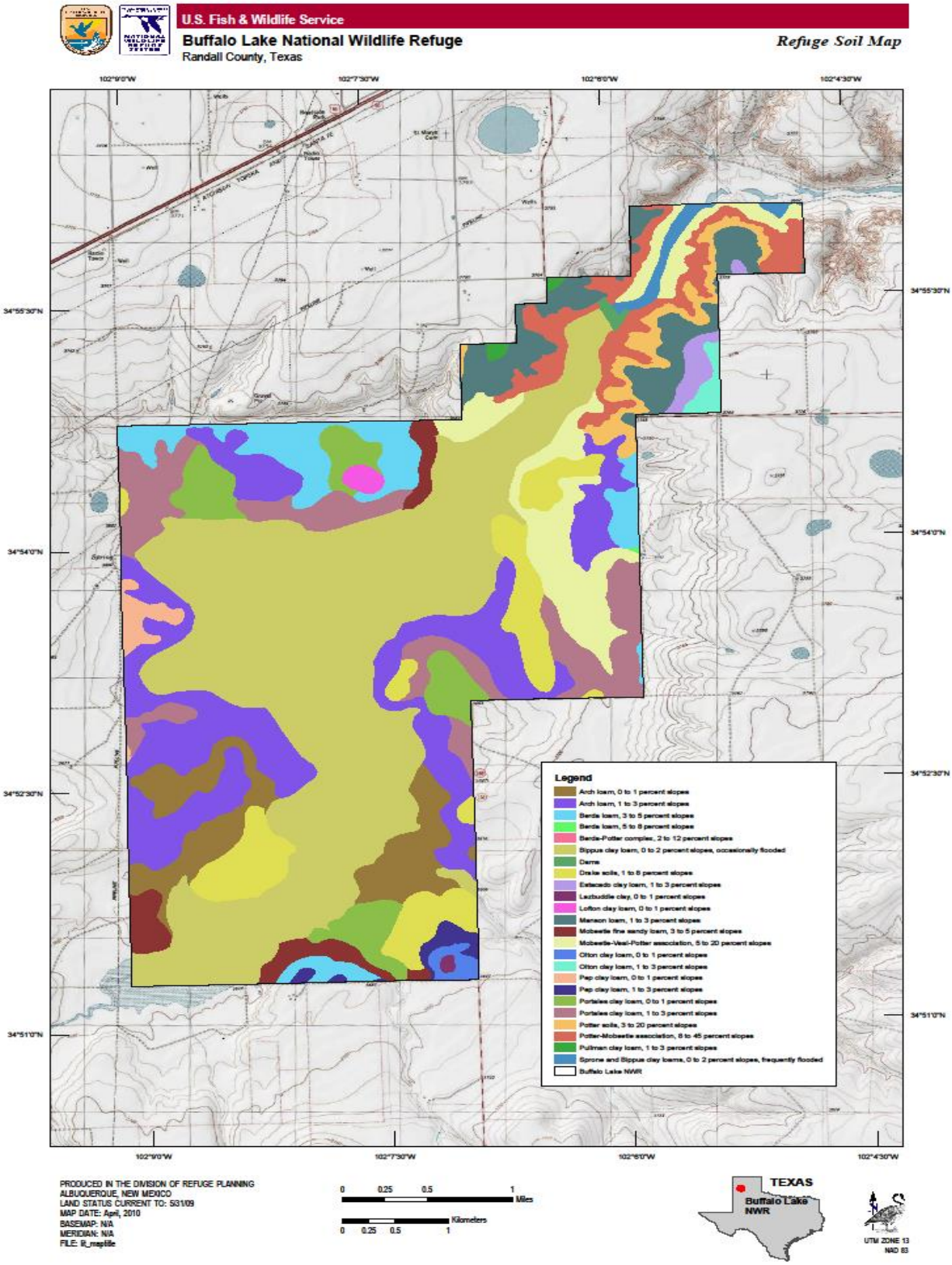
The most productive and most extensive soil in the county is Pullman silty clay loam. On the refuge, this soil type occurs on approximately 230 acres near the northeast corner. It occurs on level or only slightly sloping land and therefore has minimal erosion from runoff. The heavy texture of this soil also minimizes wind erosion.

Alluvial soils along the Tierra Blanca Creek are known as Spur silty clay loam. This soil type has been inundated by Buffalo Lake except for the extreme southwest corner. Prior to the establishment of the lake, this soil was considered well-drained, not subject to overflow, and generally alkali free; however, the establishment of the lake most likely has changed these characteristics.

The Zita clay loam type is found in eight separate occurrences within the refuge. This soil is subject to drifting in heavy winds. Caliche is not ordinarily present in the top 10 inches of this soil type.

At the southeast corner and near the middle-eastern boundary of the refuge are areas of Potter fine sandy loam. This soil type is subject to severe wind erosion.

The largest portion of the refuge is covered by the Potter clay loam soil type, a much shallower soil than the Pullman soil. It is highly calcareous and is well described by its name “chalky land”. It is subject to erosion from both wind and water, and has characteristics which are unfavorable for storing soil moisture. This soil type is best suited for land uses involving grazing.


U.S. Fish & Wildlife Service
Buffalo Lake National Wildlife Refuge
Randall County, Texas
Refuge Soil Map
102°9'0"W
102°7'30"W
102°6'0"W
102°4'30"W
34°55'30"N
34°54'0"N
34°52'30"N
34°51'0"N
Legend
Arch loam, 0 to 1 percent slopes
Arch loam, 1 to 3 percent slopes
Berda loam, 3 to 5 percent slopes
Berda loam, 5 to 8 percent slopes
Berda-Potter complex, 2 to 12 percent slopes
Bippus clay loam, 0 to 2 percent slopes, occasionally flooded
Darma
Drake soils, 1 to 8 percent slopes
Estacado clay loam, 1 to 3 percent slopes
Lazbuddie clay, 0 to 1 percent slopes
Lofton clay loam, 0 to 1 percent slopes
Manson loam, 1 to 3 percent slopes
Mobeetie fine sandy loam, 3 to 5 percent slopes
Mobeetie-Veal-Potter association, 5 to 20 percent slopes
Olton clay loam, 0 to 1 percent slopes
Olton clay loam, 1 to 3 percent slopes
Pep clay loam, 0 to 1 percent slopes
Pep clay loam, 1 to 3 percent slopes
Portales clay loam, 0 to 1 percent slopes
Portales clay loam, 1 to 3 percent slopes
Potter soils, 3 to 20 percent slopes
Potter-Mobeetie association, 8 to 45 percent slopes
Pullman clay loam, 1 to 3 percent slopes
Sprone and Bippus clay loams, 0 to 2 percent slopes, frequently flooded
Buffalo Lake NWR
PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: April, 2010
BASEMAP: N/A
MERIDIAN: N/A
FILE: lf_mapfile
0 0.25 0.5 1 Miles
0 0.25 0.5 1 Kilometers
TEXAS
Buffalo Lake NWR
UTM ZONE 13
NAD 83

3.2.5 Mineral Resources

Oil and Gas Occurrences

The USFWS does not own mineral interest underlying the lands within the Refuge and must provide reasonable access to mineral owners to explore and develop their mineral interests; however, oil and gas activities are allowed to take place on Refuges for a number of reasons. On the majority of refuges, oil or gas activities occur where private entities, states, or native corporations, rather than the federal government, own the mineral rights. Owners of these mineral rights have the right to develop, produce, and transport the oil and gas resources located within a refuge (USGAO 2001). However, the Department of the Interior's regulations requires "to the greatest extent practicable," that "all exploration, development and production operations" be conducted in such a manner as to "prevent damage, erosion, pollution, or contamination to the lands, waters, facilities, and vegetation of the area." Further, "so far as practicable, such operations must also be conducted without interference with the operation of the refuge or disturbance to the wildlife thereon" (50 C.F.R. Part 29.32).

Under the National Wildlife Refuge System Administration Act of 1966, as amended, the Service is responsible for regulating all activities on refuges. The Act requires the Service to determine the compatibility of activities with the purposes of the particular refuge and the mission of the Refuge System and not allow those activities deemed incompatible. However, the Service does not apply the compatibility requirement to the exercise of private mineral rights on refuges. Department of the Interior regulations also prohibit leasing federal minerals underlying refuges outside of Alaska, except in cases where federal minerals are being obtained by operations on property adjacent to the refuge. Nevertheless, the activities of private mineral owners on refuges are subject to a variety of legal restrictions, including Service regulations. A variety of federal laws affect how private mineral rights owners conduct their activities. Also, Service regulations require that oil and gas activities be performed in a way that minimizes the risk of damage to the land and wildlife and the disturbance to the operation of the refuge.

3.2.6 Concerns Regarding the Physical Environment

Environmental Contaminants

This section describes existing and potential sites of environmental contaminants based specifically off Contaminant Assessment Process (CAP) reports. A CAP is an information gathering process and initial assessment of a National Wildlife Refuge in relation to environmental contaminants. Each CAP will analyze particular contaminants of concern to fish, wildlife and other resources on the refuge. A CAP has been conducted for most of the Refuges within the Region and was concluded for Buffalo Lake National Wildlife Refuge on February 3, 1999; the following is a summary of that report.

Suggested baseline sampling sites at the refuge include sediment, water, and aquatic biota samples from the four ponds, soil/sediment samples from the Stewart Marsh Moist Soil Management Unit, the inflow area above Umbarger Dam, the Southeastern Draw as it enters the refuge, and Tierra Blanca Creek south of Stewart Marsh and at the southern boundary of the refuge. Additional sampling could be conducted at Tierra Blanca Creek at Deaf Smith CR BB and in the northwest corner of the refuge where the El Paso Natural Gas Pipeline crosses into the refuge. It is suggested, that a minimum, sediment samples should be analyzed for RCRA metals (including copper and zinc), ammonium salts, and phosphates for baseline purposes.

Climate Change

Climate change can be defined as a change in the state of the climate characterized by changes in the mean and/or the variability of its properties, persisting for an extended period, typically decades or longer (IPCC 2007b). There is consensus in the scientific community that the world climate is changing, and there is enough scientific evidence to affirm that the world is warming and that changes in atmospheric composition are the drivers for global warming (Bierbaum et al. 2007).

The greenhouse effect is a normal process by which greenhouse gases like water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3), absorb infrared radiation emitted by the Earth's surface, by the atmosphere itself, and by clouds and trap heat within the surface-troposphere system (IPCC 2007a), heating the Earth's surface and the lower atmosphere. This warming process has occurred naturally and by means of human activities, primarily economic production activities (IPCC 2007a).

From 1900 to the present, CO_2 emissions have increased from 280 parts per million (ppm) to about 380 ppm (Feely et al. 2004,) at a rate of 1.7 percent per year (IPCC 2007a). From 1990 to 2100, carbon dioxide concentrations are projected to increase from 350 ppm to 770 ppm (Titus and Narayanan 1995). Projected increases in global average surface temperature range from 0.6 to 4°C by the end of the century, relative to 1980 to 1999 levels, depending on different scenarios of economic growth and technological change (IPCC 2007a). Furthermore, assuming constant emissions, temperatures will continue to rise 0.15°C every decade after 2100 for the next two centuries (Titus and Narayanan 1995).

The greenhouse effect has had varying worldwide consequences. Among the most important are:

- an increase in the global average surface temperature, with 11 of the last 12 years (1995-2006) ranking among the 12 warmest years of global surface temperature;
- an increase in atmospheric water vapor content since at least the 1980s;
- a decline in mountain glaciers and snow cover in both hemispheres;

- an average increase in global average sea level of 1.8 millimeters per year between 1961 and 2003, and an increase of approximately 3.1 millimeters per year between 1993 and 2003;
- an increase in average arctic temperatures at nearly twice the global average rate over the last century;
- an increase in intensity and length of droughts since the 1970s; and
- an increase in the frequency of heavy precipitation events over most land areas (IPCC 2007).

Department of the Interior Secretarial Order 3226 states that "there is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decision making…This Order ensures that climate change impacts are taken into account in connection with Departmental planning and decision making". Additionally, it calls for the incorporation of climate change into long-term planning documents such as the CCP: "Each bureau and office of the Department will consider and analyze potential climate change impacts when undertaking long-range planning exercises, when setting priorities for research and investigations, when developing multi-year management plans, and /or when making major decisions regarding the potential utilization of resources under the Department's purview. Departmental activities covered by this Order include, but are not limited to, programmatic and long-term environmental reviews undertaken by the Department, management plans and activities developed for public lands, planning and management activities associated with oil, gas and mineral development of public lands, and planning and management activities of water projects and water resources."

3.3 Biological Environment

This section describes the biological environment in which the Buffalo Lake National Wildlife Refuge is found. It includes a description of the present, historical, and potential future condition of terrestrial and aquatic habitat types found on the refuge, as well as, the natural processes that influence them. It identifies priority wildlife species and focal species used for monitoring purposes, and includes a discussion of various wildlife types found on the Refuge. The section concludes with a short discussion about the Service's concerns pertaining to the biological environment.

Photo 3-2 Ornate Box Turtle USFWS

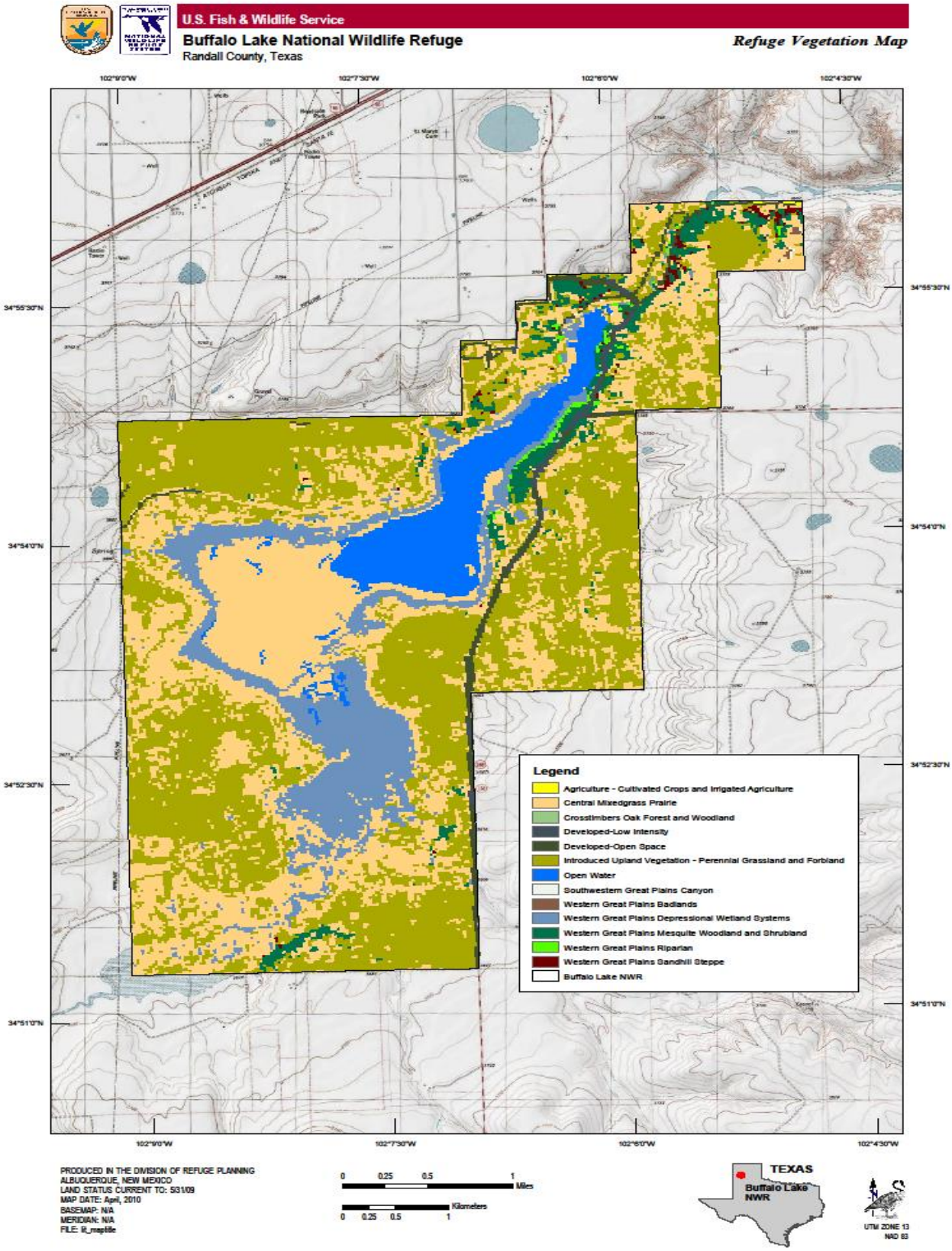
3.3.1 Habitat Types

3.3.1.1 Terrestrial Vegetation Classes

Central Mixed Grass Prairie

This mixed grass prairie system ranges from South Dakota into the Rolling Plains and the western Edwards Plateau of Texas. It is bordered by the short-grass prairie on its western edge and the tall-grass prairie to the east. Regions in west-central Kansas and central Nebraska, the Red Hills region of south-central Kansas and northern Oklahoma are all located within this system. Because of its proximity to other ecoregions, this system contains elements from both short-grass and tall-grass prairies, which combine to form the mixed-grass prairie ecological system throughout its range. The distribution, species richness and productivity of plant species within the mixed-grass ecological system is controlled primarily by environmental conditions, in particular soil moisture and topography. Grazing and fire are important dynamic processes in this system. The relative dominance of the various grass and forb species within different associations in the system also can strongly depend on the degree of natural or human disturbance.

This system can contain grass species such as sideoats grama, little bluestem, big bluestem, needle and thread, prairie dropseed, and blue grama, although the majority of the associations


U.S. Fish & Wildlife Service
Buffalo Lake National Wildlife Refuge
Randall County, Texas
Refuge Vegetation Map
Legend
Agriculture - Cultivated Crops and Irrigated Agriculture
Central Mixedgrass Prairie
Crosstimbers Oak Forest and Woodland
Developed-Low Intensity
Developed-Open Space
Introduced Upland Vegetation - Perennial Grassland and Forbland
Open Water
Southwestern Great Plains Canyon
Western Great Plains Badlands
Western Great Plains Depressional Wetland Systems
Western Great Plains Mesquite Woodland and Shrubland
Western Great Plains Riparian
Western Great Plains Sandhill Steppe
Buffalo Lake NWR
PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: April, 2010
BASEMAP: N/A
MERIDIAN: N/A
FILE: lil_maplile
Miles
Kilometers
TEXAS
Buffalo Lake NWR
UTM ZONE 13
NAD 83

within the region are dominated by western wheatgrass or little bluestem. Numerous forb and sedge species can also occur within the mixed-grass system in the Western Great Plains. Although forbs do not always significantly contribute to the canopy, they can be very important. Some dominant forb species include cuman ragweed, blacksamson echinacea, and rush skeletonplant. Oak species such as bur oak can occur also in areas protected from fire due to topographic position. This can cause an almost oak savanna situation in certain areas, although fire suppression may allow for a more closed canopy and expansion of bur oak beyond those sheltered areas. In those situations, further information will be needed to determine if those larger areas with a more closed canopy of bur oak should be considered part of Western Great Plains Dry Bur Oak Forest and Woodland.

Likewise, within the mixed-grass system, small seeps may occur, especially during the wettest years. Although these are not considered a separate system, the suppression of fire within the region has enabled the invasion of both exotics and some shrub species such as eastern red-cedar and also allowed for the establishment of western yellow pine in some northern areas (Natureserve, 2009).

Southwestern Great Plains Canyon

This ecological system occurs in both perennial and intermittent stream canyons of the southwestern Great Plains. Soils can range from deep loams to alluvial to sandy. The mosaic of soil types which have developed from sandstone, limestone, basalt, and shale parent materials creates a complex mosaic of grasslands, shrublands and woodlands within the canyon system. Although the system combines many elements from southern rocky mountain juniper woodland and savanna, rocky mountain lower montane-foothill shrubland, western great plains shortgrass prairie, and other shrublands, the varied geology, diverse soil types, and topographic dynamics together form a distinct ecological system characteristic of the canyons and dissected mesas of the southwestern Great Plains.

Vegetation varies both regionally and locally depending on latitude, aspect, slope position and substrate and can range from riparian vegetation to xeric- or mesic-woodlands and shrublands. Rocky outcrops with sparse vegetation are also common. Open to moderately dense piñon-juniper woodlands occupy most of the canyonland slopes. Scattered two-needle piñon may occur within these community types but are never dominant. Woodlands may be floristically similar to Southern Rocky Mountain Juniper Woodland and Savanna but are distributed along rocky outcrops, canyon slopes and mesas. One-seed Juniper is the most common tree species and forms extensive woodlands with a grassy understory of black grama, blue grama, hairy grama, sideoats grama, and galleta, or sometimes with an open shrub layer dominated by mountain mahogany. In Kansas, eastern red-cedar can become more dominant and replace oneseed juniper. Isolated patches of Ponderosa Pine or Quaking Aspen are found in some locations. Shrublands occur on canyon bottoms, in narrow side canyons, and integrate with

woodlands on upper slopes. A mosaic of shrub species is characteristic of canyon walls and slopes and varies with substrate and moisture availability. Common species include bigelow sage, mountain mahogany, skunkbrush sumac, current spp., honey mesquite, common hoptree, littleleaf mock orange, and soapweed yucca, James' seaheath and spiny greasebush form a community restricted to gypsiferous and calciferous soils. Canyon floors often support degraded shrubby grassland of rubber rabbitbrush and cholla cactus with a grassy understory.

Because of the varied topography, relatively permanent water along streambeds and southern location, these canyonlands have a rich herpetofauna. This system provides good habitat for a number of snake species that are otherwise uncommon in the Central Shortgrass Prairie ecoregion. Occasional seeps and springs of the canyon walls provide habitat for rare ferns (Natureserve, 2009).

Western Great Plains Badlands

This ecological system is found within the northern Great Plains region of the United States and Canada with some of the better known and extensive examples in North and South Dakota. In contrast to Western Great Plains Cliff and Outcrop, this system is typified by extremely dry and easily eroded, consolidated clay soils with bands of sandstone or isolated consolidates and little to no cover of vegetation (usually less than 10% but can be as high as 20%). Vegetated patches within the badlands system may have cover higher than 20%. In north-central Montana, badlands often are a mosaic of bare substrate with small patches of grasses and/or shrubs that may exceed 10% cover. In those areas with vegetation, species can include scattered individuals of many dryland shrubs or herbaceous taxa, including curly-top gumweed, broom snakeweed (especially with overuse and grazing), greasewood, gardner's saltbush, birdfoot sagebrush, buckwheat spp., plains muhly, bluebunch wheatgrass, and hooker's sandwort. Patches of various herbs and shrubs can also occur. This system can occur where the land lies well above its local base level or below and is created by several factors, including elevation, rainfall, carving action of streams, and parent material (Natureserve, 2009).

Western Great Plains Depressional Wetland System

This system is found mostly in south-central areas of the Western Great Plains Division ranging from southwestern Wyoming and southwestern Nebraska up into the Nebraska Sandhill region, south though eastern Colorado, and New Mexico to central Texas, although some examples may reach as far north as the Badlands of South Dakota. The climate is semi-arid to arid for much of the region in which this system occurs. This system is found on somewhat excessively to excessively well-drained, deep sandy soils that are often associated with dune systems and ancient floodplains. In some areas, this system may actually occur as a result of overgrazing in Western Great Plains Tallgrass Prairie or Western Great Plains Sand Prairie.

Typically, this system is characterized by a sparse to moderately dense woody layer dominated by sand sagebrush, but other characteristic species may be present, including leadplant, honey mesquite (southern stands), chickasaw plan, western sandcherry (northern stands), skunkbrush sumac, and soapweed yucca. Associated herbaceous species can vary with geography, amount and season of precipitation, disturbance, and soil texture. The herbaceous layer typically has a moderate to dense canopy but may include stands with sparse understory. Several mid- to tall grass species characteristic of sand substrates are usually present to dominant, such as sand bluesterm, giant sandreed, prairie sandseed, little bluestem, sand dropseed, giant dropseed, or needle and thread.

In the southern range of this system, Harvard Oak may also be present to dominant and represents one succession pathway that develops over time following a disturbance. Harvard Oak is able to re-sprout following a fire and thus may persist for long periods of time once established forming extensive clones. Edaphic and climatic factors are the most important dynamic processes for this type, with drought and extreme winds impacting this system significantly in some areas. Because harvard oak is able to re-sprout rapidly following fire, fire tends to cause structural changes in the vegetation, and compositional shifts are less significant in most cases. Overgrazing can lead to decreasing dominance of some of the grass species such as sand bluestem, giant sandseed, and little bluestem. In the western extent of this system in the shortgrass prairie, more xeric mid- and shortgrass species such as needle and thread, sand dropseed and blue grama often dominate the herbaceous layer (Natureserve, 2009).

Western Great Plains Mesquite Woodland and Shrubland

This system is found primarily in the southern portion of the Western Great Plains Division, primarily in Texas, Oklahoma and eastern New Mexico. It is dominated by Honey Mesquite with shortgrass species in the understory. Lotebush and fourwing saltbush can co-dominate in some examples, as can paddle cactus species in heavily grazed areas. Short-grass species blue grama or buffalo grass are typically present. Other grasses may include purpe threeawn, sideoats grama, black grama, hairy grama, ring muhly, james' galleta, alkali sacaton, and sand dropseed. Historically this system probably occurred as a natural component on more fertile soils and along drainages, but it has expanded its range into prairie uplands in recent decades (Natureserve, 2009).

Western Great Plains Riparian

This ecological system is found in the riparian areas of medium and small rivers and streams throughout the western Great Plains. It is likely most common in the Short-grass Prairie and Northern Great Plains Steppe but extends west as far as the Rio Grande in New Mexico and into the Wyoming Basins in the north. Major rivers include the North and South Platte, portions of the Arkansas, Cimarron, Canadian and upper Pecos rivers and tributaries to where they extend into Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland. It is found on

alluvial soils in highly variable landscape settings, from deep cut ravines to wide, braided streambeds.

Hydrologically, these sites tend to be flashy with less developed floodplains than on larger rivers that are classified as floodplain systems, and may dry down completely for some portion of the year. Water sources for this riparian system are largely snowmelt near the Rocky Mountains, but it will respond to summer rains. This system includes numerous smaller prairie rivers and streams that are often groundwater-fed, such as the Arikaree River, a tributary of the Republican River. Dominant vegetation shares much with generally drier portions of larger floodplain systems downstream, but overall abundance of vegetation is generally lower. Communities within this system range from riparian forests and shrublands to gravel/sand flats. Dominant species include Eastern Cottonwood, Willow, Silver Sagebrush, Western Wheatgrass, Switchgrass, Vine Mesquite, Sand Dropseed, and Little Bluestem.

On the North Platte in southeastern Wyoming, green ash may be present to dominant. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded. salt cedar, Russian olive, and less desirable grasses and forbs can invade degraded examples up through central Colorado. Groundwater depletion and lack of fire have resulted in additional species changes (Natureserve, 2009).

Western Great Plains Sandhill Steppe

This system is found mostly in south-central areas of the Western Great Plains Division ranging from southwestern Wyoming and southwestern Nebraska up into the Nebraska Sandhill region, south though eastern Colorado, and New Mexico to central Texas, although some examples may reach as far north as the Badlands of South Dakota. The climate is semi-arid to arid for much of the region in which this system occurs. This system is found on somewhat excessively to excessively well-drained, deep sandy soils that are often associated with dune systems and ancient floodplains. In some areas, this system may actually occur as a result of overgrazing in Western Great Plains Tallgrass Prairie or Western Great Plains Sand Prairie.

Typically, this system is characterized by a sparse to moderately dense woody layer dominated by *Sand Sagebrush*, but other characteristic species may be present, including leadplant, honey mesquite (southern stands), chickasaw plum, western sandcherry (northern stands), skunkbush sumac, and soapweed yucca. Associated herbaceous species can vary with geography, amount and season of precipitation, disturbance, and soil texture. The herbaceous layer typically has a moderate to dense canopy but may include stands with sparse understory. Several mid- to tallgrass species characteristic of sand substrates are usually present to dominant, such as sand bluestem, giant sandseed, prairie sandseed, little bluestem, sand dropseed, giant dropseed or needle and thread.

In the southern range of this system, Harvard oak may also be present to dominant and represents one succession pathway that develops over time following a disturbance. Harvard Oak is able to re-sprout following a fire and thus may persist for long periods of time once established forming extensive clones. Edaphic and climatic factors are the most important dynamic processes for this type, with drought and extreme winds impacting this system significantly in some areas. Because Harvard Oak is able to re-sprout rapidly following fire, fire tends to cause structural changes in the vegetation, and compositional shifts are less significant in most cases. Overgrazing can lead to decreasing dominance of some of the grass species such as sand bluestem, giant sandreed, and little bluestem. In the western extent of this system in the shortgrass prairie, more xeric mid- and shortgrass species such as needle and thread, sand dropseed and blue grama often dominate the herbaceous layer (Natureserve, 2009).

3.3.1.2 Aquatic Classes

Playa lakes are the most valuable waterfowl habitat in the Southern High Plains area. It has been estimated that 31,000 playas are interspersed throughout this region of the Texas panhandle; however, playas have seasonal water regimes and, generally, only roughly 5% hold water at any given time. During some years, the refuge provides the only suitable wetland habitat in the area.

The refuge wetlands provide a unique habitat for resident and wintering wildlife. These wetlands include man-made ponds, the reservoir, and the constructed wetlands in the Moist Soil Management Unit (MSMU). Each area provides unique and valuable wintering and migration habitat for waterfowl.

All wetland habitat is only seasonally flooded since the refuge lacks a dependable water supply. Tierra Blanca Creek, in the past, provided a minimal stream flow throughout most years; however, changes in farming practices and upstream impoundments have caused Tierra Blanca Creek to be dry except after heavy rains.

Stewart Marsh and the 40-acre MSMU serve the refuge as a limited buffer against contaminated storm water intrusion, and as the primary habitat for migratory waterfowl, shorebirds, and other associated species. The MSMU wetlands consist of 10 units, each approximately 4 acres in size. Each unit is capable of independent seasonal flooding. The refuge staff floods Stewart Marsh twice a year, in the spring/early summer and again in the fall. During the summer, as the wetlands slowly dry, aquatic plants that are favored by waterfowl take hold. The resulting wet-dry cycle produces a highly diverse plant community and is commonly referred to as simply moist-soil management. For example, Smartweed produces large quantities of nutritious purple seeds that are irresistible to waterfowl. Other aquatic plants include bulrush, pike rush, dock, lambsquarter, millet, and sunflower. These aquatic plants are critical food sources for a variety of migratory and residential wildlife species, a valuable link in the terrestrial food chain (Haukos and Smith 1997). In the fall, the marsh is flooded again just before the winter migration period.

The refuge's MSMUs provide important habitat in the central flyway corridor for waterfowl that are seeking food and shelter during migration.

This unit is flooded each spring, then slowly dries, promoting growth of invertebrates and aquatic plants such as smartweed, bulrush, pike rush, dock, lambsquarter, millet, and sunflower. The unit is flooded again each fall just before the ducks arrive. Additional water is found in artificial ponds and water tanks throughout the refuge.

3.3.1.3 Natural Disturbance Processes

While the climate at Buffalo Lake NWR is considered a temperate semi-arid, significant amounts of rainfall does occur. Most precipitation occurs in the late spring to early summer in the form of rain from heavy thunderstorms. These storms are important for the health of playa lakes in the area. In the resulting downpours from thunderstorms, playa lakes catch the runoff and have the potential to fill. The playa lakes provide important flood control for the land as well as habitats for resident and migratory wildlife.

3.3.1.4 Historical Habitat Description

Historically, the Refuge was a short to mixed grass prairie. This prairie was dominated by blue grama, sideoats grama, and buffalo grass. Trees are rare and only found along the Tierra Blanca Creek and its tributaries.

3.3.1.5 Estimated Future Habitat Conditions due to Climate Change

The information on climate change and its positive or negative impacts are still unknown or undefined. In addition, there is not much modeling or specific data available to assist in predicting how climate change influences the environment on the Refuge.

3.3.1.6 Concerns Regarding Refuge Habitat

Climate Change

The U.S. Fish and Wildlife Service believe that there are concerns regarding the effect climate change may have on the Refuge system. The Service acknowledges that climate change has the potential to alter the distribution of habitat types in Texas and the rest of the world; as habitats change, the wildlife species that inhabit those habitats will also change. Temperatures are projected to increase across Texas (Neilson-Gammon 2008). A warmer and drier climate would lead to greater evaporation, as much as a 35 percent decrease in streamflow, and less water for recharging groundwater aquifers. Increased rainfall could mitigate these effects but could also contribute to localized flooding. Additionally, climate change could give rise to more frequent and intense rainfall, resulting in flash flooding (Zing et al. 2003).

Texas is predicted to have warmer temperatures, with a 3-10 °F rise in winter lows and a 3-7 °F rise in summer highs. Also expected are more frequent intense rainfall events with longer drier periods in between, an increased hurricane intensity, and sea level rise along the Texas coasts, (Union of Concerned Scientists 2009).

The refuge is concerned that if these trends continue, it could eventually lead to changes in vegetative communities and associated species shifts, as well as accelerating and intensifying existing stressors as discussed in Chapter 1 of the CCP.

The refuge plans to document changing conditions through data collection, and adapt management to reflect changes in hydrology and plant communities. Concerns regarding climate change also indicate the need to develop baseline data on refuge habitat resources so that the refuge can appropriately respond to changing conditions.

Habitat Fragmentation

Much of the land surrounding the refuge is used for agricultural purposes, thereby reducing or fragmenting the amount of shortgrass prairie habitat available to wildlife species. Five members of the public provided comments expressing concern over habitat loss associated with development, and one individual requested that the refuge work on preventing fragmentation both on its land and on surrounding lands. The refuge has an opportunity to increase habitat restoration practices beyond its current borders by working with adjacent landowners and acquiring additional lands.

Wind Energy Research

Although there are no wind energy developments being proposed on or adjacent to the refuge, staff is interested in how the presence of such developments nearby may impact migratory birds that use the refuge. In anticipation of possible construction of wind turbines near the refuge, refuge staff has been conducting diurnal avian activity surveys to better understand how wind energy developments may affect migratory birds. The refuge views this development as a potential partnership opportunity and has initiated acoustic monitoring with a current wind energy developer. Refuge staff maintains knowledge of future projects through partnerships with wind energy developers in order to track and anticipate potential changes in habitat fragmentation and wildlife behavior.

Prairie Management and Restoration

Buffalo Lake NWR provides 4,373 acres of native short grass prairie in an area where much of this habitat has been lost through development and fragmentation. Members of the public and refuge staff are concerned with protecting this remaining native short grass prairie habitat provided on the refuge. In addition, the refuge recognizes the need to enhance the quality of existing prairie habitat through restoration efforts.

Photo 3-3 Prescribed Fire on the Refuge USFWS

Prescribed burning and grazing are the primary management tools used to maintain and restore native prairie. When properly managed, grazing and prescribed fire serve to maintain and encourage native grasses and forbs and to cycle nutrients through the ecosystem. The refuge currently leases grazing lands on the refuge.

The public wants to see the continued use of both grazing and prescribed fire on the Refuge to enhance forage types and deter noxious weeds. Specifically, members of the public suggested the use of intensive rotational or patch grazing and burning, recommending that Buffalo Lake NWR mimic the grazing patterns at Muleshoe NWR. In addition, one member of the public requested an in-depth review of the grazing rights and fees associated with the refuge.

Invasive Flora Species

One threat to the refuge is the presence of invasive plant species; however, it is estimated that only 2 percent of the refuge has been encroached upon by invasives. The primary invasive species on the refuge include salt cedar, Siberian elm, Russian olive, kochia, and musk thistle. These plant species out-compete native plant species and reduce the quality and potential of habitat. The majority of the non-native trees are located within or around the edges of the lake

bottom and along Tierra Blanca Creek, but they are not spreading at an alarming pace due to the lack of reliable flooding. Historically, encroachment of woody species into grasslands was minimized by periodic fires characteristic of short grass prairie ecosystems; however, nearby farming, fire suppression, and introduction of exotic species have caused an increase of woody species distribution throughout the short grass prairie. The refuge is concerned about this management problem, and the public identified the need for eradication of certain invasive species through grazing and prescribed burning.

Moist Soil Management

The refuge contains 10 individual four-acre ponds in the Tierra Blanca Creek floodway, which were constructed to compensate for the lack of migratory bird habitat due to the receding water table and subsequent drying of Buffalo Lake. The moist-soil units are managed as necessary to provide annual plant growth to be used as food for ducks in late winter an early spring. These moist soil units have become the fundamental resource bringing migratory birds to the refuge, thereby serving the purpose of Buffalo Lake NWR. Refuge staff is concerned with providing this integral habitat for migratory birds in order to continue serving the purpose of the refuge.

Lakebed Management

The 2,818-acre dry lakebed of Buffalo Lake contains high concentrations of organic contaminants including nitrogen and nitrates that have been deposited over the years from upstream cattle feedlots. One commenter expressed the desire for the lake to be decontaminated, the dam repaired, and the lake refilled so that humans and waterfowl alike could enjoy it. Because of the high contamination levels, however, the refuge is limited in their abilities to manage the lakebed. Current management options do not include re-establishing the lake for this reason coupled with the limited water supply, the potential for spread of disease due to insufficient flows and subsequent stagnant water conditions, and the sheer expense of such a project. Please refer to the discussion in the "Water Quality" section of 1.8.1 or the background information in Section 1.3 for more information on this management problem.

Since it was last drained, the lakebed reverted to monotypic, dense stands of kochia, a non-native invasive plant. These stands restrict native vegetative growth and increase the threat of wildfire, thereby presenting a management problem for refuge staff. Cooperative farming in this area is the primary management tool that the refuge uses to deal with this management problem and reduce organic contaminants in the soil, break up monotypic stands of kochia, and reduce woody encroachment by salt cedar, while simultaneously providing desirable wildlife food sources.

Water Quality

As mentioned in Section 1.3 (Background), the area surrounding the refuge experiences significant flood events during periods of heavy rainfall. These events carry contaminated run-off to the former Buffalo Lake. The refuge is located downstream from multiple cattle

operations in Hereford, Texas. As a result, the surface run-off during flood events contains a high amount of fecal coli form contamination that, if not removed from the flood waters, is transported through the refuge and into the watershed. This is an issue recognized by refuge staff and members of the public.

Receding Water Table

The tapping of the Ogallala Aquifer for residential and commercial uses has caused the water table to drop substantially, causing the natural springs that fed Tierra Blanca Creek to cease flowing. Therefore, Buffalo Lake has gone dry, and the Refuge has a limited water supply for management purposes. Multiple members of the public are concerned about the current water shortage and the potential for continued lowering of the water table. One individual suggested that the refuge adapt its management to the drier habitat that exists there now, and another person wrote that, without water, the refuge may have no value.

3.3.2 Wildlife

The refuge supports a wide array of plants and animals that typically occur in the Texas Panhandle. Conservation of migratory birds is often considered the central connecting theme of the Refuge System. Approximately 50 species of waterfowl and other migratory game birds have been Service priorities since the 1930s. Although the refuge was established to provide habitat for migratory birds, its habitats support a wide variety of wildlife common to the panhandle of Texas, as well as several state and federally-listed species. These species, including game and non-game vertebrates, and invertebrates, are important contributors to the overall biodiversity on the refuge. Management of many of these species remains a collaborative effort with the Texas Parks and Wildlife Department who has primary responsibility for these species off refuge lands. Approximately 345 species of birds, 51 species of mammals, 47 species of reptiles and amphibians occur on the refuge.

3.3.2.1 Priority Species

<u>Threatened and Endangered Species</u>

The refuge provides potential habitat for a variety of species of special interest, including several federally proposed, listed (threatened or endangered) and candidate species and other species of concern. Declines may be related to loss and fragmentation of suitable habitat, increasingly large areas being cultivated for crops, drought, loss of playa lakes, lack of natural fire regime, and the replacement of native grasses with exotic grasses. The refuge provides habitat for several listed and sensitive species. Some species inhabit the refuge on a regular or seasonal basis while others are migrants or accidental visitors that are infrequently sighted on the refuge, as described below. There is no known state, federally-listed or sensitive plants on the refuge or Randall County.

Management actions taken on the refuge will adhere to compatibility standards, National Environmental Policy Act (NEPA), Endangered Species Act (ESA) compliance and Service regulations to ensure that endangered species are not adversely impacted. The refuge will

provide technical assistance on endangered species management to neighbors and individuals from the private sector whenever it is requested. A list of threatened and endangered species that may occur in Randall County, Texas can be found in Table 3-1.

The purpose of the Endangered Species Act is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. Under the law, species may be listed as either "endangered" or "threatened". Endangered means a species is in danger of extinction throughout all or a significant portion of its range. Threatened means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. Proposed species means any species of fish, wildlife, or plant that is proposed in the *Federal Register* to be listed under section 4 of the ESA.

Table 3-1 Rare, Threatened, and Endangered Species of Randall County, Texas.

Taxon	Common Name	Scientific Name	Federal Status	State Status
Birds	Baird's Sparrow	Ammodramus bairdii		
Birds	Western Burrowing Owl	Athene cunicularia hypugaea		
Birds	Ferruginous Hawk	Buteo regalis		
Birds	Snowy Plover	Charadrius alexandrinus		
Birds	Western Snowy Plover	Charadrius alexandrinus nivosus		
Birds	Mountain Plover	Charadrius montanus		
Birds	Prairie Falcon	Falco mexicanus		
Birds	Peregrine Falcon	Falco peregrinus	DL	T
Birds	American Peregrine Falcon	Falco peregrinus anatum	DL	T
Taxon	Common Name	Scientific Name	Federal Status	State Status
Birds	Arctic Peregrine Falcon	Falco peregrinus tundrius	DL	
Birds	Whooping Crane	Grus americana	LE	E
Birds	Bald Eagle	Haliaeetus leucocephalus	DL	T
Birds	Interior Least Tern	Sterna antillarum athalassos	LE	E
Birds	Lesser Prairie-Chicken	Tympanuchus pallidicinctus	C	
Mammals	Gray wolf	Canis lupus	LE	E

Mammals	Pale Townsend's big-eared bat	Corynorhinus townsendii pallescens		
Mammals	Black-tailed prairie dog	Cynomys ludovicianus		
Mammals	Black-footed ferret	Mustela nigripes	LE	
Mammals	Western small-footed bat	Myotis ciliolabrum		
Mammals	Cave myotis bat	Myotis velifer		
Mammals	Big free-tailed bat	Nyctinomops macrotis		
Mammals	Palo Duro mouse	Peromyscus truei comanche		T
Mammals	Plains spotted skunk	Spilogale putorius interrupta		
Taxon	**Common Name**	**Scientific Name**	**Federal Status**	**State Status**
Mammals	Black bear	Ursus americanus	T/SA;NL	T
Mammals	Swift fox	Vulpes velox		
Reptiles	Texas horned lizard	Phrynosoma cornutum		T

Whooping Crane *(Grus americana)*

The whooping crane was listed as endangered on March 11, 1967. Once widespread throughout North America, the whooping crane faced almost certain extinction in 1937 when the wild population dipped to just fifteen birds. The whooping crane has begun a slow but seemingly steady recovery. As of December 23, 1997, crane numbers have increased to 181 (152 adults, 29 chicks). Several factors contributed to the historic decline of the species including the draining of crucial wetland habitats, conversion of habitat to rice culture (Allen, 1952), coastal and marine pollution, illegal hunting, disease, predation, collision with utility lines, loss of genetic diversity within the population, and vulnerability to natural and human caused disturbances which may have had adverse effects on crane behavior. The historic wintering grounds in the southwest included the Gulf Coast of Texas, interior west Texas, and the highlands of northern Mexico (Allen, 1952; Howell and Webb, 1995). Whooping cranes are a common winter resident in Aransas and Matagorda Counties where the largest wild population of this endangered species seems to be slowly increasing (Texas Ornithological Society, 1995). Otherwise, whooping cranes are very rare in Texas other than during migration where they utilize a narrow corridor north of their primary wintering areas. A few rare sightings have been reported on Buffalo Lake NWR, but no documentation exist; typically, when they have reported to the staff at Buffalo Lake NWR, it has been determined that the sighting was not on the refuge and in the greater Western Great Plains depressional wetland system.

Interior Least Tern Error! Bookmark not defined. ***(Sterna antillarum athalassos)***
The interior populations of the least tern were federally listed as endangered in 1984. All subspecies of the interior least tern were abundant through the late 1880s, but were nearly extirpated for their delicate plumage used for fashionable hats at that time. After the signing of the 1918 Migratory Bird Treaty Act, commercial harvesting became illegal and the species began to increase through the 1940s. However, human development and use of interior least tern nesting beaches for housing and recreation subsequently lead to another rapid population decline. In the interior United States, river channelization, irrigation diversions, and the construction of dams contributed to the destruction of much of the terns' sandbar nesting habitat. By the mid 1970s, least tern populations had decreased by more than 80% from the 1940s. The interior least tern nests on saltflats, sand or gravel bars, and reservoir islands in the central United States. Nearby nesting localities are along the Canadian River in the northeastern Texas Panhandle (Seyffert, 2001), the Cimarron River in southwestern Kansas (Thompson and Ely, 1989), and Bitter Lake NWR, New Mexico. The interior least tern is considered very rare in the western third of northern Texas (Texas Ornithological Society, 1995). It is a casual to rare migrant in the western third of Texas, and a rare local summer resident in the eastern Panhandle and along the Red River (Texas Ornithological Society, 1995). Generally, the habitat on the refuge is not available for them unless the water levels of the lake are low and would likely be found in the western Great Plains depressional wetland system. There has only been one documented record of the interior least tern on the refuge (L. Nymeyer, per. com).

Black-footed Ferret ***(Mustela nigripes)***
The black-footed ferret was listed as endangered in 1967 because much of the shortgrass prairie habitat on which the ferret depends had been plowed for crops. They rely on prairie dogs for food and shelter, and live in burrows made by prairie dogs. Almost 90% of their diet consists of prairie dogs. Scientists estimate that over 100 million acres of western rangelands were occupied by prairie dogs in the early 1900s. Much of this area was also occupied by black-footed ferrets. It takes about 100 acres of prairie dog colony to support one ferret family (a female and her young). Prairie dogs have been reduced in number due to habitat loss, disease, and eradication efforts. The black-footed ferret historically occurred in the High Plains, Rolling Plains and Trans-Pecos regions. Central mixed grass prairie would be suitable for black-footed ferrets on the Refuge. Wild populations exist in Wyoming, South Dakota, and Montana. The black-footed ferret was last observed in Texas (Bailey County) in the 1960s (TPWD, 1991). With the existence of a healthy and expanding prairie dog colony complex on the refuge, it is possible that ferrets could be supported in the area depending on future recovery efforts and priorities but would have to be relocated to the refuge.

Gray wolf ***(Canis lupus)***
The gray wolf has been extirpated from the state of Texas.

Black Bear *(Ursus americanus)*
This bear is categorized as federally "threatened by similarity of appearance" to the Louisiana black bear.

Other Species of Concern
Several grassland bird species have been identified as Priority Bird Populations and Habitats by the PIF program for the Short-grass Prairie BCR. These species are indicators of the condition of the grassland and wetland systems within this. Their populations have been emphasized as a priority for monitoring. These include the Swainson's hawk, mountain plover, ferruginous hawk, long-billed curlew, scaled quail, Wilson's phalarope, black-chinned hummingbird, Lucy's warbler, and Cassin's sparrow. The grassland bird species are found in central mixed grass prairie and the western Great Plains depressional wetland system.
There are several avian species of conservation concern that occur in the habitats provided by Buffalo Lake NWR as well as the surrounding areas (B. Howe, per. com). Some of these species have been identified as rare and declining in the Pecos and Staked Plains Physiographic Region of Texas (Shackelford and Lockwood, 2000), as well as in the larger central short-grass prairie region (B. Howe, pers.com.). Many of these species are experiencing serious declines according to over 30 years of breeding bird survey data. These species are indicators of the condition of the grassland and wetland systems within this region. Their populations and habitats have been emphasized as a priority for monitoring by the PIF program.

Through a prioritization process, scores were determined for these species in the central short-grass prairie region. Overall scores for each species represent relative abundance, breeding distribution and nonbreeding distribution, threats to breeding and nonbreeding areas, population trends, and area importance using various criterions established for these categories. There are several species that utilize habitats within Buffalo Lake NWR and are considered a high priority for protection, management, and monitoring at this refuge. The bird species identified for the central Short-grass Prairie BCR that are known to occur in the habitats provided on Buffalo Lake NWR are listed in Table 3.3.2.1.; if data is available, the status of these species at Buffalo Lake NWR are also provided (B. Howe, pers. com.).

The short-grass prairie of Buffalo Lake NWR provides a variety of habitat components that are particularly important to several of these species. The woodland and riparian areas provide nesting habitats and important resting and foraging areas for many migrants. The prairie dog town provides an abundant food source for raptors and nesting areas for burrowing owls. The grasslands of Buffalo Lake NWR are composed primarily of blue grama and buffalo grass with a mixture of lesser dominant mixed short-grass species. The upland areas are interspersed with various densities of forbs, shrubs, and yucca species. It is the forbs and yucca that appear to be important components for attracting several species of conservation concern for breeding and also during migration.

The upland grassland habitats with scattered to dense yucca and forbs are used by many species during migration and winter, such as Baird's sparrow (*Ammodramus bairdii*) migration, Savannah sparrow (*Passerculus sandwichensis*) winter, western meadowlark (*Sturnella neglecta*) winter, and eastern meadowlark (*Sturnella magna*) few in winter. When the yucca are in bloom, these upland areas become intensively used by many species including Bullock's oriole (*Icterus bullockii*), kingbird (*Tyrannus spp.*), loggerhead shrike, and scissor-tailed flycatchers.

The riparian and woodland habitats of the refuge are heavily used during migration and are a very important stopover site for many species of flycatchers, warblers, vireos, thrushes, tanagers, grosbeaks, buntings, and many more.

3.3.2.2 Focal and Representative Species

Focal species are a subset of priority species and represent larger guilds of species that use habitats in a similar fashion. Focal species are selected based on the knowledge that factors limiting their populations are sensitive to landscape scale characteristics and that by addressing the needs of these focal species, other priority species within a guild are expected to benefit. In addition, an appropriate set of focal species includes consideration for the specifics of the respective ecoregion, availability of data and information, and programmatic obligations, as defined in the Strategic Habitat Conservation Report (USFWS 2006). Therefore, focal species are those species and their associated habitats included in CCP objectives and strategies for which protection, management, research, and monitoring efforts will be focused and for which management and protection efforts are necessary to sustain them.

For this CCP, focal species are grouped into three categories, each meeting specific criteria. The first group includes listed species that meet the following criteria: 1) a Federal or State-listed species that is known to (or may) reproduce or nest on the refuge; 2) are representative of particular habitats at risk; and 3) are included in State or Federal landscape-level or conservation plans. The second group includes priority bird species that meet the following criteria: 1) are known to nest on the Refuge; 2) are rare or uncommon on the refuge during any season; and 3) are included in State or Federal landscape-level or conservation plans.

Palo Duro Mouse *(Peromyscus truei)*

The Palo Duro mouse is State listed as threatened. It is known to occur in Texas from the caprock at the eastern edge of the High Plains in Armstrong, Briscoe, and Randall Counties. This mouse is restricted to rocky areas in cedar forests, canyon slopes, and floors in the Palo Duro Canyon region. Areas in the juniper-mesquite association that have large, massive boulders seem to support the highest populations. Their food items include insects, spiders, acorn mast, piñon nuts, and juniper berries depending on the region within their range. In general, the breeding habitats and food habits of this species is poorly known. This species has been identified in Texas as State threatened (Zimmerman et. al., 1990). There is no

documentation of this mammal on the refuge, however, it could possibly occur along the caprock escarpment and bluffs on the western part of refuge. The Palo Duro Mouse is located in the southwestern Great Plains Canyon habitat and crosstimbers oak forest and woodland.

Black-tailed Prairie Dog *(Cynomys ludovicianus)*

Prairie dogs live in short-grass and mid-grass prairies and grass-shrub habitats (Finch, 1992). The historic range of black-tailed prairie dogs covered approximately 100 million acres and extended over 12 states, throughout the Great Plains from southern Canada throughout most of western United States to New Mexico. Of the three subspecies of prairie dogs, black-tailed prairie dogs occupy most of the eastern half of New Mexico, are cited in northwestern Texas, and straddle the Texas/New Mexico border (Jones et al., 1987). Prairie dogs have been reduced to less than one percent of their original range due to poisoning by private landowners, plague, shooting, agriculture, and development. What remains is fragmented into remnants of various sizes. This species is considered a critical link or keystone species, one that significantly influences the distribution, abundance, and or diversity of other species (Kotliar *et al*., 1999; Finch, 1992). It is also considered an ecosystem regulator as their natural behavior patterns lead to manipulation of soils as well as increases in plant and animal densities. Prairie dogs are helpful to other species that benefit from holes, un-vegetated areas, short vegetation, as well as to prairie dog predators (Clark *et al*., 1982). On Buffalo Lake NWR, the Black-tailed Prairie Dog live in the Central Mixed Grass Prairie and depressional wetland system habitats.

One very large and historic prairie dog town, encompassing 640 acres, continues to thrive within the refuge. The population of this town is estimated between 2,500 to 3,500 prairie dogs. The refuge staff continually monitors its status and expansion and has tried various methods to contain the town within the refuge boundary.

The refuge hosts a very large black-tailed prairie dog complex that also supports a variety of other species. There is a surprising diversity of small mammals occurring within the varied habitats adjacent to Tierra Blanca Creek below Umbarger Dam that has the potential for further study and documentation (B. Sullivan, per. com).

Bald Eagle *(Haliaeetus leucocephalus)*

The bald eagle was listed as endangered on March 11, 1967 as a result of population declines due to pesticide-induced reproductive failure, loss of riparian habitat, and human impacts, such as shooting, poisoning, and trapping. Nationwide recovery efforts have improved the population status of this species On August 11, 1995, it was down-listed from endangered to threatened status in the majority of the contiguous U.S., including Texas, due to nationwide recovery efforts (USFWS 2009). In 1999, the bald eagle was proposed for delisting (USFWS 2009). On August 9, 2007, the Service removed the bald eagle from the endangered species list (USFWS 2009); however, it will still be protected under the Migratory Bird Treaty Act and the Bald and Golden

Eagle Protection Act. Texas currently lists the bald eagle as threatened. They are present year-round throughout Texas as spring and fall migrants, breeders, and winter residents. Breeding populations occur primarily in the eastern half of the state and along coastal counties from Rockport to Houston. Non-breeding or winter populations are located primarily in the Panhandle, Central, and East Texas, and in other areas of suitable habitat throughout the state. They can be found in areas such as the western Great Plains Depressional Wetland System and the Western Great Plains Riparian System. Their numbers appear to be increasing in winter and during migration, probably in response to an increase in the number of reservoirs throughout the state (Texas Ornithological Society, 1995). Bald eagle wintering habitat is generally characterized by abundant, readily available food sources. They are opportunistic and will forage on fish, prairie dogs, and sick or dead waterfowl, cranes, and carrion.
Bald eagles frequent the refuge during the winter months (November through February), roosting in trees along Tierra Blanca Creek. Usually three to five adult bald eagles are observed during the mid winter bald eagle surveys conducted each January. Bald eagles did build a nest one breeding season; however, there is probably not enough food in the area to maintain a nesting pair.

White-faced Ibis *(Plegadis chihi)* - *State-listed as threatened*
The white-faced ibis frequents marshes, swamps, ponds, and rivers. It nests in isolated colonies from Oregon to Kansas, but its center of greatest abundance seems to be in Utah, Texas, and Louisiana. They are declining throughout North America, where continuing threats include draining of wetlands and the widespread use of pesticides. They currently are listed as State threatened in Texas. After reaching a population low in the early1970s (Terres, 1980), the species has rebounded in portions of its breeding range. Beginning around 1979, white-faced ibises started moving into the region, and as early as 1973, pairs were breeding at nearby Tucumcari Lake, New Mexico (Hundertmark, 1974). Currently, white-faced ibis are now a common migrant to the area, particularly in autumn (Ryder, 1967). Some birds move southward as transients from breeding areas in San Luis Valley, Colorado. Locally, the species feeds in shallowly flooded playas, generally with vegetation. Open water bodies receive less use. This species is well known for its opportunistic breeding behavior. Colonies shift locations and appear in areas where nesting habitat, usually dense stands of cattails and hardstem bulrush, is readily available. On Buffalo Lake NWR, this is typically the seasonal rainfall areas in the western Great Plains Depressional Wetland System. In 1999, a colony of breeding pairs constructed 20 nests in the dead salt cedars at the south end of Buffalo Lake. Several other colony nesting species, cattle egrets, snowy egrets, and black-crowned night herons also nested in the same area. These birds did not return to the area during the 2000 breeding season (B. Howe, pers. com.).

Mountain plover *(Charadrius montanus)*

The mountain plover was proposed for listing as threatened under the Endangered Species Act on February 16, 1999 (USFWS 1999). This proposal was later withdrawn when the Service determined that threats to the species, as identified in the proposed rule, are not as significant as earlier believed. This species' decline is due to the agricultural and urban conversion of its habitat and pesticide use. Mountain plovers are a disturbance-evolved species that breeds in the Plains and gathers in flocks to migrate to their fall wintering grounds. It is a breeding bird of the shortgrass prairie of western North America, occupying a range extending from Montana to New Mexico and Texas (Graul and Webster, 1976). It has fairly specific habitat requirements, preferring level areas with very short grass and scattered cacti (Graul, 1975). Historically, these plovers were commonly associated with bison and prairie dog towns. The mountain plover requires expansive dry short-grass prairie such as high plains and semidesert mesas having a high proportion of bare ground (>30 percent) for nesting. Typical associated plants include blue grama, buffalo grass, and scattered cacti or forbs. They feed primarily on insects (ants, beetles, grasshoppers, crickets, etc.) and spiders. In New Mexico, the species nests from April through July and may be found nesting in open plains, mesas, or dry playas (lake bed flats). They commonly nest in or near prairie dog towns. Other sites that attract plovers for nesting, include farm fields, highway/powerline rights-of-way, and stock tanks. The mountain plover is found within the Central Mixed Grass Prairie habitat on the refuge.

They prefer to nest in prairie dog colonies and also select nesting sites in areas heavily grazed in summer by livestock because of the low vegetation and generally level terrain. They are somewhat colonial during the breeding season, and may shift their breeding areas from year to year. Historically, the mountain plover was most likely a common breeding bird in the Staked Plains, but during the past century human settlement, the eradication of prairie dogs, and the conversion of native prairie to cropland has significantly reduced the suitable habitats for this species producing a significant decline in the continental population. Their present center of breeding abundance is in Montana, Wyoming, and northeastern Colorado (Graul and Webster, 1976). Mountain plovers occur on the refuge during migration and are usually associated with the prairie dog colonies.

The mountain plover is listed as an accidental visitor to the refuge. The refuge is within this species range and there is potential nesting habitat on the refuge, particularly around the prairie dog town, but nesting has not been documented in the area. It undoubtedly uses the refuge during migration.

Ferruginous hawk *(Buteo regalis)*

The ferruginous hawk is primarily found on grassy prairies, dry mesas, irrigated agricultural lands, and other habitats that support many rodents and rabbits. Ferruginous hawks range over much of the western half of the United States. They prefer forest edge or mature, isolated, flat-topped junipers, with thick support branches for nesting and are highly sensitive to human disturbance. The ferruginous hawk preys mainly on small to medium-sized mammals (Stravers

and Garber 1998). Historically, ferruginous hawks experienced declines in the southwestern states, although recent trends are uncertain (Hall *et al*. 1988). Habitat destruction, reduced prey availability, and persecution have been implicated in the decline of the species (Harlow and Bloom 1989). It is common to see the ferruginous hawk on the refuge. They are regular winter/spring residents of the area. Ferruginous hawks are found in the Central Mixed Grass Prairie habitat.

Conversion of grassland to intensive cultivation has reduced the amount of preferred habitat that is available to the ferruginous hawk and has been implicated in the population decline of the species in some areas (Schmutz, 1984; Olendorff, 1993). Agricultural development has restricted the species to areas of greater topographic relief or other areas unsuitable for agriculture (Stewart, 1975). Nest disturbance, shooting while perched along roadsides, and widespread control of prairie dogs, a vital source of food, are other factors that may have led to the current decline of this species. The fall migration of ferruginous hawks is also tied to prairie dog colony locations, as the hawks eat young dogs as well as other rodents associated with the towns (Dechant *et al*., 1999).

Peregrine falcon *(Falco peregrinus)*

The peregrine falcon was originally listed as endangered on June 2, 1970. Their shrinking numbers were the result of decreased nesting success attributed to accumulation of chlorinated pesticides such as DDT and its metabolite DDE. After banning DDT in the United States in 1972, the population has shown a tremendous comeback from the bird's most critical low level of 30 pairs in the mid 1960s. Through captive breeding and release programs, the population of these birds has rebounded remarkably and has exceeded the recovery goals for this species. Recovery efforts resulted in delisting of the peregrine falcon on August 25, 1999 (64 Federal Register 46543); however, this species is still listed as State endangered in Texas. Regionally, peregrines breed in Colorado, New Mexico, far western Texas, and in the mountains of northern Mexico. Nests are primarily on high, vertical cliffs, but pairs have been reported nesting in trees, on tall buildings, and recently under bridges. Adequate nesting places are unavailable on the western Texas plains, but there is migration habitat, particularly in autumn. Peregrines use a wide variety of habitats for foraging, including riparian woodlands, coniferous and deciduous forests, shrublands and prairies (Finch 1992). Singles are usually encountered near lakes and playas where waterfowl and/or shorebirds are concentrated. There is, on occasion, winter occurrences of peregrine falcons particularly at times when habitats attract masses of wintering ducks. Few peregrine falcons have been seen in spring, but a number of Arctic bound birds apparently overfly (Littlefield, 2000). There is no known nesting habitat on or near the refuge; however, there is migration habitat, particularly in autumn. Single birds are usually encountered near playas where waterfowl and/or shorebirds are concentrated. Peregrines are seen infrequently, but consistently throughout the year on the refuge. Peregrine falcons often utilize central mixed grass prairie, southwestern Great Plains canyon, and the western Great Plains Depressional Wetland System.

Burrowing owl *(Athene cunicularia)*
Burrowing owls are found throughout grassland and deserts in western portions of North America and in drier regions of central and South America. Burrowing owls prefer open area within deserts, grasslands, and shrub-steppe such as central mixed grass prairie, western Great Plains depressional wetland system, and the western Great Plains mesquite woodland and shrubland They use well drained, level to gently sloping areas characterized by sparse vegetation and bare ground such as moderately or heavily grazed pastures. Populations in the northern part of this range are migratory. Burrowing owls prey primarily on arthropods and small mammals and are believed to be opportunistic feeders. They do excavate their own homes; however, they prefer to take use of other burrowing animal dens. They typically nest in vacated prairie dog burrows.

Urban development, conversion of pasture to cropland, and cultivation of grasslands limit burrowing owl populations through the destruction of nesting habitat. Elimination of burrowing rodents through control programs has been identified as the primary factor in the recent and historical decline of burrowing owl populations. The campaign to eradicate prairie dogs in the west has indirectly affected many non-target species, such as the burrowing owl. Prairie dogs have been reduced by 50 percent or more in many areas of the southern High Plains. Currently, the center of abundance of burrowing owls is on the short-grass prairie where remnant prairie dog colonies continue to persist (Littlefield, 2000).

Burrowing owls are common on the refuge in spring, summer, and autumn. Nesting occurs on the refuge, but populations fluctuate with the prairie dog towns. In 1992, a peak population of 34 birds was recorded on the refuge. Typically, in past years, there have been 5-6 pairs, but in recent years, there have only been two pairs nesting on the refuge.

Cassin's Sparrow *(Aimophila cassinii)*
During the breeding season, Cassin's sparrows inhabit short-grass prairies mixed with scattered shrubs, such as the central mixed grass prairie and the western Great Plains mesquite woodland and shrubland. Their populations are known to experience considerable annual fluctuations in abundance, primarily in response to changes in precipitation levels. In the southwestern deserts, they are generally most numerous during wetter years, but become scarce during droughts. As a result of considerable annual fluctuations in abundance, the historic changes in Cassin's sparrow populations are poorly understood in most of their range. The Cassin's sparrow is commonly observed on Buffalo Lake NWR but is of particular interest on Maxwell NWR since that refuge represents the western limit of its normal breeding distribution on the eastern plains (Hubbard 1978).

Black tern *(Chlidonias niger)*

In New Mexico, black terns are found near water at lower (2800 - 5500 feet) and middle (5000 - 7500 feet) elevations (Hubbard 1978). This species breeds and feeds in vegetated marshes with some open water. In 1992, Breeding Bird Surveys denoted significant declines for the species. The black tern was listed by the Office of Migratory Bird Management in 1982 and 1987 as a species of management concern because of indisputable confirmation of widespread declines, fragmented distribution, and dependence on limited wetland habitats (Finch 1992). The black tern is commonly seen in small numbers on the refuge during migration usually in western Great Plains Depressional Wetland System habitat.

Yellow-billed cuckoo *(Coccyzus americanus)*

This species breeds in North America and winters primarily south of the U.S. - Mexico border. The species is associated with lowland deciduous woodlands, willow and alder thickets, second-growth woods, farmland, and orchards. Caterpillars form the main component of the diet, with cicadas, grasshoppers, beetles, bugs, ants, wasps, frogs, lizards, and small fruit being consumed in smaller amounts (Howe 1986). It nests in localized riparian valleys statewide. It occurs at elevations where stream conditions provide sufficient permanent moisture for emergent plants or for a narrow band of deciduous trees and shrubs; at low elevation characterized by cottonwood and sycamore, at mid-elevation by white alder (*Alnus rhombifolia*), and bigleaf maple (*Acer macrophyllum*), and at high elevations by willows. The greatest factors adversely affecting the yellow-billed cuckoo have been the invasion of exotic woody plants into Southwest riparian systems, and clearing of riparian woodlands for agriculture, fuel development, and attempts at water conservation (Howe 1986). Yellow-billed cuckoos are seen and/or heard in most of the woodlots on the refuge, but no definitive evidence of breeding has been observed (Mehlman 1997). They are found in habitats such as the Western Great Plains Riparian System and the Western Great Plains Mesquite Woodland and Shrubland.

Swift Fox *(Vulpes velox)*

The swift fox historically occurred throughout the Great Plain of North America, from southern Alberta/Saskatchewan Canada, and the United States from Montana to western Minnesota, south to New Mexico and the Texas Panhandle. United States populations are currently known from Montana, South Dakota, Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Texas, and New Mexico. In New Mexico, the species occurs on the eastern half of the state, including San Miguel County. Populations are primarily extirpated over much of its historical range. Prairie development and indiscriminate predator control programs are major causes for swift fox declines. Swift foxes are opportunistic predators, scavenging or feeding on small mammals, birds, reptiles, amphibians, fish, insects, grasses, and berries. Their preferred habitat is plains grasslands and deserts with loose sandy soil, but they may also frequent pastures/rangelands, farm fields, and fence rows. In New Mexico, the species is primarily found on Plains-Mesa Grassland and Desert Grassland habitat, commonly on soft soils that support large rodent populations such as kangaroo rats. The refuge is within the range of the swift fox and may provide potential habitat. They typically appear in the Central Mixed Grass Prairie and the Western Great Plains Sandhill Steppe in Texas.

Texas Horned Lizard *(Phrynosoma cornutum)*

The Texas horned lizard was designated the Texas State Reptile in 1992, the same year its precipitous decline was documented. It is State-listed as a threatened species. Of the three horned lizard species in Texas (Texas Horned Lizard, Mountain Short-haired Lizard and Roundtail Horned Lizard), it has the greatest range in the state and is therefore much better known. This species ranges from the south-central United States to northern Mexico. It is found

in arid and semiarid habitats in open areas with sparse vegetative cover throughout much of Texas, Oklahoma, Kansas, and New Mexico. While populations of the species no longer exist in east Texas, they are present, though probably declining, in north and central Texas, and appear stable in south and west Texas. The Texas horned lizard is easily differentiated from the other two species by the double row of spines on each side of the abdomen. It feeds heavily on ants and other insects and arthropods as available. Pesticides, loss of habitat, the displacement of red ants by fire ants, and other causes are suspect in this species decline. Texas horned lizards have been observed throughout the refuge.

3.3.2.3. Birds

The refuge is located within the Central Flyway (see Section 3.1.1.), a route traveled annually by numerous species of waterfowl and other migratory birds, moving between tropical wintering and U.S. nesting areas. Birds constitute the largest group of vertebrate species occurring on the refuge and populations vary according to seasonal migrations. Years of observation and recording indicated that 345 different bird species occur on the refuge, of which at least 76 species are known to nest.

Photo 3-4 Black Necked Stilts USFWS

Many species of neotropical migrants pass through the refuge each spring and fall with many remaining to nest. Neotropical migrant songbirds are those species that nest in the U.S. or Canada and spend the winter primarily south of our border in Mexico, Central or South American or in the Caribbean, such as warblers, flycatchers, tanagers, orioles, sparrows, and numerous other species that provide color and song in the trees. Many of them are experiencing population declines due to the widespread loss of habitats important for their survival. Preservation of many different habitats for nesting, wintering, and migratory stopover sites is becoming vital for the survival of many of these birds.

Additionally, there are several unusual bird species that are either rare in the Texas Panhandle region, have declining populations, or are species of concern. These species nest within the various habitats on the refuge and include: Swainson's hawk, burrowing owl, yellow-billed cuckoo, scissor-tailed flycatcher, loggerhead shrike, Dickcissel, Cassin's sparrow, grasshopper sparrow, eastern meadowlark, orchard oriole, and eastern kingbirds. Other species depend on the habitats on the refuge during migration such as the McCowns longspur, Lapland longspur, chestnut-collared longspur, lark bunting, lark sparrow, Brewer's sparrow, clay-colored sparrow, Sprague's pipit, scissor-tailed flycatcher, prairie falcon, and ferruginous hawk.

Waterfowl Use Days 1974 – 2000

Date	Ducks	Geese	Total
1974	36,988	29,078	66,066
1975	329,883	92,654	422,537
1976	9,601,987	813,330	10,415,317
1977	4,140,067	830,397	4,970,464
1978	10,829,044	511,309	11,340,353
1979	20,720,180	3,449,976	24,170,156
1980	8,387,101	213,168	8,600,269
1981	125,699	2,106	127,805
1982	164,255	61	164,316
1983	39,073	0	39,073
1984	491,547	25,680	517,227
1985	355,975	41,323	397,298
1986	250,351	8,801	259,152
1987	601,383	4,944	606,327
1988	128,189	2,450	130,639
1989	3,617	930	4,547
1990	10,583	0	10,583
1991	43,541	2,430	45,971
1992	7,066	1,890	8,956
1993	201,040	8,225	209,265
1994	145,306	1,813	147,119
1995	8,044	378	8,422
1996	93,618	335	93,953
1997	14,279	356	14,635
1998	9,283	674	9,957
1999	172,215	730	172,945
2000	593,347	66,710	660,057

Grassland-Dependent Species

There are several bird species occurring on the refuge that can only be found in the shortgrass prairie habitats, or depend heavily on this habitat seasonally or during migrations such as the burrowing owl, grasshopper sparrow, Cassin's sparrow, lark sparrow, lark bunting, and mountain plover.

Waterfowl

The refuge and surrounding area has been designated as a "focal" wetland in the Playa Lakes Joint Venture, thereby identifying the area as important to waterfowl, neotropical migrants, and other avian species. Marsh birds, shorebirds, and other waterbird species that may be seen on the refuge include Wilson's phalaropes, American avocets, cattle egrets, black-crowned night herons, white-faced ibis and double-crested cormorants. Peak shorebird and marsh/wading bird migrations at Buffalo Lake NWR occur in August through October (fall migration) and April and May. The numbers of birds from these two groups vary annually depending on the available habitats.

At least twenty four species of waterfowl are frequently seen on the refuge. The number of

waterfowl on the refuge depends on annual habitat conditions and varies from year to year. Large concentration of waterfowl can be observed on the refuge from late September through March. Species most commonly observed with the largest concentrations are: American widgeon, blue-winged teal, gadwall, green-winged teal, mallard, northern pintail, and northern shoveler. In 1999, an unusually high number of snow geese, approximately 2,000, occurred on the refuge in March. Canada Goose numbers usually range between 50 to 400 most years. In the past seven years, few snow geese were observed on the refuge.

At various times since its establishment, the refuge has been a winter haven for approximately one million ducks, 80,000 geese, over 300 species of other birds, approximately 30 species of mammals, and a variety of native reptiles, and amphibians.

Raptors

A variety of raptors migrate through or winter on the refuge including the bald eagle, golden eagle, rough-legged hawk, ferruginous hawk, Cooper's hawk, red-shouldered hawk, Mississippi kite, American kestrel, peregrine falcon, prairie falcon, osprey, and turkey vulture. Several raptor species also nest in the area, including: Swainson's hawk, red-tailed hawk, northern harrier, great-horned owl, burrowing owl, and barn owls. Upland game birds observed on the refuge include ring-necked pheasant, northern bobwhite, and wild turkey.

Photo 3-5 Swainson's Hawk USFWS

3.3.2.4 Mammals

The refuge provides habitat for 8 orders of mammals. Over 50 species of mammals, including black-tailed prairie dogs, mule deer, white-tailed deer, mountain lion, Virginia opossum, raccoon, porcupine, woodrat, coyote, bobcat, red fox, gray fox, badger, eastern cottontail, desert cottontail, black-tailed jackrabbit and a wide variety of rodents that are typical of the area grasslands. The diversity of mammals in families *Rodentia* and *Insectivora* occurring within the

refuge's varied habitats surpasses many places in the Texas Panhandle and warrants further investigation (B. Sulllivan, per. com.). The refuge management objectives for managing these species are to maintain representative populations of each.

The refuge supports large populations of both mule- and white-tailed deer and are in the order Artiodactyla, or even-toed hoofed animals. Mule deer on the refuge can be seen utilizing many habitat types but prefer more open areas. The herd is quite visible year-round and provides a great deal of public view enjoyment. White-tailed deer on the other hand are more skittish and, as a result, are far more challenging to view than the mule deer. The white-tailed deer prefer more cover and often spend most of their time in crosstimber oak forests, woodland and western Great Plains riparian habitats.

Mule and white-tailed deer are regularly observed on the refuge year-round. During the spring and summer months, does and their fawns take advantage of cover and seclusion provided by the crop fields. Since they regularly move on and off the refuge, little is known about their status and population trends.

The refuge has seven species of mammals in the Order Carnivore including the coyote, raccoon, skunk, bobcat, fox, badger, and mountain lion. They utilize all the habitat types on the Refuge including central mixed grass prairie, cross-timbers oak forest and woodland, southwestern Great Plains canyon, western Great Plains badlands, western Great Plains depressional wetland system, western Great Plains mesquite woodland and shrubland, western Great Plains riparian, and western Great Plains sandhill steppe.

There has been one documented sighting of a nine-banded armadillo on the Refuge. Armadillos are in the Order Xenarthra. Armadillos tend to like areas where they can dig relatively easy.

Order Didelphimoria is represented on the Refuge by the Virginia opossum. Opossums like deciduous woodlands but can be found in prairies. They can be found in central mixed grass prairie as well as western Great Plains mesquite woodland and shrubland.

The Order Lagomorpha includes the desert cottontail, eastern cottontail, and the black-tailed jackrabbit. On the refuge these mammals prefer habitats such as central mixed grass prairie, western Great Plains badlands, western Great Plains depressional wetland system, western Great Plains mesquite woodland and shrubland, and the western Great Plains riparian habitats.
The Refuge is home to shrews that belong to the Order Insectivora. Shrews spend most of their time foraging in grasslands for insects. Shrews prefer habitats such as central mixed grass prairie on the Refuge.

Order Rodentia is represented on the Refuge by porcupines, mice, and rats. The porcupines can occupy a variety of habitats including forests, tundra, grasslands, and deserts. They can be found in central mixed grass prairie, southwestern Great Plains canyon, western Great Plains badlands, western Great Plains mesquite woodland and shrubland, and western Great Plains sandhill steppe. Other mammals from the order rodentia include yellow-faced pocket gopher, plains harvest mouse, white-footed mouse, hispid pocket mouse, deer mouse, white-thoroated woodrat, thirteen-lined ground squirrel, and black-tailed prairie dog. They utilize all the habitat types on the Refuge including central mixed grass prairie, crosstimbers oak forest and woodland, southwestern Great Plains canyon, western Great Plains badlands, western Great Plains depressional wetland system, western Great Plains mesquite woodland and shrubland, western Great Plains riparian, and western Great Plains sandhill steppe.

Order Chiroptera consists of bats. Bats that occur in Randall County include members from the families Vespertilionidae and Molossidae. Bats in these families prefer habitats such as southwestern Great Plains canyon, western badlands, and western Great Plains mesquite woodland and shrubland.

For a complete list of mammals on the Refuge refer to Appendix E.

3.3.2.5 Reptiles

There are two orders of reptiles on the Refuge, Order Testudines and Squamata. Order Testudines has three representatives. They include the yellow mud turtle, ornate box turtle and the red-eared slider. The red-eared slider prefers a more permanent water source such as the western Great Plains riparian area. Red-eared sliders can be seen when the moist soil units are flooded or when heavy rains fill up the lake. The yellow mud turtle and the ornate box turtle can be found in grasslands, woodlands, and the moist soil units. The mud turtle and ornate box turtle can utilize a varity of habitats including, central mixed grass prairie, southwestern Great Plains canyon, western Great Plains badlands, western Great Plains depressional wetland system, western Great Plains mesquite woodland and shrubland, western Great Plains sandhill steppe, and western Great Plains riparian. Order Squamata represents the snakes, skinks, and lizards on the Refuge. There are 15 snakes that can be found on the refuge including, Texas blind snake, bullsnake, and prairie rattlesnake. The refuge is home to 6 species of lizards and 1 species of skink. The reptiles in the Order Squamata can be found in all the habitat types including, central mixed grass prairie, crosstimbers oak forest and woodland, southwestern Great Plains Canyon, western Great Plains badlands, western Great Plains depressional wetland system, western Great Plains mesquite woodland and shrubland, western Great Plains riparian and western Great Plains sandhill steppe.

3.3.2.6 Amphibians

Order Caudata and Anura represent the amphibians that can be found on the Refuge. Amphibians need a source of water in order for them to carry out their lifecycles. The barred tiger salamander is the only species the refuge has in Order Caudata. Barred tiger salamanders can be found in the western depressional wetland system and occasionally in the central mixed grass prairie. Order Anura represents the frogs and toads. They can utilize areas with water such as central mixed grass prairie, western Great Plains depressional wetland system, and western Great Plains riparian habitats.

3.3.2.7 Fish

Currently, there is no species list for aquatic vertebrates occurring in the moist soil units or Tierra Blanca Creek.

3.3.2.8 Invertebrates

There is currently no species list for invertebrates for Buffalo Lake NWR; however, numerous invertebrates can be observed in all the habitat types.

3.3.2.9 Concerns Regarding Wildlife Populations

Native Fauna

While many members of the public expressed their general support for the refuge's management of wildlife, concerns regarding native fauna were focused on deer, prairie dogs, bison, gophers, and coyotes. The public has expressed concern that certain native species, including deer and prairie dogs, are currently overpopulated on the refuge. The public raised this issue with concern over resulting damage to habitat and the potential for these overpopulated species to spread onto neighboring lands causing crop damage. Other concerns regarded wildlife disease and balancing wildlife management with providing public use opportunities. One individual also commented with the desire to reintroduce bison on the refuge due to their historic presence prior to their eradication in 1880. Another member of the public expressed concern over the spread of gophers while one individual commented on his perception that the refuge is too focused on protecting coyotes although the refuge manages habitat for the benefit of all wildlife.

Invasive Fauna

There has been a rapid increase in the population of feral hogs across the panhandle of Texas in recent years. Feral hogs can cause massive habitat destruction by rooting into soils when digging for food, subsequently leaving the disturbed soils highly vulnerable to the spread of invasive flora. Although feral hogs are not currently present on the refuge, the refuge recognizes the importance of not letting this invasive species become established on refuge land. Members of the public also commented with concern about the looming threat of feral hogs.

Historical and Projected Population for Randall County, Texas 1900-2040

Year	Population and Projected Growth	Growth Ratio
1900	963	0.00
1910	3312	243.93
1920	3675	10.96
1930	7071	92.41
1940	7185	1.61
1950	13774	91.70
1960	33913	146.21
1970	53885	58.89
1980	75062	39.30
1990	89673	19.47
2000	104312	16.32
2005	110672	6.10
2010	116844	5.58
2015	122613	4.94
2020	128112	4.48
2025	133161	3.94
2030	137012	2.89
2035	139687	1.95
2040	141452	1.26

Source (Historical): U.S. Bureau of the census
Source (Projected): Texas Office of the State Demographer: http://txsdc.utsa.edu/cgi-bin/prj2008otnum.cgi

Shift Refuge Emphasis

The refuge was originally established to provide habitat for migratory birds. At that time, the lake provided habitat for millions of migrating and wintering waterfowl along with other wetland-dependent wildlife. As discussed in Section 1.3 (Background) and 1.8.1 (Ecosystem-Related Management), the lake has since dried up, thereby decreasing the amount of migratory waterfowl habitat available on the refuge. Members of the public also expressed concern over water availability to attract waterfowl. Suggested remedies included keeping water in the lake, the Stewart Marsh area, and behind the dikes, as well as creating a small wetland. Another commenter requested the refuge shift their emphasis from waterfowl to grassland wildlife due to the water shortage.

3.4 Socioeconomic Environment

This section describes the socioeconomic environment of the Buffalo Lake National Wildlife Refuge. It includes a discussion of nearby human populations and economies; the archeological, cultural, and historical resources associated with the Refuge; public use opportunities and access; and public use and FWS administrative facilities. It concludes with a short discussion about the FWS's concerns pertaining to the socioeconomic environment.

3.4.1 Population

Population trends of the 1980s and 1990s suggest that the Texas Panhandle is in a transitional, and somewhat confusing, phase. Between 1970 and 1980, the regional population grew by nearly 60,000 or about 18%. In the 1980's, although the overall population loss was slightly less than 6%, only two counties had statistically significant population gains - Moore County and Randall County by nearly 20% because of Amarillo's southwestward expansion beyond the Potter County line and the emergence of Canyon as a virtual suburb of Amarillo. Of the remaining counties, four lost more than 20% of their population, and thirteen lost from 9 to 19%.

All of these counties are agricultural counties or oil and gas producing counties or both. The decline of formerly reliable industries has compelled a search for alternatives, among which tourism and prisons are promising.

The Ogallala Aquifer remains the Panhandle's most precious resource, and its depletion necessitates earnest consideration and planning if the economic well-being of the region is to endure (Texas Historical Association, 2010).

According to the 1999 census data from the U.S. Census Bureau, the State of Texas had a population estimate of 20,044,141. Among the 50 states, it is ranked second only to California for the most populated. The population of Texas was approximately 7% of the total U.S. population. Between 1990 and 1999, the estimated rate of change for Texas was 18% compared to the national rate of change at 9.6%. Texas has 254 counties. Approximately 99,584 residents live in Randall County. The population change in this county between 1990 and 1999 was estimated at 11.1%. The 1999 census data indicates the composition of the counties' population is 87.7% white, non-Hispanic, 9.4% is Hispanic, 1.5% is black, and the remainder is American Indian or Asian.

Following 2000, the growth trend has significantly slowed in the Texas Panhandle. While the reasons behind this are not specifically identified by the Texas State Demographer, this population growth trend is expected to continue through 2040.

3.4.2 Economy

Economic uses, either public or private, may be authorized on a wildlife refuge when it is determined that the use contributes to the achievement of the refuge purposes or the mission of the Refuge System, and the use is determined to be compatible. Economic uses include, but are not limited to, grazing livestock and cultivating crops. The only economic use currently on the Refuge is a cooperative grazing program and cooperative farming. These programs help the refuge to mimic historical grazing regimes of bison and control of invasive species and reduction of organic contaminants, respectively.

3.4.2.1 Regional Economic Profile

Based on the State of Texas Comptroller's new 13-region economic model of Texas, employment in the High Plains region (covering a 41-county area centered around the Amarillo and Lubbock Metropolitan areas) is projected to grow at a 1.7 percent annual rate, up somewhat from the 1.2 percent rate seen from 1995 to 2000, but slightly slower than the 1.9 percent growth rate expected for the state as a whole. By 2005, total employment in the High Plains region should reach nearly 500,000.

Comptroller projects improving economic growth for the region, based on historical data since 1970. Although the High Plains region has generally under-performed Texas as a whole, the next five years should see growth in line with that seen during the early 1990s and much better than figures posted in the 1980s. The primary challenge for this region is providing the educational skills needed to train the work force to meet the changing needs of business in an Internet economy.

High Plains Region Employment and Growth 1980-2000

	1980	1990	2000	Average Annual Growth Rate
Service to Business	10,853	18,432	25,541	4.40%
Healthcare	18,887	27,909	38,305	3.60%
Tourism and Entertainment	24,959	29,085	40,943	250%
Personal Services	13,187	17,382	20,860	2.30%
State Government	12,982	15,843	18,097	1.70%
Finance, Insurance and Real Estate	25,660	24,784	33,702	1.40%
Local Government	33,959	29,274	44,431	1.40%
Other Services	17,775	19,905	21,898	1.00%
Construction, Building Materials	22,485	20,241	24,772	0.50%
Wholesale and Retail Trade	69,615	68,251	74,067	0.30%
Agricultural, Ag-related and Ag Processing	56,199	50,456	57,137	0.10%
Other Durable Goods Manufacturing	8,768	4,060	8,209	-0.30%
High Tech, Communications Aviation and Electronics	11,681	8,897	10,476	-0.50%
Other Transportation and Public Utilities	16,780	14,008	14,545	-0.70%
Federal Government	5,675	5,722	4,752	-0.90%
Other Non-Durable Goods Manufacturing	6,678	6,321	5,507	-1.00%
Other	1,622	1,349	1,252	-1.30%
Oil and Gas Production, Refining and Petrochemicals	25,522	24,315	16,859	-2.10%

Source: Texas State Comptroller of Public Accounts; REMI

This report details recent economic changes in the High Plains region, presents "baseline" economic forecasts for key indicators through 2005, discusses the structural changes that have led and will lead to economic growth in the region, presents a forecast for occupational changes likely to be seen in the region over the next five years and identifies possible target industries for future development. Economic Development leaders within the region may wish to use this report to guide development of the region's economy in upcoming years.

The Last 30 Years

The High Plains region saw significant growth during the last 30 years of the 20th century. In real terms (1992 dollars), gross regional product in this region–the sum total of all value added within the region–nearly doubled from $10.4 billion in 1970 to $19.8 billion in 2000. This represents an average annual growth rate of 3.3 percent.

During this time, the population of the High Plains region increased only 13.2 percent, from 665,900 to 753,400. As a result of growth in the value of production in the region and somewhat slower population growth, per capita real incomes rose dramatically over the last 30 years. For example, in real terms (1992 dollars) disposable personal income—income not used to pay federal taxes—rose from $13,000 in 1970 to $21,800 in 2000. This means that the average person or household in the region had two-thirds more real purchasing power in 2000 than they did in 1970.

In terms of jobs, growth in this region was good during much of the 1970s and early 1980s. From about 1982 to 1992, the region was buffeted with many of the same economic storms that hit much of Texas oil boom and bust, real estate ups and downs and a national recession in the early 1990s. Starting in 1993, employment growth in the region resumed an upward path and since that time has grown at a 1.8 percent annual rate, compared with the 30-year annual growth rate of 1.3 percent.

These growth rates determine if the region is playing a larger role in the Texas economy. In terms of population, employment and regional product, the High Plains region has declined compared with the rest of Texas since 1970. In 1970, the region accounted for 5.9 percent of the state's population, 6.2 percent of the state's employment and 5.4 percent of the gross regional product. By the end of the century, the region accounted for 3.7 percent of the state's population, 3.8 percent of the state's employment base and 3.3 percent of the value of production.

Shifting Growth Patterns

Even within slowly growing economies, important structural shifts occur over time. These shifts often result from regional and even nationwide changes in production, consumption and technology. Understanding these shifts can help identify prospects for future growth within the region.

The table presents the historical employment figures for the High Plains region for 18 broad industries in 1980, 1990 and 2000. These industries correspond to a functional classification of activities within the region rather than through Standard Industrial Classification (SIC) codes usually used to examine the economic structure of a region. The sectors in this table are ranked according to the average annual growth rate in employment over the last 20 years.

Topping this list is business services. This is largely the result of a long-term reorganization of many existing businesses that increasingly rely on outsourcing. The post-World War II model of industrial organization continues to pare down as more and more responsibilities that were previously held within the structure of the parent firm are now outsourced to other companies. In the case of responsibilities such as janitorial services, this is a trend toward specialization. In the case of copy machine repair, or training personnel to use new computer programs, outsourcing is driven by increasing technological sophistication as specially trained workers are needed to operate equipment. Increased use of contract workers who may replace full-time employees is direct outsourcing and drives the growth of business services employment because some of these contract workers are provided through temporary help agencies.

To a large extent the increasing use of contract labor is merely a reshuffling of employment opportunities from other sectors (manufacturing in particular) to this sector. As such, this shift represents a positive change in the productivity and competitiveness of these businesses rather than degradation of manufacturing capacity.

The second-fastest growing sector in the High Plains region during the last 20 years has been health care. Here, national trends are dominating regional growth. As incomes grow, more and more is spent on health care. As populations age, more and more is spent on health care. The increasing technological sophistication of health care, while improving the effectiveness of health care, also drives up costs. Unfortunately, because health care is a service that most often must be administered by trained professionals on a one-on-one basis, the ability of technological innovations to lower personnel requirements, a byproduct of technology seen in many other industries, has not been as broadly felt in health care. As a result, the demand for health care services has risen rapidly over the past 20 years

The third and fourth fastest growing sectors both reflect the same influence-increasing wealth. With rising incomes, consumers can spend more on personal services and have more leisure time–or at least more money to spend on leisure and entertainment. Rising real incomes are behind many of the gains in the entertainment, tourism and personal services industries.

State government is the only remaining sector displaying an average annual employment growth rate above the long-term average for the High Plains region, although only marginally so. This is attributable mostly to growth in both higher education and prison populations.

At the other end of the growth spectrum are the areas in which the region has lost ground. In some cases, such as oil and gas, this is part of a much wider trend brought on by the distribution of natural resources and industry consolidation. But the appearance of some industries at the bottom of this list, such as high tech, communication, aviation and electronics, may seem puzzling in light of the focus on the growth of these technologically-based industries. In part,

these industries have been recovering in the region in the 1990s after absorbing some major job losses in the manufacture of electronics goods during the 1980s. Some parts of this sector, such as computer programming, have been strong employment growth sectors throughout the last 20 years and will likely continue to be strong sources of growth.

3.4.2.2 Economic Significance of the Refuge

The Refuge's contribution to the local economy includes the local benefits of attracting approximately 5,000 visitors annually. Additionally, there is the direct expenditure of Refuge resources such as salaries to local employees and the purchase of equipment, services, and supplies from local vendors. In the past five years, annual Refuge budget expenditures averaged $450,000; much of which makes its way into the local economy. Refuge Revenue Sharing Act payments from the Department of the Interior are designed to offset the burden that counties feel when Refuge properties are removed from the tax rolls. Buffalo Lake NWR's tax payments to Randall County average $6,000 per year; any fluctuation is related to the refuge's grazing program.

3.4.2.3 Concerns Regarding the Socioeconomic Environment

There are no concerns at this time.

3.5 Archeological, Cultural and Historical Resources

There are 27 historic and prehistoric sites throughout the refuge in the form of transitory camps and hunting sites by early Indian tribes along the edge of the dry Buffalo Lake bed.

3.5.1 Concerns Regarding the Archeological, Cultural and Historical Resources

There are no concerns at this time.

3.6 Current Management and Administration

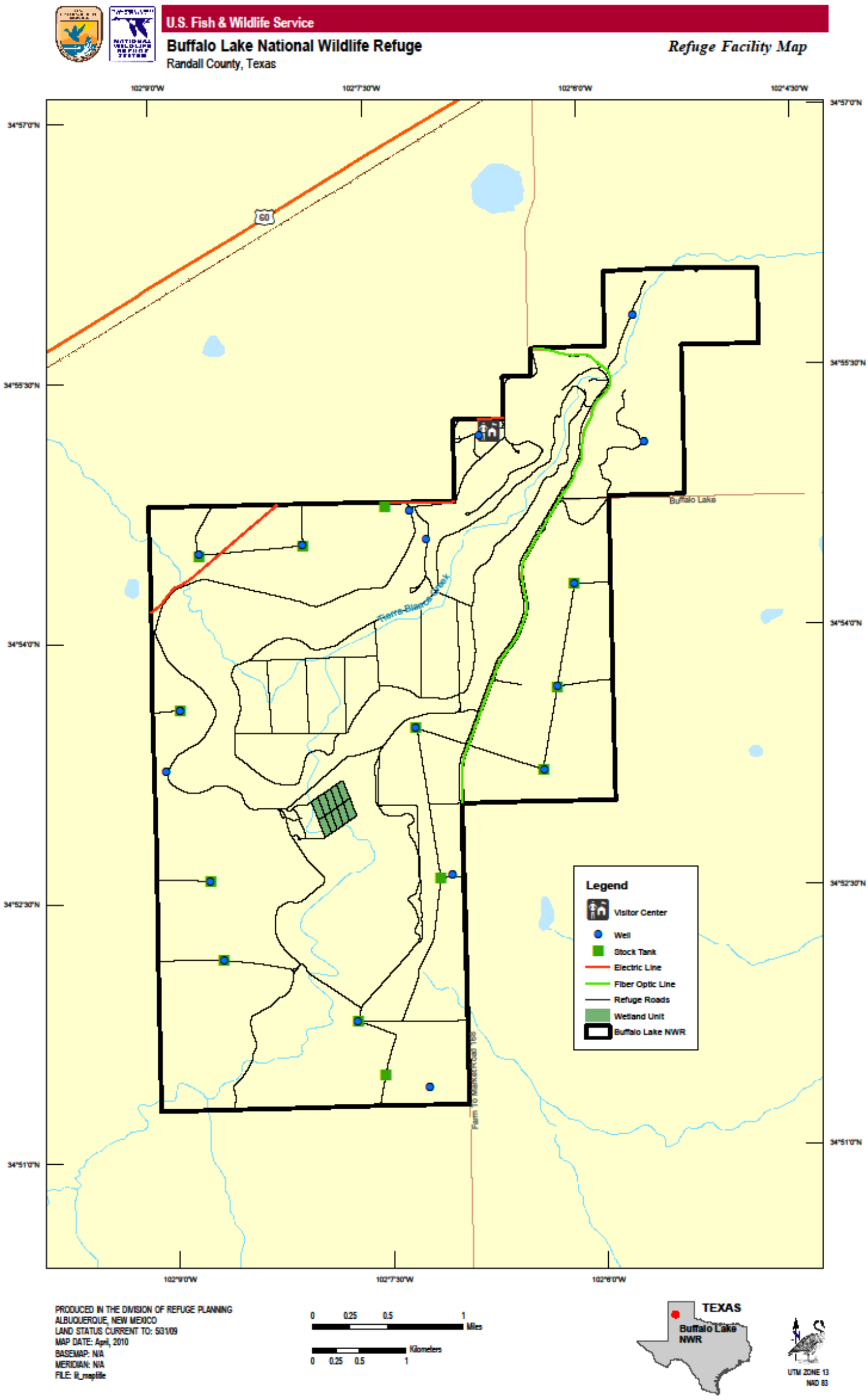
3.6.1 Administrative Facilities

Headquarters

Photo 3-6 Refuge Headquarters Building USFWS

The refuge headquarters complex is situated on 85 acres and consists of an office building, which is also used as a visitor contact center, a shop/maintenance building, two equipment storage buildings, a refuge house with vehicle garage and storage building, two cooperative trailer quarters, an oil storage building, a small storage building, two sign storage bin buildings, a water well pumping station house, and a supply yard storage building. Other outbuildings on the refuge include: two outhouse style restrooms, chemical restroom, two flush style restrooms, an observation blind, and a water well building. There are 25 miles of interior fences and 40 miles of boundary fences.

Above ground fuel storage tanks are also located in the compound. Other refuge facilities include a public restroom. There is interpretive information at the Headquarters Office. The office/visitor center has orientation materials and limited interpretive displays. There are existing power line and telephone rights-of-way within the refuge.


U.S. Fish & Wildlife Service
Buffalo Lake National Wildlife Refuge
Randall County, Texas
Refuge Facility Map
102°9'0"W
102°7'30"W
102°6'0"W
102°4'30"W
34°57'0"N
34°55'30"N
34°54'0"N
34°52'30"N
34°51'0"N
60
Buffalo Lake
Tierra Blanca Creek
Farm To Market Road 168
Legend
Visitor Center
Well
Stock Tank
Electric Line
Fiber Optic Line
Refuge Roads
Wetland Unit
Buffalo Lake NWR
PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: April, 2010
BASEMAP: N/A
MERIDIAN: N/A
FILE: lil_maplite
0 0.25 0.5 1 Miles
0 0.25 0.5 1 Kilometers
TEXAS
Buffalo Lake NWR
UTM ZONE 13
NAD 83

Umbarger Dam

Construction of Umbarger Dam was authorized in 1938 by the State of Texas, to impound 18,121 acre feet (ac-ft) of water. The dam was completed in June of 1940 by the Bureau of Agriculture and Economics for "beneficial purposes of recreation". Soon after its completion it was turned over to the US Forest Service where it remained until 1959 when Buffalo Lake National Wildlife Refuge was formally established.

Although initial intentions of the dam were for the "beneficial purpose of recreation" it also became apparent that it was highly beneficial to waterfowl attracting millions of waterfowl from throughout the flyway shortly after the dam was complete and full of water. Historically, these uses were accommodated with a reasonable degree of compatibility since the bulk of recreational activities on the lake were in the middle of the summer and the greatest concentrations of waterfowl use was primarily during migration with the lake supporting large numbers of wintering waterfowl.

Another beneficial purpose of the dam was water retention. Almost immediately after the construction of the dam, housing developments were initiated in the downstream floodplain within the city limits of Canyon, Texas (PC Refuge Manger Nymeyer).

Today, Umbarger Dam is operated for flood control and detention. This entails the management of the reservoir's impounded waters; normally the sluice outlet gate in the Dam's spillway is partially open allowing two inches of flow downstream. The reservoir provides protection up to the 100-year flood event. At its maximum, Buffalo Lake's reservoir would exhibit a storage capacity of 187,305 acre-feet and a surface elevation o 3,571.1 feet during probable maximum flood (PMF).

Contaminants in Umbarger Dam

Since the inception of the dam there has been some concern about the level of contaminants in the lake following significant rain events. In 1959 a large fish kill occurred in the Lake and it was determined that high concentrations of organic matter had contaminated the lake. An investigation revealed that the pollution was an accumulation of animal waste from upstream stockyards, rotten vegetables from packing sheds and bloody waste from slaughterhouses.

Another fish kill occurred in 1964, initiating a water quality survey by the State Health Department and Texas Parks and Wildlife Department for Tierra Blanca Creek in Randall and Deaf Smith Counties. Again it was determined that the major source of contaminants were from upstream feedlots, vegetable processing plants and slaughterhouses. As a result, all pollution sources were directed by the State of Texas to obtain pollution permits and take action to constrain their water. Feedlot owners were to build retention dikes to hold back runoff from their property and vegetable packing houses and slaughterhouses to treat their effluent.
Heavy rains in the summer of 1967 contributed to over 2,200 acre feet of water in June and 1,100

acre feet of water in July. It was estimated with this event that over 400,000 fish were killed as a result of contaminants bought into the lake form upstream contaminant sources. Coli form counts in the water exceeded 3 million/100ml where the minimum acceptable coli form count for water used for recreational purposes was 200/100ml of water. The results of these tests initiated total closure of the lake and the entire lake was immediately posted and closed.

Irwin and Dodson (1991) documented severe contamination of BLNWR during the initial contaminant survey in 1986. Upstream watershed from BLNWR included numerous combined animal feedlots (CAFO). Approximately one million dry tons of manure is generated annually by an estimated 500,000 head of beef cattle within the 1,724 square mile watershed of Tierra Blanca Creek and Frio Draw.

Umbarger Dam Safety and Design

In January of 1941, the downstream water users became concerned about the reduced flow in Tierra Blanca downstream from the dam. An injunction was issued in January 1941 to restrain the Department of Agriculture from impounding water. At that time a court decree was issued to govern storage and release the water. The government could store all flow in excess of 3cfs. Although a modification to this decree was made in 1946, the January 1941 court decree was reinstated in October of 1947 and remains in effect today.

On June 4, 1941 water flowed through the dam spillway for the first time. Department of Agriculture engineers found the spillway deficient almost immediately. Analysis of the original problems revealed that a flood crest of four feet sustained at that level for a time instigates turbulence that can break apart the concrete floor of the spillway apron and expose the earthen fill to erosion.

In 1949, reconstruction of the spillway was analyzed along with construction plans and cost estimates. The project was deferred due to a lack of funds. In 1964, the Corps of Engineers completed another study which specified that the spillway was structurally and hydraulically inadequate to pass large flood flows.

In May of 1978, the lake filled within 5 feet of the spillway in a 4 hour period. After many years of insufficient water in the lake there was new hope for recreational activities. However general concern of dam safety resulted after several dam failures around this same period was occurring throughout the country. Under increased public pressure the Service requested assistance in determining safety of the spillway from the Bureau of Reclamation. It was concluded that that a total reconstruction of the spillway or breaching the dam were the only alternatives to solve the

safety problem. Service engineers recommended the immediate draining of the lake as a public safety measure in the event a second major storm would fill the lake, overflow the spillway and potentially blow out the dam.

On August 22, 1978, officials agreed to a discharge of 30 cubic feet per second, however a Federal District Judge in Lubbock, Texas had issued a temporary restraining order against further drainage of the lake based on a file for injunction by the Buffalo Lake Survival Committee. Ultimately the Judge ruled that no irreparable harm would result from the draining and that the public interest would be served by protecting life and property and allowed the lake to drain. In his written opinion, he noted that the State of Texas dam construction standards required that the dam must be capable of withstanding a 100 year flood event. Therefore, the drain gate was opened and the once again on September 8, 1978 and the lake was completely dry by the end of March of 1980.

Modifications to the dam were initiated in 1991 and completed in 1993. This work involved replacing the old dirt dam with a new dam with the placement of roller compacted concrete (RCC) over the top of the dam. These improvements were designed to resolve dam safety issues, provide temporary flood retention, and maintain existing flood control benefits.

The most recent dam inspection reports (2012) identified a problem with RCC on top of the dam. The top two lifts are “tenting” and an analysis by Schnabel and Associates predicted that a 100 year flood event may cause sufficient uplift to lift off the top two RCC lifts and potential for a cascading failure effect of the remaining RCC lifts and an erosion failure to the embankment.

Today, Umbarger Dam is operated for flood control and detention. This entails the management of the reservoir’s impounded waters; normally the sluice outlet gate in the Dam’s spillway is partially open allowing two inches of flow downstream. The reservoir provides protection up to the 100-year flood event. At its maximum, Buffalo Lake’s reservoir would exhibit a storage capacity of 187,305 acre-feet and a surface elevation of 3,571.1 feet during probable maximum flood (PMF).

Randall County Roads

There are no county roads that bisect or surround the Refuge. Farm to Market Road 168 is a State road.

Electric Cooperative

An easement for an overhead transmission line crosses the refuge from north to south, for approximately 3 miles. There is a 25KVA transformer at the headquarters, which provides power to the office, shop buildings, and the residence.

Mid-Plains Rural Telephone Coop
An underground telephone line runs through the refuge primarily through refuge administrative areas.

3.6.1.2 Partnerships

Although there are no wind energy developments being proposed on or adjacent to the refuge, staff is interested in how the presence of such developments nearby may impact migratory birds that use the refuge. In anticipation of possible construction of wind turbines near the refuge, refuge staff has been conducting diurnal avian activity surveys to better understand how wind energy developments may affect migratory birds. The refuge views this development as a potential partnership opportunity and has initiated acoustic monitoring with a current wind energy developer. Refuge staff maintains knowledge of future projects through partnerships with wind energy developers in order to track and anticipate potential changes in habitat fragmentation and wildlife behavior.

3.6.2 Habitat Management

Climate Change
In order to minimize the refuge's impact on climate change, refuge personnel actively recycles plastic, paper, printer cartridges and motor oil. Refuge staff collects plastic, paper and other recyclables and transports them to the Canyon, Texas recycling dumpsters monthly. While the refuge does not address climate change in the environmental education program, it has installed solar panels, planted native trees, and recycles in an effort to reduce the carbon footprint.

Habitat Fragmentation
Currently, all of the refuge facilities are necessary for day-to-day operations and no new construction projects are proposed. Under the no action alternative, the refuge would continue to limit the creation of new roads and infrastructure (e.g., fences) in order to protect habitat integrity and promote the natural movement of wildlife. Existing fences, roads, fire breaks, utility right-of-ways, and trails would continue to be maintained regularly as they are necessary to carry out the current management programs for the refuge.

Wind Energy Research
In anticipation of possible construction of wind turbines near the refuge, staff currently works with a regional wind energy developer to conduct a diurnal avian activity survey and acoustic monitoring. These efforts are conducted in order to better understand the impacts of wind energy developments on migratory birds.

Prairie Management and Restoration

The refuge has been using grazing as a management tool since 1959. Prior to refuge establishment, grazing was permitted during management by the U.S. Forest Service. From 1959 through 1984, grazing on the Refuge took place annually in the fall, spring and summer. Grazing permits were issued to multiple permit holders each grazing season. In 1963, no summer grazing took place and summer grazing was cut from the annual grazing regime. In 1969, the Bureau of Land Management, the refuge and the Palo Duro Soil and Water Conservation District developed a plan for future guidelines of land use on the refuge. In the plan, a six month grazing program was established in which grazing could take place from October 1 to March 31. Animal Units and Animal Use Months that utilized the grazable units of the refuge were dependent upon range conditions. For example, if the area was in a drought and range conditions poor, fewer (or no) animal units were allowed to graze. If conditions were good, more animal units were allowed to graze. In 1986, competitive bids were sought from qualified livestock operators within a 30-mile radius of the refuge; the minimum bid was set at $8.30/AUM. No grazing took place on the Refuge during the following years: 1994, 1995, 1998, 2001, and 2002 due to extensive drought.

Grazing on the refuge is used as a valuable habitat management tool that mimics the historical grazing of bison. Controlled livestock grazing helps keep the grassland in natural conditions; the removal of dead vegetation and hoof action are beneficial to the grassland by aerating the soil and re-seeding native vegetation which prevents plant stagnation and promotes plant succession. Improved range conditions from effective grazing practices can provide habitat conditions that are desirable for diversity of animal populations.

All units have a water source to provide clean fresh water for the livestock. The stock tanks provide water for livestock as well as wildlife and are filled either via windmill or through a network of pipes. Grazing units are grazed according to the Natural Resource Conservation Service (NRCS) take half leave half regime.

Photo 3-7 Livestock Grazing on the Refuge USFWS

Fencing, watering, husbandry, and control of livestock will be the responsibility of the cooperative private party. Frequency and control of livestock will be based on site-specific evaluation of the grassland unit being managed.

Units are grazed get deferred from grazing the following year in order to allow adequate recovery time of the grassland. Stocking rates, areas to be grazed, and seasons to be grazed are determined by refuge staff.

The 12 grazing units consist of grasslands that are grazed for management purposes and to enhance wildlife habitat for grassland species such as mountain plovers, northern bobwhite quail, scaled quail, chipping sparrow, field sparrow, grasshopper sparrow, meadow larks, horned larks, and numerous other bird species. All units have a water source to provide clean fresh water for the livestock. The stock tanks provide water for livestock as well as wildlife species and are filled either via windmill or through a network of pipes. Grazing units are grazed according to the (NRCS) take half leave half regime.

The refuge has 12 grazing units consisting of 4,156 acres that could potential be used to graze. The grasslands consist primarily of buffalo grass-blue grama short-grass prairie. Other grasses that can be found in the units include: sideoats grama, western wheat grass, sand dropseed, little bluestem, and other grasses. The refuge utilizes a graze/rest rotation. If an area is grazed one

year the following year the grazed portion is deferred (rested). Cattle numbers will be evaluated annually based upon range site conditions for each pasture being grazed. Cattle numbers will utilize the animal use month system and be based on requirements to remove 50 percent of annual forage production. With changing environmental conditions, cattle numbers may vary considerably from year to year and grazing will be terminated anytime continued grazing would be detrimental to the grassland.

Currently, permit selection for refuge grazing is conducted by sealed bid. To be eligible to bid, a bidder must be a current livestock operator and have at least a portion of their livestock operation within a 30-mile radius of the refuge. Other regulations include no sub-leasing of cattle; a bidder must own at least fifty-one percent of the cattle that are to be grazed on the refuge. If the bidder desires some other person(s) cattle to help make up all or part of the remaining forty-nine percent of livestock needed to equal the total AUMs that are required, the bidder can select whomever they choose; however, the bidder can only collect from that person the same dollar amount per AUM as was awarded on the bid. The bidder would be solely responsible for the livestock grazed, the amount paid and all grazing regulations. Additional AUMs may be allowed dependent upon the grassland conditions; switching cattle is not permitted once grazing has started and all livestock will be marked (branded or ear-tagged) so as to identify the bidder as the owner. Overall care of livestock is the responsibility of the bidder, no insecticides may be used on livestock while they are on the refuge and the permit holder is restricted to designated access routes and areas of travel within the Refuge. If the permit holder must be on the refuge before or after dark, refuge personnel must be notified prior to going onto the refuge. The permit holder will also maintain all fences and stock watering facilities and is liable for any damages to refuge facilities such as fences, water tanks, and other property caused by livestock. The refuge manager reserves the right to discontinue grazing on any or all pastures at any time should conditions change and continued grazing would potentially damage the range environment. Should grazing be terminated due to environmental change, the fee the bidder has paid for unused AUMs will be refunded. Any violations of the grazing regulations will result in the immediate cancellation of grazing on the Refuge. Bid forms are mailed to interested cattle owners/operators and bid are accepted in sealed envelopes. On a preselected date the envelopes are opened and the highest bidder gets the permit to graze.

In 2011, grazing units 5 and 6 were bid out for grazing. A total of 522 AUMs were bid for 5 months. Grazing starts on May 15 and continues through October 15. Under Alternative A, grazing would continue as a prairie management and restoration tool.

Prescribed Fire

Each of the 7 existing fire lanes would continue to be maintained by refuge staff while the Zone Fire Crew would remain stationed at the Wichita Mountains Wildlife Refuge. Prescribed fires would continue to take place during the early spring months each year.

The current Fire Management Plan (FMP) for the Refuge was written in 2009. The purpose of this FMP includes the following:

1) To meet and supplement policies, objectives, and standards for fire management presented in the Department Manual (620 DM), Service Manuals (095 FW 3, 232 FW 6, 241 FW 3, and 241 FW 7) and Fire Management Handbook (621 FW 1-5)
2) To help achieve resource management objectives defined in the refuge's Comprehensive Conservation Plan and resource-management plans.
3) To provide refuge staff written guidance in carrying out fire management operations.

Fire represents an ecological factor very important in the development and structure of nearly every terrestrial ecosystem in North America and has been present in natural ecosystems since the origin of climates on earth. It has been well established that plains and hardwood timber ecosystems historically experienced frequent, fast running, short duration fires. Recorded accounts of early European explorers and settlers indicate that fires were a common occurrence on the plains and were often ignited by lightning activity during the late spring to early autumn seasons. Further, these writings note that the plains were often on fire because of Native-American attempts at signaling others, herding game, to adjust the vegetation mix and to clear campsites.

This FMP implements these guiding principles of federal wild land fire policy:

- Firefighter and public safety is the first priority in every fire management activity.
- The role of wild land fire as an essential ecological process and natural change agent has been incorporated into the planning process. Federal agency land and resource management plans set the objectives for the use and desired future condition of the various public lands.
- Fire management plans, programs, and activities support land and resource management plans and their implementation.
- Sound risk management is a foundation for all fire management activities. Risks and uncertainties relating to fire management activities must be understood, analyzed, communicated, and managed as they relate to the cost of either doing or not doing an activity.
- Fire management programs and activities are economically viable, based upon values to be protected, costs, and land and resource management objectives.
- Fire management plans and activities are based upon the best available science.
- Fire management plans and activities incorporate public health and environmental quality considerations.
- Federal, State, tribal, local, interagency, and international coordination and cooperation are essential.

Standardization of policies and procedures among federal agencies is an ongoing objective.

This FMP meets the direction in the National Fire Plan because it emphasizes the following primary goals of the *10-Year Comprehensive Strategy and Cohesive Strategy for Protecting People and Sustaining Natural Resources*:

- Improving fire prevention and suppression,
- Reducing hazardous fuels,
- Restoring fire-adapted ecosystems, and
- Promoting community assistance.

Invasive Flora Species

The primary invasive species on the refuge include Salt Cedar, Siberian Elm, Russian Olive, Kochia, and Musk Thistle. These plant species out-compete native plant species and reduce the quality and potential of habitat, although they have only encroached upon 2% of the refuge. The majorities of the non-native trees is located within or around the edges of the lake bottom and along Tierra Blanca Creek, but are not spreading at an alarming pace due to the lack of reliable flooding.

The refuge is currently using 100 gallon pump sprayers to treat Salt Cedar and occurs from May through September, weather permitting. Kochia and Musk Thistle is treated using a 50 gallon pump/boom sprayer; Kochia is treated spring and summer depending on available staff while Musk Thistle is usually treated in April and May or while the they are in rosette stage. The products that are used to treat invasive species include Roundup Pro, Glyfos X-Tra, Garlon 4, Garlon 3A, Habitat, and the corresponding surfactants. All products are used following the label instructions.

The refuge would continue to remove invasive species, including salt cedar, Russian olive, and musk thistle, by manually-applied chemical means. This management is guided by the refuge's Integrated Pest Management Plan completed in 2001.

Moist Soil Management

Historically, Buffalo Lake provided 2,818 acres of wetland habitat. Since the lake has dried, the refuge has used moist soil management units to mimic this historic habitat. Currently, the refuge provides wetland habitat to migratory waterfowl, shorebirds, and wading birds on a total of 40 acres (less than 0.01 percent of the refuge's 7,664 acres) comprised of ten 4-acre ponds. Wetland habitat, then, makes up only 1.4 percent of the original habitat provided by Buffalo Lake. These plants provide calories required for migration for waterfowl and shorebirds as well

as providing an additional food source for numerous species of wading birds. Units are flooded during migration and wintering periods to accommodate populations of waterfowl and wetland-dependent wildlife.

Lakebed Management

When the dam was constructed in 1938 on upper Tierra Blanca Creek, it created an artificial reservoir with a capacity of 18,150 acre-feet. In the 1950s, a severe drought adversely impacted the area and, coupled with irrigation practices on farm and ranchlands in the area, caused the water table to lower. By the 1970s the lake was beginning to dry because of irregular water inflow. Today, the lake is usually dry unless a large rain event occurs over the watershed. The lake usually receives water every 5 to 10 years which is retained if there is enough rainfall; however, once the water has evaporated, the plant community begins its growth cycle.

Through Alternative A, 581 acres of the dry lakebed (2,818 acres total) would continue to be managed through a cooperative farming program. Farming is currently conducted to reduce nitrogen and phosphate loads, decrease invasive weed species and woody vegetative encroachment into the lake, provide wildlife food, and reduce fire danger. Buffalo Lake NWR does not permit the use of genetically modified crops (GMCs) in their farming program.
The rest of the lakebed is not farmable due to encroachment of Salt Cedar. As discussed previously, the refuge plans to eradicate this invasive flora through chemical methods. The refuge does not actively plant native grasses in the lakebed and relies on natural seeding of grasses and succession for the spread of native vegetation.

Water Management

The refuge retains surface water during flood events by using the Umbarger Dam. Water retention continues to permit fecal coli forms originating from off-refuge cattle operations (dairy farms) to settle out of the water. The water then either percolates downward entering the groundwater or flows through the dam during periods of excess rainfall and moves down the watershed.

3.6.3 Wildlife Management

Native Fauna

The refuge would continue to manage prairie dog populations through the use of barrier fences and the establishment of raptor perches around the existing prairie dog town to limit population growth. The refuge currently does not have any management programs in place that would assist in controlling population levels of mule-deer and white-tailed deer; collared dove, ring-necked pheasant and starling are currently removed to control population numbers.

Invasive Fauna

As mentioned in Section 1.8.3, there has been a rapid increase in the population of feral hogs across the panhandle of Texas although this invasive species has not yet established a population on the refuge. In the case that feral hogs, dogs, or cats are found on the refuge, staff implements an immediate removal policy. The refuge will continue to remove invasive fauna species as they are located on the refuge. This practice has kept invasive species from establishing a meaningful population on the refuge. While it continues to be acknowledged that the refuge supports habitat that is conducive to invasive fauna utilization, staff members will continue the removal of invasive fauna species will continue through hunting and trapping programs across all alternatives.

3.6.4 Visitor Services and Infrastructure

3.6.4.1 Wildlife-dependent Recreation Opportunities

Interpretation

Opportunities for interpretation are provided on the refuge through the use of the 5-mile auto tour route and 2.25 miles of self-guided hiking trails. The auto-tour route has nine kiosks that offer refuge visitors an opportunity to learn about the refuge. The Cottonwood Canyon Birding Trail also has six interpretive kiosks but limited space in the existing office and visitor center restrict the use of interpretive displays; however, refuge brochures are located in the office as well as the entry kiosk.

Environmental Education

Environmental education is offered on the refuge during an annual education day and on an as-needed basis when local schools request a course on the refuge. In the past, the refuge has provided environmental education opportunities to West Texas A&M University, Texas Tech, and various clubs such as Amarillo Astronomy Club. The refuge participates in other educational events, such as speaking at Kiwanis' and Lion's Club meetings, Girl and Boy Scout groups as well as local school events.

Wildlife Observation and Photography

The refuge offers a variety of opportunities for wildlife observation and photography by providing walking and birding trails, an auto tour route, observation decks, and scenic overlooks. Two trails exist on the refuge: Cottonwood Canyon Birding Trail and the Prairie Dog Town Walking Trail. The Cottonwood Canyon Birding Trail is one-half mile long and features restrooms, benches, and an interpretive trail head sign. The Prairie Dog Town Walking Trail offers information on the prairie dog town ecosystem. The auto tour road, however, is the most convenient way to observe wildlife and habitats. The auto tour route takes visitors through grasslands, introduced woodlands, dry playas, farm fields, and the "Windmill for Wildlife" exhibit. The route begins with a rangeland interpretive display and ends at the Stewart Marsh

observation deck and photo blind.

3.6.4.2 Other Recreation Opportunities

Camping

The Refuge would continue to allow primitive camping in designated campgrounds that are equipped with picnic tables and a pull-in parking area with restroom facilities nearby. The campground contains 25 camp sites plus a group site. Open fires are prohibited, but the use of propane cook stoves is allowed. Mowing occurs routinely in order to maintain the function of the campgrounds. This management would continue across all alternatives.

Bicycling

Bicycling has been permitted on the auto tour route; however, cross country or off-road uses of bicycles are prohibited. Upon analysis, it is determined that no changes to this public use is required in order to meet anticipated needs.

3.6.4.3 Commercial Related Services: Farming

The refuge utilizes cooperative farming in part of the 2,818 acre dry lake bottom to reduce excessive nutrient levels in the soil (i.e., organic contaminants such as nitrogen and nitrates from cattle feedlot wastes), prevent/reduce monotypic stands of Kochia, reduce wildfire hazard resulting from weed invasion, and provide food and cover for a variety of migratory and resident wildlife species.

Analysis of soils on the refuge has indicated that there are several areas where the productive crops can be supported. These areas include approximately 1,100 acres above the spillway elevation, approximately 300 acres of bottomland below the spillway when exposed, and approximately 300 acres of creek bottom. With approximately 20 inches of rainfall, the area can support crop production four out of five years. Since the refuge has no water rights for consumptive use, dry land agriculture must be implemented.

In the past, the lake bottom has been separated into 27 specific farming units averaging 40 acres in size. These units were farmed rotationally on yearly basis. Currently farming is conducted in 1 large unit of 581 acres. Each spring and fall a farming rotation is developed for the 581 acres. However, more intensive farming is needed to control non native invasive species such as Musk Thistle, Salt Cedar, Russian olive, Elm, and Kochia. More intensive farming will also help control native vegetation that is over abundant within the lake bottom such as cottonwood.

Farming is by cooperative agreement with payment by crop share. The cooperative farmer harvests two-thirds of the crop for his share and the remainder is retained by the refuge to provide food for wildlife. Sections of the dry lake bed have been planted with native grass which has successfully replaced unwanted weeds and exotic species. Other sections of the lake bed have been disked and left fallow as a treatment in deterring invading Kochia. The disking had

encouraged new growth including numerous species which benefit wildlife.
Fence rows consisting of native grasses and shrubs (i.e. grammas and saltbush) will be planted over the next 10 years to designate farming units. These native fence rows will also provide edge habitats and corridors for native wildlife. Protocols to monitor wildlife use will be developed within this time period. These will likely consist of flush counts on line transects within the fence rows.

3.6.4.4 Public Use Access

The refuge is located approximately in Umbarger, Texas (30 miles southwest of Amarillo, Texas) on U.S. 60 between Hereford and Canyon, Texas. The refuge entrance road is accessed from FM Road 168 (Farm to Market Road). Signs direct the visitor to refuge headquarters and the visitor check station. Refuge hours are 8:00 a.m. to 8:00 p.m. daily from April 1 through September 30 and 8:00 a.m. to 6:00 p.m. from October 1 through March 31. The refuge office is open from 8:00 a.m. to 4:30 p.m., Monday through Friday. All refuge areas except the designated camping area are closed to the public after the official closing time including the auto-tour route. The refuge entry gate is timer operated. Campers may leave at any time by driving across the one-way exit. After the official closing time, there is no entry or re-entry into the refuge. The refuge continues to use an entrance fee program charging $2.00 per private vehicle on a self service/honor permit system, which is paid at a kiosk at the refuge entrance. Group rates are $15.00 up to 20 people and $25.00 for 21 people or more. The refuge also accepts seasonal passes such as the Golden Eagle Passport, Golden Age Passport, and the Federal Duck Stamp.

Public Access and Transportation Management

Public access on refuges is provided primarily to facilitate the six priority public uses of the Refuge System (hunting, fishing, wildlife observation, photography and environmental education and interpretation), when and where they are compatible with refuge purposes. Public access is normally only allowed in designated areas and along designated routes of travel (e.g., roads, trails, waterways, and other routes). Designated routes of travel can be either public roadways (e.g., state or county roads) and waterways or refuge roads, trails, and waterways. Refuge routes of travel and access are maintained, improved, or added through various funding sources with one of the main sources being the Refuge Roads Program (RRP).

The RRP was established in June 1998, as part of the Transportation Equity Act for the 21st Century (TEA-21) and reauthorized in August 2005 under the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU). This makes Federal highway funds available for refuge roads to pay the cost of maintenance and improvement of these roads as well as parking areas, rest areas, pedestrian and bicycle trails, and related facilities. This also includes administrative costs associated with such maintenance and improvements. Refuge roads are generally any road open to public travel that provides access to

or within a unit of the Refuge System, and for which title and maintenance responsibility are vested in the United States Government.

All projects funded under the RRP must be consistent with the goals and objectives outlined in CCPs and step-down management plans. The Service's refuge planning policy requires that one of the elements to be considered in the development of a CCP are transportation issues, including public use roads and trails, passenger vehicles, pedestrian and bicycle needs, as appropriate for the refuge. Refuge transportation infrastructure and related issues will be coordinated with the respective State or county transportation agencies and metropolitan and rural road planning organizations to assure that, among other considerations, there are no negative impacts to traffic congestion or air quality.

Roads
The refuge has approximately 9.5 miles of public roads including the entrance and tour road (8 miles), camping road (.75 miles), and birding routes (1.0 miles). There are 47 miles of fire lanes and 10 miles of other service roads which are unimproved and closed to the public.

Trails
The Refuge has two trails including the Cottonwood Canyon Birding Trail and the Prairie Dog Town Interpretive Walking Trail. The Refuge is in the process of constructing a Grassland Interpretive Trail.

3.6.4.5 Public Use Facilities

In the past, when the lake had water, the refuge was important as a recreational area where picnicking, swimming, fishing, boating, and camping are enjoyed by the rural communities and the nearby Amarillo metropolitan areas. In more recent years, since the lake dried out, the majority of public visitation has been for wildlife observation, picnicking, and camping. Although a majority of the refuge is closed to the public, it has been determined that the following public uses are compatible with the purpose for which this refuge was established: wildlife observation, photography, hiking, picnicking and camping. These uses have been confined to the 6.5 mile auto tour route, wildlife observation points, Prairie Dog Town Walking Trail, Cottonwood Canyon Birding Trail, the refuge headquarters, camping and picnicking areas, and specific areas opened for special events and organized environmental activities. During the 1960's, refuge visitation was very high, over 300,000 visitors. More recently, however, the refuge averages of 5,000 people annually.

Approximately 95% percent of the total visitation to the refuge is to participate in wildlife observation and photography opportunities.

Wildlife Observation and Photography
The Cottonwood Canyon Birding Trail is a divided trail. The trail to the south is a level III accessible trail while the trail to the north offers a little more challenging terrain. Both sections pass through small canyons and are lined with large elms and cottonwood trees. They offer a quiet and peaceful hike with plenty of opportunity for bird and other wildlife viewing. The trail offers visitors to get a close look at towering canyon walls. Benches are located along the trail to offer resting places to stop, watch, and listen to wildlife.

The Prairie Dog Town Interpretive Walking Trail allows visitors to pass through a pristine piece of mixed grass prairie. It offers visitors to experience Black-tailed prairie dogs up close. The prairie dog colony offers visitors the opportunity to view many grassland birds, plant communities, and other wildlife species.

Camping
Camping and picnicking are permitted at a designated site. The refuge maintains 25 camp sites plus a group site with tables, drinking water, and restrooms. In addition, a covered site is available by reservation for group camping activities. The site also includes a group picnic area for use by reservation only. The picnicking area is located in the riparian area which is a valuable habitat to many bird species. These 25 sites require continual maintenance such as mowing.

The use of these sites for non-wildlife oriented use such as weddings, family reunions, and fraternity/sorority parties is not allowed.

Research and Investigations
Natural science information is necessary for the proper management of any wildlife refuge. It is the policy of the Service and Buffalo Lake NWR to encourage and support research and management studies in order to provide scientific data upon which decisions regarding management of the refuge can be based. The refuge will also permit the use of refuge lands for other scientific investigations when compatible with the purposes for which the refuge was established. Priority is be given to studies that contribute to the enhancement, protection, use, preservation, and management of endangered species and their habitats as well as other native wildlife and their habitats.

3.6.5 Special Management Areas

This section identifies special management areas designated within Buffalo Lake National Wildlife Refuge. The “special” status of lands within individual refuges may be recognized by additional designations (i.e., legislative or administrative). Special designations may also occur thought the actions of other agencies or organizations. The influence that special designations may have on the management of lands and waters within refuges may vary considerably.

The refuge has a 175 acre tract of exceptional shortgrass prairie that has been designated as a

Registered Natural Landmark. The area is located in the extreme northeast corner of the refuge, Units 10 and 11, and is known as the High Plains Natural Area. It is used by West Texas A&M University (located in Canyon, Texas) range, and wildlife science classes for study, and is also periodically inspected by the National Park Service.

3.6.5.1 Wilderness Areas

The 1964 Wilderness Act recognized wilderness as a resource in and of itself and also established a mechanism for preserving that resource in a national system of lands and waters. The definition of wilderness found in the act provides a framework for identifying and describing wilderness values. According to the act, the fundamental qualities of wilderness are: undeveloped, untrammeled, natural, and outstanding opportunities for solitude, or a primitive and unconfined type of recreation. In addition, the act states that wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value." According to refuge planning policy, all refuge CCPs must include a review of the refuge's potential suitability for wilderness designation. The Service has considered the potential for designating wilderness areas on Buffalo Lake NWR. The refuge was evaluated for the presence of: (1) size; (2) naturalness; (3) opportunities for solitude and/or primitive and unconfined recreation; and (4) General Management of Designated Wilderness.

After completing the inventory phase of the Wilderness Review, it was determined that Buffalo Lake NWR does not have any inventory units that meet the minimum criteria for a Wilderness Study Area. Therefore, we do not recommend any land areas as designated Wilderness. The Refuge's Wilderness Review is provided in Appendix F.

3.6.5.2 Research Natural Areas

The Service recognizes the importance of preserving plant and animal communities in a natural state for research purposes. Research Natural Areas (RNAs) on National Wildlife Refuges are part of a national network of research areas under various ownerships. This network is the result of a designation system recognized by other Federal land administering agencies and the Federal Committee on Ecological Reserves. RNAs are intended to represent the full array of North American ecosystems; biological communities, habitats, and phenomena; and geological and hydrological formation and conditions. RNAs are areas where natural processes are allowed to dominate without human intervention. However, under certain circumstances deliberate manipulation is used to maintain unique features that the RNA was established to protect.

Designation and management of RNAs is delegated to the director of the Service by the National Wildlife Refuge System Administration Act of 1966. The Service administers 210 RNAs on refuges nationwide comprising a total of 1,955,762 acres. The Service's Southwest Region administers 27 RNAs totaling 59,940 acres on 14 national wildlife refuges. Buffalo Lake NWR contains one RNA totaling 320 acres.

3.6.5.3 Other Special Management Areas

The refuge has a 175 acre tract of exceptional shortgrass prairie that has been designated as a Registered Natural Landmark. The area is located in the extreme northeast corner of the refuge, Units 10 and 11, and is known as the High Plains Natural Area. This special management area (as with the RNA's), is used by the West Texas A&M University and inspected by the National Park Service.

3.6.5.4 Other Research Projects on Buffalo Lake NWR

From 1988 to 1991, a student from Southeastern Louisiana University conducted a comparative genetic study on the variations in reproductive characteristics of Garter Snakes. In 1993, a graduate study was initiated with West Texas A & M University, Canyon Wildlife Science Department, to study the populations of black-tailed prairie dogs to identify populations, rate of spread, size of town, and to develop and implement an integrated pest management population control plan. Approximately 4,500 linear feet of 48-inch tall, three-quarter inch mesh, high density polyethylene netting was installed as a deterrent barrier to divert prairie dog migration from private land and back onto refuge land.

In 1994, a research study with West Texas A&M University entitled "An Investigation of the Affects of Cattle Grazing on the Vegetation of Buffalo Lake National Wildlife Refuge" was completed. This study was designed to observe the effects of cattle grazing and other environmental factors on the vegetation of the refuge. This study provided information to assist in the evaluation of the grassland conditions and grazing practices. It provided a plant species list of 184 species and set up permanent sample methods to monitor range conditions. As a result of this research, the refuge grazing system was evaluated and modified. The most common plant on the refuge transects was Kochia, followed by Blue Grama, Buffalo Grass, Western Ragweed, and Sand Aster. Cattle grazing on the refuge in 1993 produced a reduction in Kochia and a slight increase in Buffalo Grass and Blue Grama within transects.

In 1997 through 1998, a study was conducted by a graduate student on the effects of public use on the refuge populations of mule deer and white- tailed deer. Although the data regarding public use was inconclusive, it was noted that horseback riding probably causes the most stress because of their travel directly in the deer's habitat, unlike vehicles that are restricted to refuge roads. Habitat use varied considerably. Edge and savannah habitat received the most use by both species. The two species exhibited different amounts of use in the different habitats. Mule deer were observed in all fourteen habitats, while white-tail deer concentrated around riparian habitats. White-tailed and mule deer habitats had some overlapping, but the overlap was mostly seasonal. There were no indications of aggression, and during the periods of cohabitation, both species could be seen feeding together. Behavior recorded indicated when deer were breeding, feeding, moving, standing, communicating, showing aggression, and alarm. The major difference in behavior between the two species was the amount and frequency of alarm expressed. A social hierarchy was apparent. It was evident that the larger males were dominant

and the smaller males yielded to them. Social hierarchy was also obvious among the females of a group.

Two environmental contaminant studies to determine if contaminants were accumulating in animal tissues or sediments in the Tierra Blanca watershed was initiated in 1987 and 1993 by the Ecological Services Branch of the Service. Results are presented in the water quality section of this CCP.

The Environmental Protection Department of the Pantex Plant in Amarillo, Texas has been conducting research on the refuge's prairie dog population since 1995 (ongoing, under Special Use Permit #89765). Specimens (prairie dogs) are sampled and monitored for the presence of contamination (such as pesticides), human critical disease agents (such as plague and Nile Virus), and radiation. The analysis of the refuge's population sampling is compared to analogous populations from Pantex Nuclear Facility lands. The study determined the general health of the prairie dog population and established a baseline for potential radionuclide contaminants in prairie dogs. Diagnostic analysis is used to determine potential disease problems in prairie dogs in localized populations of Buffalo Lake NWR and Pantex, and whether the prairie dogs pose a health threat to employees. The analysis concluded that prairie dogs from the Pantex Plant and Buffalo Lake NWR indicate radionuclides at what are considered background levels. No organochlorine pesticides have been detected in any samples. No disease (plague or Nile Virus) has been found. Necropsy and histopathology indicated prairie dogs were healthy during the sampling periods. The importance of this investigation is to establish the refuge's prairie dog town as a reference site for background clean-up levels for area prairie dog town ecosystems.

In 2005, horned lizard research was initiated on the Refuge. A graduate student from West Texas A&M conducted the study for a Master of Science degree. Limited biological information has been collected about the Texas horned lizard. These lizards occur on the refuge, but little is known about their behavior, numbers, and habitat needs. This study provided much needed biological information for the refuge and state-wide management of this species.

In 2005, the refuge was searched for frogs as part of the study being conducted by the Houston Ecological Services Field Office on frog deformities. Numerous frogs were captured on the refuge; two of which displayed deformities.

Researchers studying Swift Fox populations in the Texas Panhandle searched the refuge for foxes in 2005. They set up their base camp at the refuge headquarters and began trapping swift foxes in Randall, Deaf Smith, and Swisher counties. While they were successful in trapping foxes elsewhere in the Panhandle, they were unsuccessful in these three counties.

In 2008, a graduate student from West Texas A&M, conducted a research project for a Masters of Science on the natural history and ecology of north American porcupines at the refuge. Also in 2008, a graduate student also started a study on the effects of grazing on the herpafauna at the refuge.

3.6.5.4 Concerns Regarding Special Management Areas

There are no concerns regarding special management areas.

3.6.6 Land Protection and Acquisition

Currently, there is no Land Protection Plan for Buffalo Lake NWR. The refuge would like to acquire additional land to supplement future habitat and wildlife conservation efforts and would like to pursue expansion opportunities from willing sellers and donors.

3.6.7 Cultural Resource Management

Cultural sites on the refuge are composed of surface materials and are not advertised or marked to prevent surface collecting by refuge visitors. As such, due to the sensitive nature of these sites, their location, extent and contents is not disseminated to the public.