3. 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.

3.1 Landscape Setting

To effectively achieve the National Wildlife Refuge System mission of conserving fish, wildlife, and their habitats, the Wichita Mountains Wildlife Refuge 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, looked beyond its boundaries to determine its role in the larger conservation effort. This section describes the landscape setting in which Wichita Mountains Wildlife Refuge is located.

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 and 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. Waterfowl and other birds pass over, rest, and utilize many refuges in the U.S. Fish and Wildlife Service's Refuge System throughout the four administrative flyways. The Wichita Mountains Wildlife Refuge is situated in the middle of the Central Flyway.

The Central Flyway spans the Canadian Northwest Territory, two Canadian provinces (Alberta and Saskatchewan), numerous countries in Central and South America, and 11 U.S. states: Alaska, Montana, North Dakota, South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, and Texas (Fuller 2000).

Of the approximately 151 national wildlife refuges and/or waterfowl management units located in the 11 states found within the Central Flyway, 36 are located in New Mexico, Texas, and Oklahoma, which are managed by the Service's Southwest Region. Many refuges within the Central Flyway were established primarily for the protection and conservation of waterfowl and other bird species. The Wichita Mountains Wildlife Refuge is one of eight refuges located within the State of Oklahoma.

The Refuge provides valuable wintering habitat for waterfowl through the establishment of over 15 reservoir lakes and ponds comprised of nearly 800 acres of open water. These reservoir lakes provide habitat for resting, feeding, and breeding for many waterfowl species. These areas provide valuable habitat to sustain waterfowl and their energy requirements for spring migration and reproductive success. In any given year, ducks and geese utilize Refuge lake and pond reservoirs as wintering habitat.

3.1.2 Strategic Habitat Conservation and the Great Plains Landscape Conservation Cooperative

Strategic Habitat Conservation (SHC) is an adaptive resource management framework for making management decisions about where and how to deliver conservation efficiently to achieve specific biological outcomes (see Chapter 1) (USFWS 2006). It provides an avenue for making strategic decisions and encourages constant reassessment and improvement. These critical steps aid the Service in dealing with a range of landscape-scale resource threats such as habitat

fragmentation, genetic isolation, spread of invasive species, and water scarcity—all of which are accelerated by climate change.

SHC incorporates five key principles in an ongoing process that changes and evolves:

- Biological planning (setting targets)
- Conservation design (developing a plan to meet goals)
- Conservation delivery (implementing the plan)
- Monitoring and adaptive management (measuring success and improving results)
- Research (increasing our understanding)

In April 2009, the Service, working with U.S. Geological Survey, initiated an effort to identify a national geographic framework for implementing SHC at landscape scales. The framework provides a comprehensive, landscape focused platform that extends nationally and globally beyond national wildlife refuge boundaries and Service jurisdictions. Within the scope of affected landscapes, the Service works with diverse partners to connect site-specific conservation efforts to broader landscape conservation goals, strategies, and outcomes.

The Service used this landscape-level geographic framework as a base geography for identifying Landscape Conservation Cooperatives (LCCs). LCCs are developed on the foundation of Strategic Habitat Conservation (SHC). LCCs are management-science partnerships between the Service, Federal agencies, states, tribes, local governments, landowners, and other organizations to facilitate resource management across broad landscapes. The LCCs provide a nationwide network of scientifically credible units that optimize conservation delivery for priority species and allow for analytical comparisons of conservation results across the network. LCCs provide a consistent context for conservation action at a landscape scale by considering the entire range of a priority species or suite of species. LCCs ensure that resource managers have the information and decision making tools needed to conserve fish, wildlife, and their habitats in the most efficient and effective way possible.

LCCs consist of 22 broad geographic areas, which were developed by aggregating Joint Venture's Bird Conservation Regions (BCRs) with Freshwater Ecoregions of the World and Omernick's ecological units. BCRs are part of the North American Bird Conservation Initiative and are biologically-based, geographic delineations that represent long-standing partnerships to deliver avian conservation planning and design at the landscape scale. There are 67 BCRs identified, 35 of which fall entirely or partially within the United States (NABCI 2010). Similarly, Freshwater Ecoregions of the World are biologically-based units for aquatic species, and Omernick's ecological units integrate diverse non-avian, terrestrial species needs.

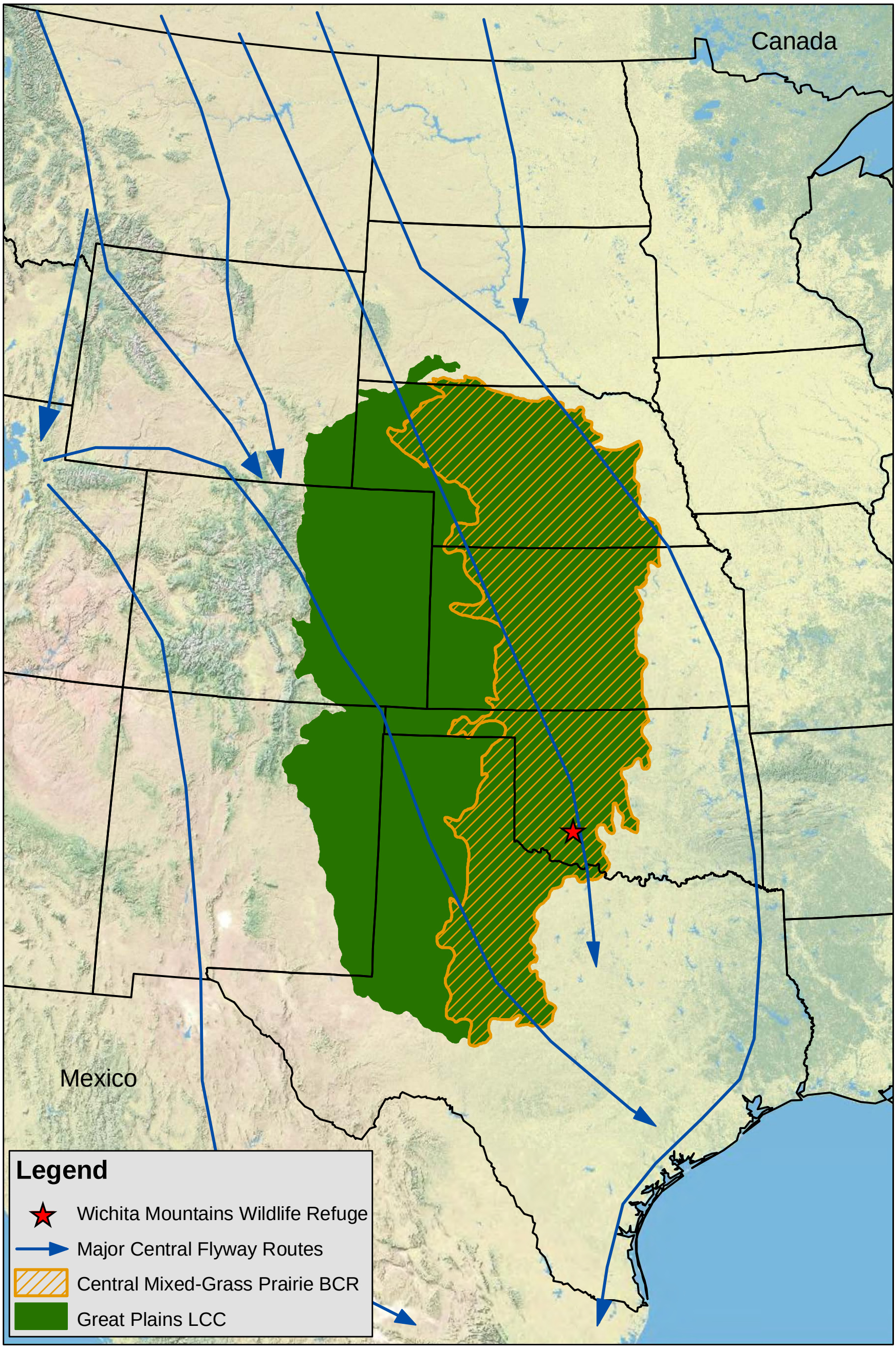
The Wichita Mountains Wildlife Refuge lies within the Great Plains LCC (GPLCC), with a geographic area that encompasses parts of eight states: New Mexico, Texas, Oklahoma, Colorado, Kansas, Nebraska, South Dakota, and Wyoming. It falls along the boundaries of two BCRs: 18 (shortgrass prairie), and 19 (central mixed-grass prairie) (see Figure 3-1). The GPLCC boundary also corresponds with the administrative boundaries of the Playa Lakes and Rainwater Basin Joint Ventures. The Rainwater Basin Joint Venture is restricted to the BCR 19 portion of Nebraska, the remaining areas within BCR 18 and 19 are within the administrative boundary of the Playa Lakes Joint Venture.

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Flyway, BCR, and LCC



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MERIDIAN: N/A
FILE: wmw_flyway_bcr_lcc_1.19.11_shl

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NAD 83

Federal lands within the GPLCC include: Bureau of Land Management public lands in southeastern New Mexico, 11 Fish and Wildlife Service National Wildlife Refuges, and U.S. Department of Agriculture (USDA) Forest Service grasslands and forests in New Mexico, Oklahoma, Texas, Colorado, Kansas, and Nebraska, and lands managed by the Department of Defense, Bureau of Reclamation, and National Park Service. State-owned lands are an important component of the GPLCC; many contribute habitats necessary to support priority species. The majority of the GPLCC area is under private ownership (GPLCC 2009).

Numerous conservation partnerships exist within the GPLCC. The Southeast Aquatic Resources Partnership within the states of OK and TX is formally recognized through the National Fish Habitat Action Plan, and multiple reservoirs in all GPLCC states are included in the Reservoir Fisheries Habitat Partnership. Strong conservation partnership coalitions are associated with the Playa Lakes and Rainwater Basin Joint Ventures, including: The Nature Conservancy (TNC), State fish and wildlife agencies, Natural Resource Conservation Service, Farm Service Agency, and U.S. Fish and Wildlife Service (Service) Partners for Fish and Wildlife program (GPLCC 2009).

Utilizing State Wildlife Plans, and ecoregion plans developed by TNC and the Service, six landscapes have been identified as high priority landscapes within the GPLCC: (1) contiguous grasslands in the short grass and mixed grass prairies, (2) playa wetlands, (3) riparian streams, (4) prairie rivers, (5) Cross-timbers, and (6) savannahs, shrub lands, and sand dune systems. These landscapes, while not all-inclusive of the fish, wildlife, and plant habitats within the GPLCC area, represent important habitats for a variety of species (GPLCC 2009). The list of GPLCC priority habitats and associated species is summarized in the Table 3-1.

Table 3-1. Priority Habitats and Species of the Great Plains Landscape Conservation Cooperative

Habitat	Priority Species
Grasslands	Burrowing owl, black-tailed prairie dog, American bison, American burying beetle, black-footed ferret, mountain plover, ferruginous hawk, long-billed curlew, lesser prairie-chicken, grasshopper sparrow, Cassin's sparrow, lark bunting, Harris' sparrow, prairie falcon
Playa wetlands	Northern pintail, sandhill crane, least sandpiper, western sandpiper, long-billed dowitchers
Non-Playa Wetlands	Whooping crane, snowy plover
Saline Lakes	Snowy plover, sandhill crane, Wilson's phalarope, least sandpiper
Prairie Rivers, Streams, and Riparian Corridors	Arkansas River shiner, piping plover, interior least tern, sandhill crane, whooping crane, Bell's vireo, Arkansas darter, Topeka shiner, pallid and shovelnose sturgeon, snowy plover
Savannahs, shrub lands, and sand dunes	Lesser prairie-chicken, sand dune lizard, blowout penstemon, American burying beetle

Source: U.S. Fish and Wildlife Service 2011.

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 non-governmental organizations that are responsible for different types of resources within the same geographic areas (EPA 2010).

Understanding ecological boundaries and the ecological processes that influence boundaries is a fundamental issue (Wiens et al. 1985, Wright et al. 1998). "The purpose of ecological land classification is to divide the landscape into various sized ecosystem units that have significance both for development of resources and for conservation of environment" (Bailey 1983). Bryce et al. (1999) described ecoregions as a framework from which we can describe the ecosystem's natural potential and predict responses to disturbances. There have been many attempts to classify geographic areas into zones of similar characteristics, notably Bailey (1976, 1980, 1995) and Omernik (1987, 1995).

Ecoregions have been defined as geographic zones that "…exhibit similarities in the mosaic of environmental resources…" (Omernik 1995). Bailey (1983) similarly defined ecoregions as "…groups or associations of similarly functioning ecosystems." Robert Bailey and James Omernik both subdivided their respective ecoregion classifications into increasingly detailed units. Küchler's (1964) classification of potential natural vegetation strongly influenced both Bailey's and Omernik's ecoregion boundaries. These ecoregional classifications allow recognition of an ecological unit regardless of current land use or succession status of vegetation.

Wichita Mountains Wildlife Refuge exists at a crossroads of ecoregional boundaries. It exists west of the "ecoregional" boundary separating the prairies of the Great Plains from the Crosstimbers of the eastern deciduous forest. Thus, Refuge acreage is addressed within the mixed-grass prairie region of the ODWC (2005) and The Nature Conservancy's 'Conserving the Biological Diversity of the Central Mixed-Grass Prairie' (Steuter et. al. 2003) and 'A Conservation Blueprint for the Crosstimbers and Southern Tallgrass Prairie Ecoregion' (The Nature Conservancy 2009). However, in each of these plans, the Wichita Mountains are identified as high priority Crosstimbers habitat. Hoagland et al. (1999) describe Crosstimbers as "…a mosaic of forest, woodland, savanna, and prairie vegetation…" Further, Blair and Hubbell (1938) and Küchler (1964) identified the Wichita Mountains within the Crosstimbers region. As described later in this chapter (Terrestrial Vegetation Classes), mixed-grass prairies are part of the Crosstimbers, but oak forests are not part of prairies. Even though Wichita Mountains Wildlife Refuge exists within the Southern Mixed-Grass Prairie ecoregion, its vegetation community associations are best represented by the Crosstimbers. For organizational purposes, this CCP is aligned with TNC's Central Mixed-Grass Prairie Ecoregion while allowing for input from TNC's Crosstimbers and Southern Tallgrass Prairie Ecoregion and ODWC's Oklahoma Comprehensive Wildlife Conservation Strategy (2005).

Chapter 4 of this CCP articulates objectives that originated during landscape conservation planning held to discuss and evaluate how the mixed-grass prairie and Crosstimbers vegetation types and management of the Wichita Mountains Wildlife Refuge could aid toward accomplishment of ecoregional objectives described in the Oklahoma Comprehensive Wildlife Conservation Strategy (2005) and both TNC documents (Steuter et. al. 2003, The Nature Conservancy 2009). The fact that Wichita Mountains Wildlife Refuge lies within the mixed-grass prairie ecoregion, while having vegetation characteristics of Crosstimbers, creates opportunities to contribute to conservation goals of both grasslands of the southern Great Plains and woodlands of the eastern deciduous forest.

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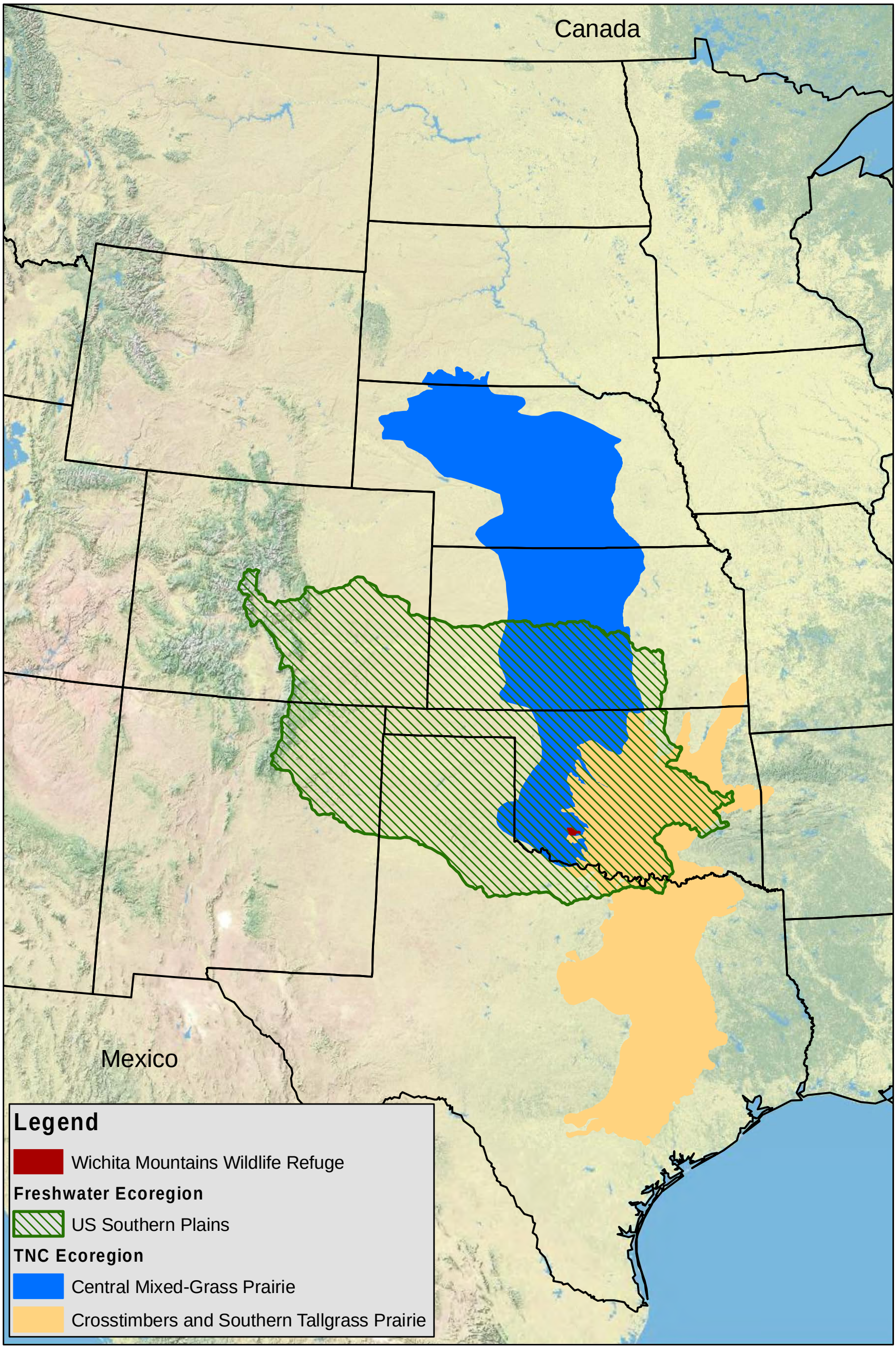
Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

TNC and Freshwater Ecoregions



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3.1.3.1 Terrestrial Description

The Central Mixed-Grass Prairie (CMGP) Ecoregion exists as a transition between the mesic tallgrass prairies to the east and the arid shortgrass prairies to the west. The culture and land use of the CMGP also has transitional qualities. A satellite view of the CMGP reveals relatively large and distinct native landscapes remaining within a cropland matrix. In contrast, native grasslands become the landscape matrix to the west, while a matrix of cropland is nearly exclusive in the east. This CCP's priorities, strategies, and actions associated with conserving biological diversity reflect the current human and ecological underpinnings of the landscape (Steuter et. al. 2003).

3.1.3.2 Aquatic Description

The Wichita Mountains Wildlife Refuge is located in the U.S. Southern Plains freshwater ecoregion of North America. The U.S. Southern Plains is an ecoregion of the Mississippi Complex located in the Arctic-Atlantic Bioregion. It covers southeastern Colorado, northeastern New Mexico, southern Kansas, western Oklahoma, and the panhandle of Texas. It is defined by the watersheds of the upper Arkansas, the South Canadian, and the upper Red Rivers (Abell et al. 2000). There are two endemic fish species and two endemic crayfish in the ecoregion. The fish do not occur on the Refuge, and it is unknown whether the crayfish also occur. The Cheyenne Bottoms Wetland, which is a stopover point for more than half of the northward migrating shorebirds of North America, is contained in this ecoregion. The ecoregion is considered vulnerable because the remaining habitat occurs in blocks or segments. This ecoregion also has established exotic species, though it may still be possible to control the expansion of established exotic species (Abell et al 2000). Other threats include the development of land and water resources for agriculture and municipal uses, including surface water depletion and contamination from agrochemicals and animal wastes, which have polluted surface water and percolated into some groundwater supplies (Abell et al 2000).

3.1.4 Protected Areas in the Central Mixed-Grass 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 they 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 percent 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 percent of the land area (1,006,619 square miles) (UNEP 2008). Wichita Mountains Wildlife Refuge is located within the Central Mixed-Grass Prairie Ecoregion, as defined by The Nature Conservancy (TNC). Within the Southern Unit of the Central Mixed-Grass Prairie Ecoregion, there are approximately (or "currently") 30 Federal, state, or privately owned or managed conservation and recreation lands, including the Refuge, consisting of 229,621 acres or 2.5 percent of the total acreage within the Southern Unit of the Central Mixed-Grass Prairie Ecoregion, that contribute to wildlife conservation efforts (see Table 3-2 and Figure 3-3). There are approximately 59 million acres of the Central Mixed-Grass Prairie Ecoregion of Oklahoma, Kansas, and Nebraska. Of this, 98.2 percent is privately owned, 1.2 percent is federally owned (708,000 acres); 0.4 percent is State

owned (236,000 acres); less than 0.5 percent is county and tribal owned. By contrast, the Wichita Mountains portfolio site, as identified in the TNC's Conserving the Biological Diversity of the Central Mixed-Grass Prairie portfolio, is approximately 296,284 acres total, of which 201,703 acres are privately owned (68.08 percent); 94,489 acres are federally owned/managed (31.89 percent); and 92 acres are State owned/managed (0.03 percent) (TNC, pers. comm., March 2010).

Table 3-2. Conservation and Recreation Lands within the Central Mixed-Grass Prairie Ecoregion

Name	Acreage	Management Entity
Federal Lands		
Wichita Mountains Wildlife Refuge	59,020	U.S. Fish and Wildlife Service
Fort Sill Military Reservation	36,360*	U.S. Army – Department of Defense
Canton Lake	9,962	U.S. Army Corps of Engineers
Washita National Wildlife Refuge	9,136	U.S. Fish and Wildlife Service
Tom Steed Lake	5,922	U.S. Bureau of Reclamation
Black Kettle National Grassland	5,816*	U.S. Forest Service
Altus Lake	4,420	U.S. Bureau of Reclamation
Foss Reservoir	3,261	U.S. Bureau of Reclamation
Altus Air Force Base	2,509	U.S. Air Force – Department of Defense
Washita Battlefield National Historic Site	314	National Park Service
State Lands		
State Land Trust	124,590	Oklahoma Commissioners of the Land Office
Sandy Sanders Wildlife Management Area	18,686	Oklahoma Department of Wildlife Conservation (ODWC)
Canton Wildlife Management Area	11,297	ODWC
Hackberry Flat Wildlife Management Area	7,074	ODWC
Mountain Park Wildlife Management Area	4,180	ODWC
Cimarron Hills Wildlife Management Area	4,001	ODWC
Quartz Mountain State Park	3,799	Oklahoma Tourism and Recreation Department
Cimarron Bluff Wildlife Management Area	3,380	ODWC
Altus-Lugert Wildlife Management Area	3,148	ODWC
Foss State Park	2,383	Oklahoma Tourism and Recreation Department
Little Sahara State Park	1,854	Oklahoma Tourism and Recreation Department
Great Plains State Park	1,718	Oklahoma Tourism and Recreation Department
Boiling Springs State Park	775	Oklahoma Tourism and Recreation Department
Glass Mountains State Park	559	Oklahoma Tourism and Recreation Department
Roman Nose State Park	523	Oklahoma Tourism and Recreation Department
Crowder Lake State Park	253	Oklahoma Tourism and Recreation Department
Washita County Wildlife Management Area	238	ODWC
Alabaster Caverns State Park	199	Oklahoma Tourism and Recreation Department
Major County Wildlife Management Area	198	ODWC
Gist Wildlife Management Area	155	ODWC
Dewey County Wildlife Management Area	154	ODWC
American Horse Lake Fishing Area	66	ODWC
Packsaddle Wildlife Management Area	19*	ODWC

*Note: These lands fall within two or more ecoregions.

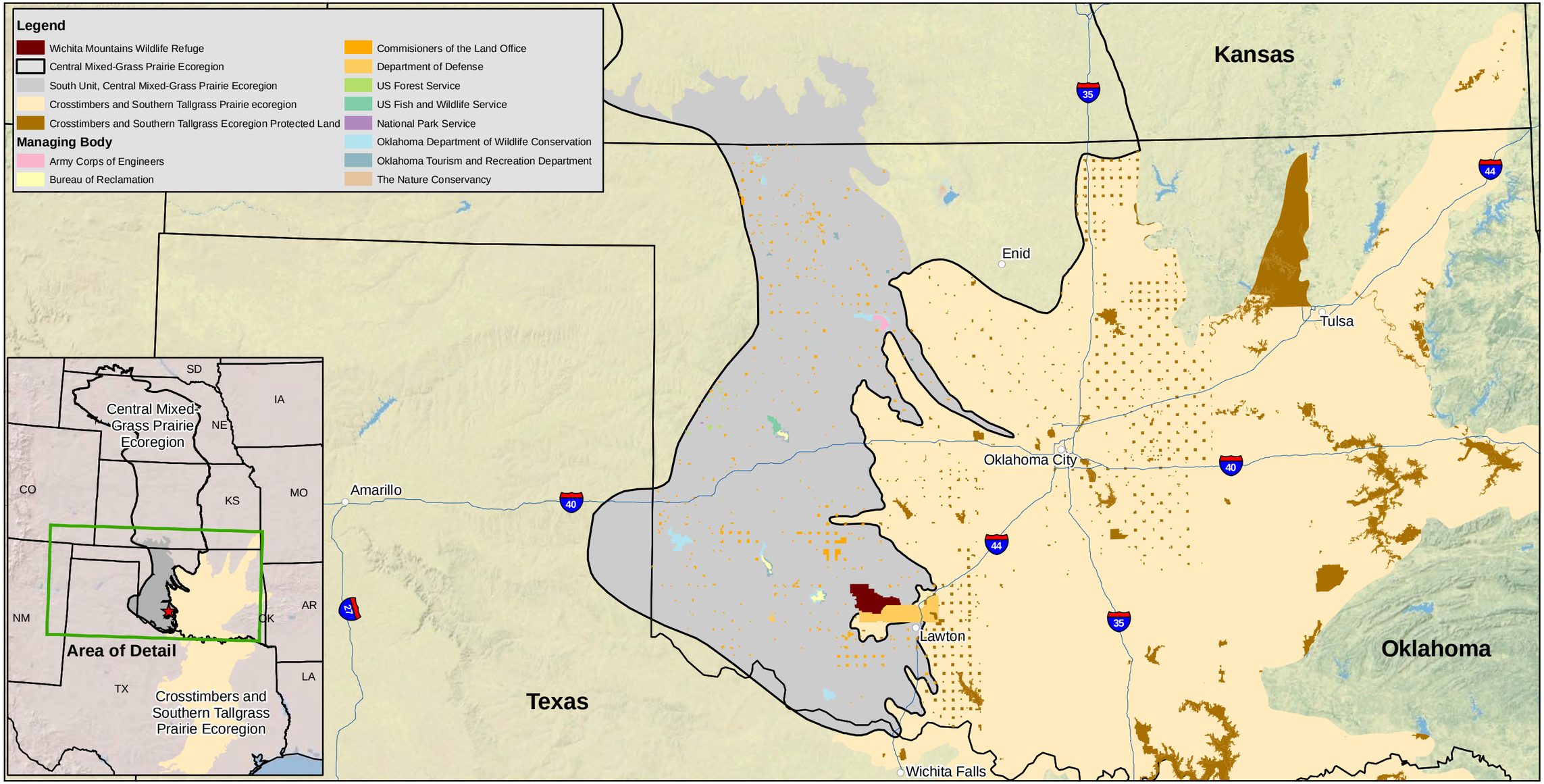
Source: The Nature Conservancy (2009), Oklahoma Department of Wildlife Conservation (no date), U.S. National Atlas et al. (2008) and Tele Atlas North America, Inc. and ESRI (2008).

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Central Mixed-Grass Prairie and Crosstimbers and Southern Tallgrass Ecoregions



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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.

The habitats of the Wichita Mountains Wildlife Refuge could be used as movement corridors for local fauna and for migration corridors for migrating birds and bats. Local fauna such as bison (*Bison bison*), white-tailed deer (*Odocoileus virginianus*), and elk (*Cervus elaphus*) may use the habitats of the Refuge to move between seasonal ranges. Corridors provide the necessary cover and food sources for these animals as they are traveling to find more available food or to find better calving grounds (Feeney et al. 2004). Habitat area increases for big-game species when they are able to inhabit multiple ranges; hence, corridors enable big game to travel to these ranges, effectively increasing their habitat range. Big-game species with larger sized ranges are more likely to survive and reproduce, and therefore are protected from possible extinction (Dixon et al. 2006). Reducing the 'island effect' has helped restore wildlife populations to many areas, especially in units ranging in size from 130 to 5,700 km^2 (Picton 1979).

Unique habitats may also provide migration corridors. The Refuge contains Crosstimbers habitats, which may function as woodland corridors. One of the unique attributes of the Crosstimbers is the existence of old-growth (more than 300 years old) stands of post oak. These gnarled, low-growing trees are some of the oldest unharvested trees in the United States (Oaks and Prairies Joint Venture 2007).

Woodland corridors are very important for many plant and animal species. These corridors can support a large diversity of species, sometimes the highest in the landscape (Stauffer and Best 1980), and can enrich the ecological opportunities for mammals (Jones et al. 1985) and birds. Songbirds in Canada were twice as likely to move through woodlands than clearings, and the majority of birds selected wooded routes over cutting across a clearing, even though the wooded routes may have been three times as long (Desrochers and Hannon 1997).

Woodland habitats in association with riparian areas may be very important for migratory bat species, as they provide tree roosts, an abundance of insect prey, a constant source of water, landmarks to follow during migration (Cryan and Veilleux 2007), and protection from predators. The Refuge contains many riparian habitats that may be used as migratory corridors for species such as red bats (*Lasiurus borealis*), hoary bats (*Lasiurus cinereus*), and Mexican-free tailed bats (*Tadarida brasiliensis mexicana*), as these species have had documented occurrences during the summer months (Caire et al. 1989, Stangl et al. 1992) and in surrounding areas of Oklahoma (Cockrum 1969, Cryan 2003). Red bats and hoary bats have been collected in Oklahoma during peak migration times in the spring and fall (Cryan 2003), and Cockrum (1969) documented a migratory corridor of Mexican free-tailed bats that occurred through eastern New Mexico, Kansas, Oklahoma, and Texas.

Endangered species such as the Whooping Crane (*Grus americana*) may also benefit from the riparian and wetland habitats of the Refuge. The endangered Aransas-Wood Buffalo Population utilizes a migration corridor through central Canada and the United States. The migration corridor (delineated by confirmed sightings: Stephen 1979, Johnson and Temple 1980, Austin and Richert 2001) basically follows a straight line, with the crane traveling through Alberta, Saskatchewan, extreme eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Fall and spring migrations follow the same general path each year (Howe

1989, Kuyt 1992), with cranes stopping nightly to roost in wetlands. If weather is unfavorable for migration, the cranes may stay in one place for many days until conditions improve. Suitable stopover habitat is necessary for whooping cranes to complete their migration. Yet, wetlands suitable for overnight roost sites may be limited in Oklahoma (Stahlecker 1992), further increasing the importance of wetland habitats like those within the Refuge as part of the whooping crane migration corridor.

Working with partners to identify key conservation corridors and crucial habitat is needed to conserve habitat and the associated wildlife species. Throughout the Oaks and Prairies Bird Conservation Region, habitat exists for terrestrial birds such as the endangered black-capped vireo (*Vireo atricapilla*), shorebirds, and waterfowl. Within this habitat, the Oaks and Prairies Joint Venture (2007) has discussed the importance of riparian corridors for terrestrial birds. Such riparian corridors could provide local movement and migratory paths within the larger Crosstimbers ecosystems of Oklahoma and Texas. Linking the existing Crosstimbers of the Wichita Mountains Wildlife Refuge to the Crosstimbers of north Texas could create a type of 'stepping stone' corridor to facilitate the movements of local and migratory fauna.

3.1.6 Refuge Location

The Wichita Mountains Wildlife Refuge is located within Comanche County, Oklahoma, approximately 25 miles northwest of Lawton. See Figure 3-4. Refuge Location.

3.1.7 Surrounding Land Uses

The conservation land status of Wichita Mountains Wildlife Refuge is just one of a variety of land uses found across the larger landscape. Urban, suburban, and rural developments, including Fort Sill Military Base and agricultural and livestock land uses, exist—all of which offer an array of threats to fish, wildlife, and their habitats, including invasive plants, feral animals, habitat fragmentation, and pollutants.

The Wichita Mountains Wildlife Refuge is found within a matrix of surrounding land uses. The acreage immediately surrounding the Refuge, within one mile of the boundary, is displayed in Table 3-3.

Table 3-3. Land Uses Surrounding Wichita Mountains Wildlife Refuge

Jurisdiction	Land Use	Acreage (Approximate)
Fort Sill Military Base	Artillery training area, public use	10,546
City of Lawton	Public use	1,625
Private Lands		
Agriculture	Previously or currently in production	70
Reclaimed Agriculture	Replanted to grasslands or fallow	200
Native Grasslands	Rangeland use	17,256
Residential	Housing/farm	989
Game Preserve	Private game farm (exotic/native fauna)	480
Town of Medicine Park	Public use	594
Lake Lawtonka	Public use and City of Lawton water supply	1,002
Total		32,762

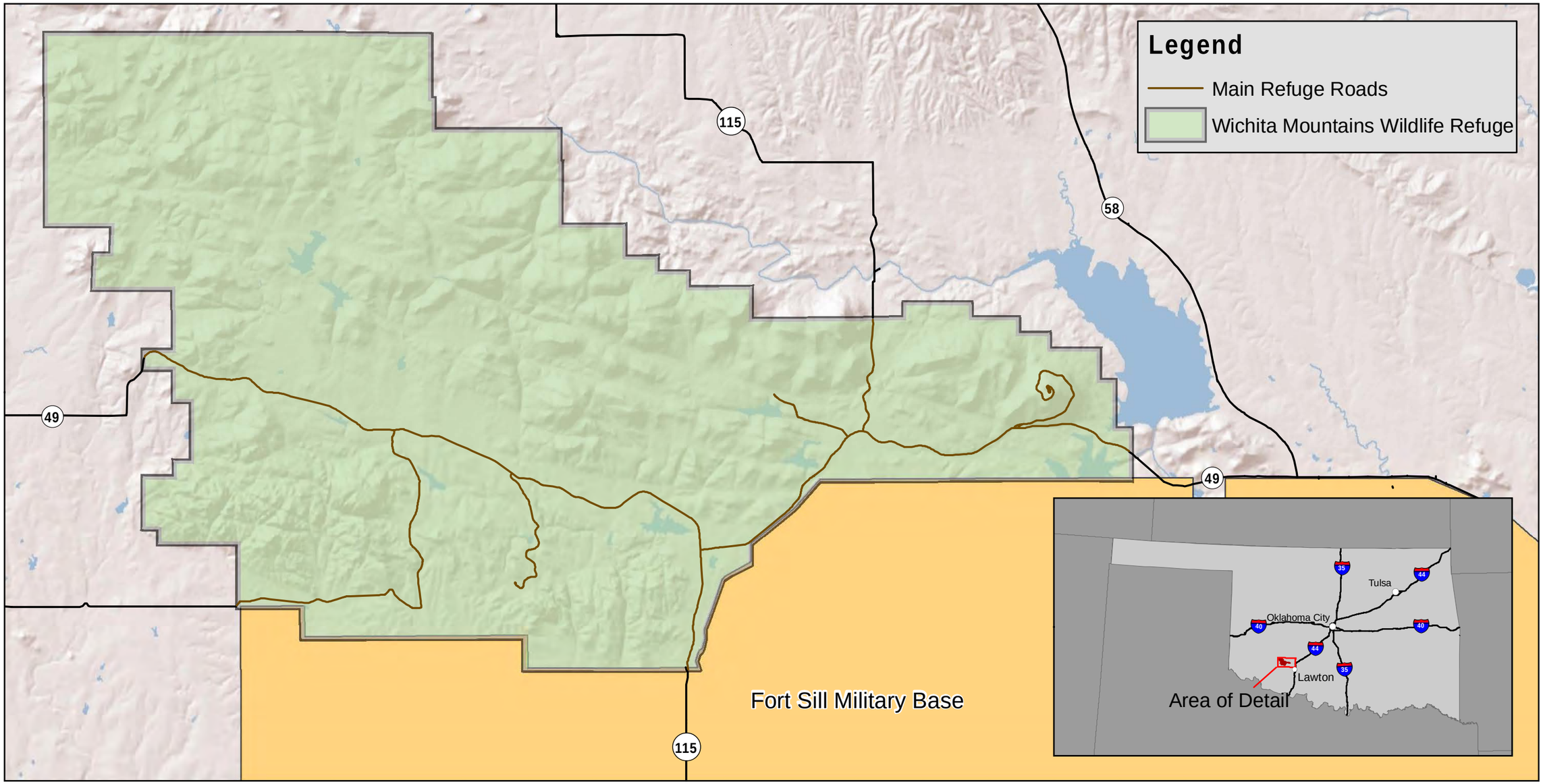
Source: Oklahoma Center for GeoSpatial Information 2008; U.S. Fish and Wildlife Service 2009; National Agriculture Imagery Program 2008.

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Refuge Location



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NAD 83

3.2 Physical Environment

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

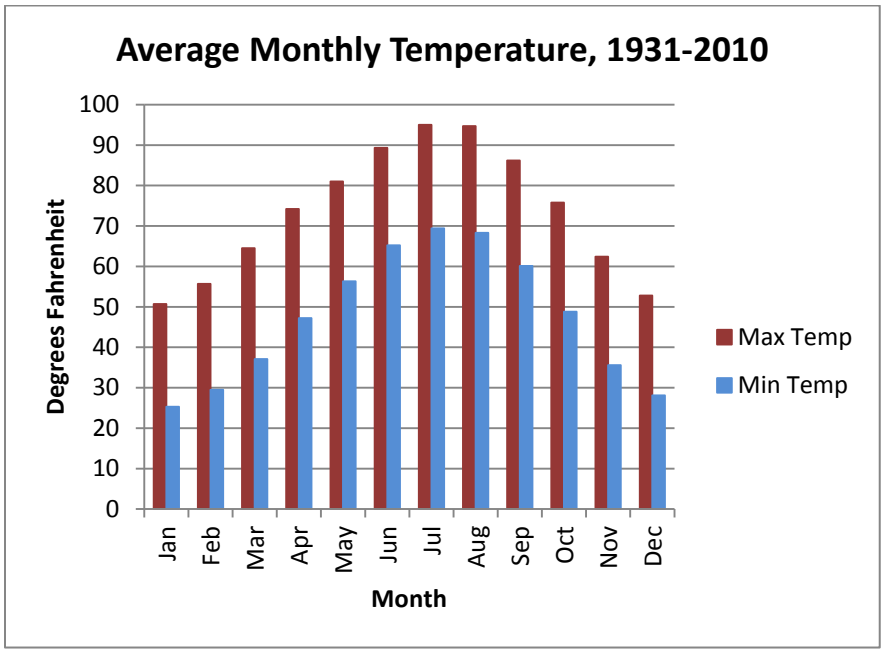
3.2.1 Climate

The climate within the Refuge is characterized as having moderate temperatures. The average annual maximum temperature, which occurs in July, is around 95 degrees Fahrenheit (32.2 degrees Celsius). Annual average minimum temperatures in January are about 25.3 degrees Fahrenheit (-3.7 degrees Celsius). The typical frost-free period at the Refuge begins in early April and extends through early November, lasting on average 208 days (NCDC 2011).

The average precipitation at the Refuge is about 31.3 inches per year (Refuge Staff 1906-2009, NCDC 2011). Fifteen percent of the annual precipitation is supplied by storms in May (NCDC 2011).

The Oklahoma Climatological Survey operates a Mesonet weather station and repeater on the Refuge through a Special Use Permit. This Mesonet weather station is one of 120 automated stations that monitor "mesoscale" weather events, which are those that range in size from about one mile to 150 miles and last from several minutes to several hours (University of Oklahoma 2011). These mesoscale events, such as wind gusts or heat bursts, are phenomenon that may go undetected without densely spaced weather observations (University of Oklahoma 2011). The data from all of the Mesonet stations, including the one on the Refuge, is submitted to the Oklahoma Climatological Survey at University of Oklahoma who then publishes the data for the public.

Figure 3-5. Average Monthly Temperatures (°F), 1931-2010.



Source: NCDC 2011

The statewide network of Mesonets, including that on the Refuge, provide weather forecasters with more frequent and more localized information than the more typical atmospheric measurement sites (University of Oklahoma 2011). Specifically, better forecasts of excessive rainfall and real-time measurements of soil moisture conditions help improve the lead time on flood warnings (University of Oklahoma 2011). The Refuge also uses the data collected at the Mesonet weather station for baseline weather information to determine conditions suitable for prescribed burning on the Refuge. Future uses for collected weather data are anticipated to increase, and some potential uses (i.e., air and water quality monitoring) will require an up-to-date source that the Mesonet station on the Refuge can provide.

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, a Federal land manager 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 and 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).

Within the boundaries of the Refuge, ambient air quality does not vary considerably. The Lawton measuring stations in Comanche County have not recorded ambient criteria pollutant (ground-level ozone and particulate matter 2.5) concentrations that approach the maximum concentration permitted by the NAAQS (OKDEQ 2010.

The National Atmospheric Deposition Program/Mercury Deposition Network (MDN) monitors weekly mercury concentrations and depositions near Refuge Headquarters. The station, Wichita Mountains Wildlife Refuge (MDN OK06), has been operating since November 20, 2007.

Of 112 samples taken between November 20, 2007, and January 5, 2010, 100 were used for summary purposes. Mercury deposition ranged from a low of 3.4 ng/m^2 to a max of 1,126.79 ng/m^2. Wet deposition rates vary seasonally but tend to be highest in the summer. Additional data and a full data report of the weekly measurements are available through the National Atmospheric Deposition Program website (NADP, 2010).

3.2.3 Water Resources

Aquifers and Groundwater

One distinctive feature of this semi-arid region is the presence of heavily used aquifers, such as the famous Ogalalla Aquifer and the Arbuckle-Simpson Aquifer. Groundwater in the area around

the Refuge occurs in three aquifers: the Arbuckle Group (Cambrian and Ordovician), the Post Oak Conglomerate (Permian and Cimarronian), and Alluvial (Quaternary). All are partially recharged from Refuge surface waters.

The Arbuckle Group aquifer is the largest source of groundwater in the immediate area, but it is generally poor quality. Several small communities in the area use this water source. Oklahoma has designated beneficial uses for the Arbuckle Group such as irrigation, municipal and domestic water supply, industrial, and non-irrigation agricultural. This aquifer is characterized by limestone, dolomite, sandy dolomite, mudstone, and conglomerate, about 6,000 feet thick. It yields 90–600 gallons per minute to wells. The Arbuckle Group aquifer is relatively undeveloped, but critical subterranean and spring ecosystems in the area are threatened by pumping.

Recharge occurs principally along the southern flank of the Wichita Mountains and through the overlying Post Oak Conglomerate. The Post Oak Conglomerate consists of limestone conglomerate, about 40 feet thick near limestone outcrops. It generally yields only about 10 gallons per minute to wells. It is considered a minor aquifer.

The Alluvial aquifer is made up of sand, clay, and gravel along floodplains, and it is as much as 32 feet thick. Water yields vary from 5 to 500 gallons per minute. Recharge is by precipitation on floodplains and stream bed infiltration. Most water produced is for domestic and stock use. It might occasionally exceed State drinking water primary or secondary standards (USACE 2006).

The Refuge maintains Federal Reserve groundwater water rights. Reserved water rights are established when the Federal government reserves land for a specific Federal purpose, as was the case when President William McKinley established a Forest Reserve in 1901 on what was to become the Wichita Mountains Wildlife Refuge years later.

Surface Water

The Wichita Mountains Wildlife Refuge lies at a higher elevation than the surrounding landscape and is thereby situated at the top of the watershed. Creeks and streams on the Refuge are intermittent and seasonal. Prior to Refuge establishment, there were no year-round sources of water on the Refuge except small springs. Modified springs capture and store water, making it available for animals to drink rather than allowing it to seep back into the ground, evaporate, or flow downstream.

Manmade reservoirs and ponds account for the largest waterbodies on the Refuge. Most of the reservoirs that exist today were constructed during the Civilian Conservation Corps and the Works Progress Administration (WPA) period of the 1930s. Today, the Refuge supports 107 impoundments. Most impoundments were constructed to provide a water source for wildlife and are fed by the numerous seasonal creeks that bisect the Refuge. Of these structures, 77 are earthen ponds less than one acre in size. The remaining 30 impoundments were constructed with concrete and range in size from one-quarter acre to 336 acres.

Photo: USFWS

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. (USGS 2001)

The Clean Water Act of 1977 requires states to identify and prioritize waters that do not currently support designated uses. Waterbodies 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.

Wichita Mountains Wildlife Refuge does not contain any impaired waterbodies currently listed on Oklahoma Department of Environmental Quality's 303(d) list.

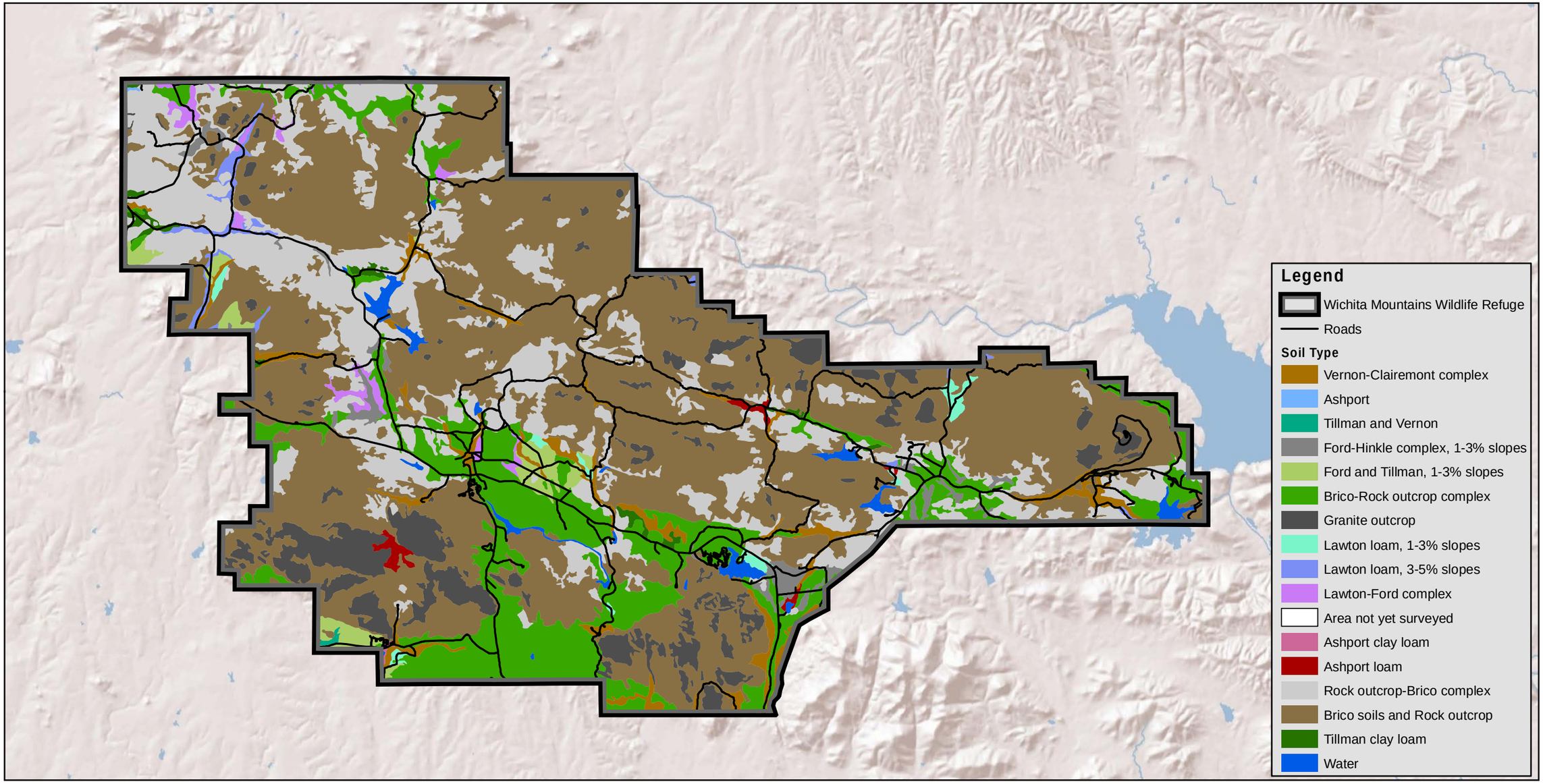
3.2.4 Geology and Soils

The geology of this region represents some of the oldest geologic strata outcroppings in Oklahoma. The Wichita Mountains were formed during the Cambrian Period, 550 to 525 million years before present (B.P.) and are composed primarily of igneous rocks such as granite and rhyolite (USACE 2005).

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Soils



PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: October, 2010
BASEMAP: N/A
MERIDIAN: N/A
FILE: WMW_soil_10.3.10_shl

0 1 2 4 Miles

0 1 2 4 Kilometers

UTM ZONE 14
NAD 83

Wichita Mountains is in a region of low to moderate seismic events. Since 1900, there have been at least 20 earthquakes recorded with intensities of IV or greater within a 100-mile radius of the Refuge.

The maximum elevation is approximately 2,479 feet at the summit of Mt. Pinchot, and the minimum elevation is approximately 1,280 feet at the base of the Lake Elmer Thomas dam.

Rocky outcroppings are common. Soils in the area of potential effect are largely in the Foard, Tillman, Vernon, and Hollister soil series—each with extensive distribution in the region. The Foard series are very deep and well-drained soils occurring on nearly level to gently sloping broad summits and shoulder slopes of terrace pediments. The Tillman series are very deep and well-drained soils found on alluvial plains and alluvial plain remnants. Vernon soils are well-drained, moderately deep soils over claystone bedrock on broad, gently sloping to steep plains and escarpments. Hollister soils are very deep and well-drained, occurring on broad, flat, plain terraces (see Figure 3-6).

The granite exposed in the southern part of the Refuge from Quanah Mountain westward to Charons Garden is more coarsely crystalline than that forming Mt. Scott. The age of a very coarse granite dike in Charons Garden was determined at the Carnegie Institution of Washington as 500 to 550 million years old.

The earliest sediments deposited are Upper Cambrian in age, probably a little less than 500 million years old. The sediments formed during this time are present in the "Slick Hills" a few miles north of Meers. The sediments are sandstone overlain by limestone. These rocks were removed by erosion from the Refuge area.

The mountains of the Wichita region were formed some 300 million years ago (Pennsylvanian period). They were created by a tremendous uplift accompanied by large folds and faults. Some of the faults were miles in length and produced large blocks. Some of these settled with respect to others, and the large flat areas bordering the Wichita Mountain Scenic Byway in the central part of the Refuge probably originated by faulting.

The mountains originally were considerably higher than the present ones, as erosion has stripped off the upper parts and deposited this material in the intervening flats, reducing the relief. Most of this erosion took place in Permian time (some 250 million years ago) and produced extensive gravel deposits. Remnants of these gravels may be seen north of Crater Lake, north of Lake Elmer Thomas, east and south of Lost Lake, and in several other parts of the Refuge. Granite is the dominant rock of the Refuge, and the gravels formed by erosion are mainly composed of granite fragments. There are unconsolidated well-rounded boulders 6 to 18 inches in diameter, known as cobblestones, surrounded by yellow-to-brown clay. Below the weathered surface, they are well cemented.

The main geologic event since the Permian is the erosion of most of the Permian gravels which once covered this area. In recent times, some newer gravel has been deposited along the small streams and in the flats. These can be seen around Lake Lawtonka, along Sandy Creek and Wolf Creek, and in other areas of the Refuge. Boulder slides in the drainage depressions are common on many of the steep slopes. One of the best examples of boulder accumulation is the “River of Boulders” on the south side of Mt. Scott.

Table 3-4. Soil Associations and Descriptions

Soil Association	Description of Properties
Vernon-Clairemont complex	Vernon soils are located on hillslopes on hills on uplands at slopes of 5-12%. The parent material consists of calcareous clayey residuum weathered from claystone. It is well drained and not flooded. The Clairemont soils are on floodplains on river valleys of 0-1% slope. The parent material consists of calcareous silty alluvium. It is well drained and frequently flooded.
Ashport soils	Ashport soils are located on floodplains on river valleys of 0-1% slope. The parent material consists of fine-silty alluvium. It is well drained and frequently flooded.
Tillman and Vernon soils	Vernon soils are located on hillslopes on hills on uplands at slopes of 5-12%. The parent material consists of calcareous clayey residuum weathered from claystone. It is well drained and not flooded. Tillman soils are located on paleoterraces on pediments on uplands of 3-5% slope. The parent material consists of calcareous clayey and loamy alluvium derived from claystone. It is well drained and not flooded.
Foard-Hinkle complex	Foard soils are located on paleoterraces on pediments on uplands with slopes of 0-1%. The parent material consists of granitic clayey alluvium over shale and siltstone. It is moderately well drained and not flooded. Hinkle soils are on paleoterraces on uplands of 1-3% slope. The parent material consists of saline clayey alluvium and/or residuum weathered from granite. It is well drained and not flooded.
Foard and Tillman soils	Foard soils are located on paleoterraces on pediments on uplands with slopes of 0-1%. The parent material consists of granitic clayey alluvium over shale and siltstone. It is moderately well drained and not flooded. Tillman soils are located on paleoterraces on pediments on uplands of 3-5% slope. The parent material consists of calcareous clayey and loamy alluvium derived from claystone. It is well drained and not flooded.
Brico-rock outcrop complex	Brico soils are located on mountain slopes with slopes of 5-20%. The parent material consists of clayey colluviums derived from granite. It is well drained and not flooded. The granite rock outcrop has very high surface runoff.
Granite outcrop	Granite outcrop with slopes of 20-90% and very high surface runoff.
Lawton loam	Lawton soils are located on paleoterraces on uplands with slopes of 3-5%. The parent material consists of granitic outwash and loamy alluvium. It is well drained and not flooded. Particles are finely sized.
Lawton-Foard complex	Lawton soils are located on paleoterraces on uplands with slopes of 3-5%. The parent material consists of granitic outwash and loamy alluvium. It is well drained and not flooded. Particles are finely sized. Foard soils are located on paleoterraces on pediments on uplands with slopes of 0-1%. The parent material consists of granitic clayey alluvium over shale and siltstone. It is moderately well drained and not flooded.
Ashport clay loam	Ashport soils are located on floodplains on river valleys of 0-1% slope. The parent material consists of fine-silty alluvium. It is well drained and frequently flooded. Particles are fine-silty sized.
Ashport loam	Ashport soils are located on floodplains on river valleys of 0-1% slope. The parent material consists of fine-silty alluvium. It is well drained and frequently flooded. Particles are fine-silty sized.
Rock outcrop-Brico complex	Brico soils are located on mountain slopes with slopes of 5-20%. The parent material consists of clayey colluviums derived from granite. It is well drained and not flooded. The granite outcrops have slopes of 3-20%

Soil Association	Description of Properties
	and high to very high surface runoff.
Brico soils and rock outcrop	Brico soils are located on mountain slopes with slopes of 5-20%. The parent material consists of clayey colluviums derived from granite. It is well drained and not flooded. The granite outcrops have very high surface runoff.
Tillman clay loam	Tillman soils are located on paleoterraces on pediments on uplands of 3-5% slope. The parent material consists of calcareous clayey and loamy alluvium derived from claystone. It is well drained and not flooded.

Source: USDA Soil Conservation Service 1967

3.2.5 Mineral Resources

The Refuge owns subsurface mineral rights. No energy developments or activities occur on the Refuge.

3.2.6 Concerns Regarding the Physical Environment

Environmental Contaminants

Determinations of existing and potential sites of environmental contamination on refuges are based specifically on Contaminant Assessment Process (CAP) reports. A CAP is an information gathering process and initial assessment of a refuge in relation to environmental contaminants. Each CAP analyzes particular contaminants of concern for fish, wildlife, and other resources on the Refuge. A CAP was conducted on Wichita Mountains Wildlife Refuge in 1999 and was revised in 2010.

In the late 19th century, gold ore processing operations were conducted in the area now encompassed by the Refuge. Smelter sites were located on Blue Beaver Creek and Fawn Creek, while arrastras (grinding sites) were established on Cedar Creek and Panther Creek. Elevated metals concentrations were detected in the soils of these sites in the mid-1980s. A subsequent investigation indicated that these elevated metals were not readily available at normal soil pH conditions. In addition to the gold ore processing sites, the Refuge contained an unauthorized municipal solid waste disposal site (Ferguson Landfill). The area was remediated in 1998-1999.

A fisheries survey conducted in 1997 indicated that fish from the Refuge contained elevated levels of mercury. All samples collected contained mercury levels that exceeded the recommended avian predator protection limit of 0.1 mgHg/kg. These results led to fish consumption advisories on Lake Rush, Jed Johnson Lake, Quanah Parker Lake, Lake Elmer Thomas, Lost Lake, French Lake, Caddo Lake, Crater Lake, Burford Lake, Osage Lake, Post Oak Lake, and Treasure Lake. The presence of metal contamination in the sampled reservoirs indicates that contamination likely exists in associated streams. (USFWS 2010a)

Though not discussed in the CAP, the Jed Johnson Tower is widely believed to have asbestos contained in roof shingles. The roof of that structure burned many years ago and collapsed into the tower. Abatement would be necessary to prepare this structure and site for public use.

Air

From the IMPROVE monitor, sulfureous particulate contributes to haze and visual impairment in every month except January (OKDEQ 2010); nitrate particles contribute more in colder winter days.

Ozone emissions could increase due to climate change (Bell et al. 2007). Ozone would add to the current particles in the atmosphere and further increase the amount of 'haze' over the Refuge.

Water

Coal-fired plants produce mercury emissions. The State of Oklahoma has 12 coal-fired electric steam generating units (AES Shady Point Inc: 2 units; Grand River Dam Authority: 2 units; Oklahoma Gas & Electric Company Muskogee: 3 units; Oklahoma Gas & Electric Company Sooner: 2 units; Public Service Company of Oklahoma Northeast: 2 units; and Western Farmers Electric Cooperative Inc. Hugo: 1 unit). In 2002, the amount of mercury emissions from each coal-fired electric steam generating unit in Oklahoma was as follows: AES Shady Point Inc: 438 pounds (lbs); Grand River Dam Authority: 338 lbs; Oklahoma Gas & Electric Company Muskogee: 446 lbs; Oklahoma Gas and Electric Company Sooner: 288 lbs; Public Service Company of Oklahoma Northeast: 452 lbs; and Western Farmers Electric Cooperative Inc. Hugo: 165 lbs (EPA 2002). According to the EPA's Mercury report to Congress, in flat terrain, at least 75 percent of mercury emissions could be transported greater than 50 km from the source (EPA 1997). The State of Texas has 18 coal-fired plants that also contribute to the influx of mercury emissions that affect the Refuge. All of these coal-fired units are greater than 50 km (on average 309 km) from Wichita Mountains Wildlife Refuge. But considering the weather patterns and wind speed, some mercury emissions could reach the Refuge, especially as mercury has been detected in the fish of the Refuge.

The pH of the Refuge's waterbodies may be affected by climate change. As the amount of carbon dioxide increases in the Earth's atmosphere, water pH is projected to decrease (Karl et al. 2009). And as the precipitation patterns change and as higher temperatures exist due to climate change, water bodies will be stressed from drought and higher rates of evaporation. These changes (decreasing pH, increasing temperature, and drought) will affect the aquatic plant and animal life that live within these waterbodies and the terrestrial animals that depend on these waterbodies for their sole source of water.

The Refuge maintains both Federal groundwater rights, reserved by the Federal government when the Refuge was initially established as a Forest Reserve, and State surface water rights, purchased from the State of Oklahoma. With increasing urban development and agricultural water use, the Refuge is becoming increasingly concerned about maintaining its existing water rights and, if the need should arise based on a changing climate or other water scarcity issues, potentially acquiring additional water rights. This concern is amplified by surrounding land users' or developers' water needs and how their accumulation of water rights or water needs might affect the Refuge.

Soils

Efforts to control invasive and non-native plant species (such as Old World bluestem, Johnson grass, mesquite, and multiflora rose) using 2,4-D and/or a two-percent Roundup (glyphosate) solution may have caused contaminants to occur in either terrestrial or aquatic sediments. Soils on the Refuge appear to be well-drained soils. Herbicides are less likely to leach through well-drained soils than in poorly-drained soils (Huddleston 1996), effectively reducing the herbicide accumulation in groundwater sources. Also, silt loams are generally less sensitive to leaching due to their slow permeability.

The mining of gold prior to the establishment of the Refuge has left some lingering effects to the soil, such as open pits and shafts, mine tailings, and traces of mercury and other contaminants.

Activities associated with wildfires and prescribed fires may cause erosion issues if precautions are not taken. The rehabilitation of fire and control lines are important aspects of the Refuge fire program. Additionally, efforts are undertaken to reduce ground soil compaction or disturbance by limiting travel of heavy equipment in undisturbed areas.

3.3 Biological Environment

This section describes the biological environment in which the Wichita Mountains 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 and the natural processes that influence them. It identifies priority wildlife species and focal species used for monitoring purposes, and it includes a discussion of various wildlife types found on the Refuge. The section includes a short discussion about the Service's concerns pertaining to the biological environment.

3.3.1 Habitat Types

The Wichita Mountains Wildlife Refuge owes its character to the range of mountains from whence it gets its name. These topographic features and the climate of the region have created habitats of mixed-grass prairies, Crosstimbers, and rocklands that define the Refuge and the biota that live there. The habitats of the Wichita Mountains are so unusual and distinct that it was once designated as its own biotic district (Blair and Hubbell 1938). Historically, most of the habitat descriptions on the Refuge were designated by attributes of range conditions, based on soil type and depth, climate, topography and elevation, not necessarily on the flora components of the habitats (McCoy 1985, Soil Conservation Service 1988, Kimball 1992).

The Refuge lies at a vegetational crossroads along the eastern edge of the southern Great Plains region. The mixed-grass prairies are dominated by little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardi*i), switchgrass (*Panicum virgatum*), sideoats grama (*Bouteloua curtipendula*), hairy grama (*Bouteloua hirsute*), blue grama (*Bouteloua gracilis*), silver bluestem (*Bothriochloa laguroides*), buffalograss (*Bouteloua dactyloides*), and Canada wildrye (*Elymus canadensis*). The Crosstimber forests are dominated by post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*) and eastern red cedar (*Juniperus virginiana*).

Figure 3-7. Vegetation delineates the Refuge habitats by broad designations. The Refuge is divided into three distinct terrestrial habitats: rocklands, central mixed-grass prairie, and Crosstimbers Oak Forest and Woodland (Table 3-5). The most extensive habitat on the Refuge is the central mixed-grass prairie, followed closely by the Crosstimbers Oak Forest and Woodland. The rocklands, the least frequent of the habitats, contributes roughly four percent to the total land cover (Table 3-5).

The land cover of the Refuge has been extensively classified according to the National Vegetation Classification Standard (2008) and the closely related classification scheme from Hoagland (2000) and a site specific classification for associations and alliances that do not fit into existing categories. While this project has not been completed, most of the vegetation associations and alliances of the Refuge habitats have been identified and contribute to the description of the vegetation classes.

Table 3-5. Broad Habitat Types on the Wichita Mountains Wildlife Refuge

Habitat/Ecosystem	Acres on Refuge	Percentage
Central Mixed-Grass Prairie	30,941	52
Crosstimbers Oak Forest and Woodland	24,702	42
Rocklands	2,474	4
Open Water	568[1]	1
Developed	335	1
Total	59,020	100

Source: Wichita Mountains Wildlife Refuge, unpublished data 2010

3.3.1.1 Terrestrial Vegetation Classes

Central Mixed-Grass Prairie

The central mixed-grass prairie ranges from South Dakota into the rolling plains and the western Edwards Plateau of Texas. The mixed-grass prairie is bordered by the shortgrass prairie on its western edge and the tallgrass prairie to the east. The mixed-grass prairie contains elements from both shortgrass and tallgrass prairies, with species densities and distributions controlled primarily by soil moisture and topography.

On the Wichita Mountains Wildlife Refuge, the central mixed-grass prairie is dominated by several graminoid species, including little bluestem, big bluestem, Indiangrass, sideoats grama, switchgrass, silver bluestem, buffalograss, and hairy grama; and forb species, including Indian blanket (*Gaillardia pulchella*), sneezeweed (*Helenium autumnale*), leadplant (*Amorpha canescens*), and compass plant (*Silphium laciniatum*).

While the mixed-grass prairie areas in the Refuge are primary herbaceous, oaks can occur in some areas protected from fire due to topographic position. Additionally, the mixed-grass prairie is dotted by thickets of plum and sumac. Riparian areas in the central mixed-grass prairie contain species such as cottonwood (*Populus deltoides*), ash (*Fraxinus spp.*), American elm (*Ulmus americana*), and buttonbush (*Cephalanthus occidentalis*).

On the Wichita Mountains Wildlife Refuge, the central mixed-grass prairie habitat encompasses 30,941 acres of area, accounting for 52.4 percent of the Refuge. The central mixed-grass prairie habitat on the Refuge contains membership of several different associations and alliances (Table 3-6).

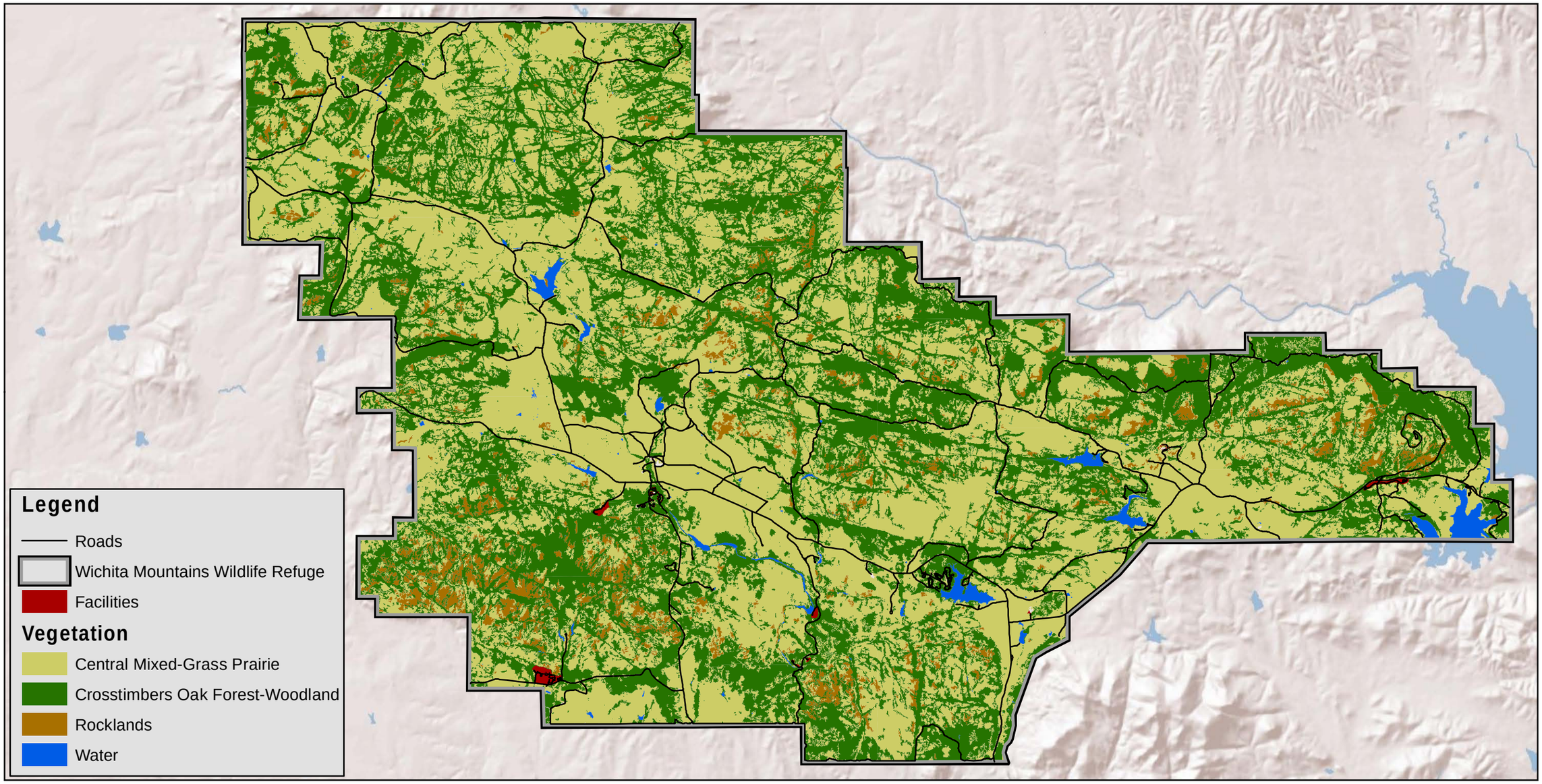
[1] This figure was estimated from digitized features on an aerial photo. This number may be different from other acreages referenced in this document due to drought or alternative methods of calculation.

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Vegetation



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BASEMAP: N/A
MERIDIAN: N/A
FILE: wmw_veg_6.10.11_shl

0 1 2 4 Miles

0 1 2 4 Kilometers

UTM ZONE 14
NAD 83

Table 3-6. Membership of Refuge Associations and Alliances in Central Mixed-Grass Prairies

Type	Predominant Species	Common Name
Forest Association	*Ulmus (americana/rubra) – Celtis (laevigata, occidentalis) – Fraxinus pennsylvanica*	American/ Slippery Elm – Sugarberry/ Hackberry – Green Ash
Woodland Association	*Schizachyrium scoparium – Juniperus virginiana*	Little Bluestem – Eastern Red Cedar
Scrubland Alliance	*Rhus trilobata*	Skunkbush Sumac
	Cephalanthus occidentalis	Buttonbush
	Rhus glabra	Smooth Sumac
	Prunus angustifolia – Schizachyrium scoparium	Sand Plum – Little Bluestem
Herbaceous Alliance	*Panicum virgatum – Tripsacum dactyloides*	Switchgrass – Eastern Grama
	Schizachyrium scoparium – Sorgastrum nutans	Little Bluestem – Indiangrass
	Bothriochloa saccharoides	Silver Bluestem
	Eleocharis macrostachya	Creeping Spikerush
	Sorghum halepense	Johnson Grass
	Cynodon dactylon	Bermuda Grass
	Bothriochloa ischaemum	Old World Bluestem
	Schizachyrium scoparium-Bouteloua (curtipendula/ hirsute)	Little Bluestem – Sideoats Grama – Blue Grama
	Schizachyrium scoparium – Andropogon gerardii	Little Bluestem – Big Bluestem
	Bouteloua (curtipendula /gracilis) – Buchloe dactyloides	Sideoats Grama – Blue Grama – Buffalograss
	Bouteloua gracilis – Buchloe dactyloides	Blue Grama – Buffalograss
	Bouteloua (gracilis/curtipendula/hirsuta)	Blue Grama – Sideoats Grama – Hairy Grama
	Bouteloua (hirsute/curtipendula)	Hairy Grama – Sideoats Grama

Source: NatureServe 2010, Hoagland 2000, and Wichita Mountains Wildlife Refuge, unpublished data 2010

Crosstimbers Oak Forest and Woodland

The Crosstimbers habitat type is characterized by a "mosaic of forest, woodland, and savanna", and NatureServe describes the Crosstimbers Oak Forest and Woodland ecological system as a "system distinguished by the dominance of short, stunted *Quercus stellata* and *Quercus marilandica* (post oak and blackjack oak)…with the understory containing species typical of the surrounding prairies."

The Crosstimbers are one of the largest ecosystem types in the State of Oklahoma, with the majority of this ecotype located in the central and eastern parts of the State. The Wichita Mountains Wildlife Refuge contains an island in the western extreme of the Crosstimbers habitat type (Hoagland et al. 1999). The Crosstimbers habitat is defined by a varying mixture and densities of oaks and red cedar. On the Refuge, post oak is the most common species, followed by blackjack oak and red cedar (Buck 1964). The composition and structure of the Crosstimbers habitat is affected by the dynamic processes of drought, fire, herbivory, and invasion of introduced species (NatureServe 2010).

On Wichita Mountains Wildlife Refuge, the Crosstimbers habitat encompasses 24,702 acres of area, accounting for 41.9 percent of the Refuge. The Crosstimbers Oak Forest and Woodland habitat on the Refuge contains membership of several different associations and alliances (Table 3-7).

Photo: USFWS

Table 3-7. Membership of Refuge Associations and Alliances in Crosstimbers Oak Forest and Woodland Vegetation Classes

Type	Predominant Species	Common Name
Forest Association	*Acer saccharum – Ulmus rubra – Juglans nigra*	Sugar Maple – Slippery Elm – Black Walnut
	Quercus stellata – Juniperus virginiana	Post Oak – Eastern Red Cedar
	Juniperus virginiana	Eastern Red Cedar
	Quecus stellata – Quercus shumardii – Carya cordiformis	Post Oak – Shumard Oak - Bitternut Hickory
	Quercus stellata – Quercus marilandica – Juglans nigra	Post Oak – Blackjack Oak – Black Hickory
Woodland Alliance	*Quercus stellata – Quercus marilandica*	Post Oak – Blackjack Oak
	Sapindus saponaria	Western Soapberry
	Quercus stellata, Quercus marilandica) / Schizachyrium scoparium	Post Oak, Blackjack Oak, Little Bluestem
	Quercus marilandica – Schizachyrium scoparium	Blackjack Oak – Little Bluestem
	Robinia pseudoacacia	Black Locust
	Jugans microcarpa	Little Walnut
Granitic Woodland Association	*Quercus fusiformis – Quercus stellata – Schizachyrium scoparium*	Texas Live Oak – Post Oak – Little Bluestem

Source: NatureServe 2010, Hoagland 2000, and Wichita Mountains Wildlife Refuge, unpublished data 2010

Rocklands Habitat

The Refuge's rockland habitats occur primarily on open and exposed mountain tops, southern slopes, and boulder slides. They are characterized by shallow soils, sparse vegetation, and gabbro and granite rock formations. The plant communities in the rocklands habitat type are dominated by annuals and species adapted to drought conditions. Plant diversity in the rocklands is positively related to the depth of soil in these habitats (Uno and Collins 1987). Exposed rock formations inhibit the establishment of vegetation but also provide habitat for specialized species.

The rockland habitats account for 2,474 acres, or 4.2 percent of the Refuge. While the majority of this habitat has been mapped as rock, this habitat does contain a vegetation association (Table 3-8).

Table 3-8. Membership of Refuge Associations and Alliances in Rocklands

Type	Predominant Species	Translated Name
Sparse Vegetation Association	*Sedum nuttallianum – Plantago wrightiana*	Yellow Stonecrop – Wright's Plaintain
	Non-vegetated rock	

Source: NatureServe 2010 and Hoagland 2000

3.3.1.2 Aquatic Classes

The Wichita Mountains Wildlife Refuge is at a higher elevation than the surrounding area and is thereby situated at the top of the watershed. Natural aquatic classes on the Refuge such as creeks and streams are intermittent and seasonal. Manmade reservoirs and ponds account for the largest waterbodies on the Refuge and are subject to evapotranspiration and occasional managed drawdowns. Aquatic classes were obtained from the National Wetlands Inventory, with the exception of creeks and streams, and these were obtained from the Wichita Mountains geodatabase.

Table 3-9. Broad Aquatic Class Classifications

Type	Aquatic Class	Description	Size
Freshwater Emergent Wetland	Palustrine emergent	Herbaceous marsh, fen, swale, and wet meadow	3 acres
Freshwater Forested/Shrub Wetland	Palustrine forested and/or palustrine shrub	Forested swamp or wetland shrub or bog wetland	1 acre
Freshwater pond	Palustrine unconsolidated bottom, Palustrine aquatic bed	Man-made freshwater ponds	104 acres
Lake	Lacustrine wetland and deepwater	Reservoir basins	799 acres
Riverine	Riverine wetland and deepwater	Stream channels	5 acres
Total Acreage			**912 acres**
Streams and Creeks	Seasonal streams and creeks	Seasonal and intermittent flow	231 miles

Source: U.S. Fish and Wildlife Service 2010b.

3.3.1.3 Natural Disturbance Processes

Natural disturbances (grazing, fire, and weather [i.e., wind, ice, heat/cold, and drought or flood]) have occurred in the Wichita Mountains since prehistory. These disturbances have created the biodiversity we see today. Management practices of the Refuge cannot change weather but can, when possible (e.g., grazing and fire), strive to mimic historic disturbances and disturbance patterns to maintain biological integrity.

Early community ecologists could be grouped in two cohorts. The historic model, which remained in favor through the 1960s, asserted that plant assemblages reached climax as a community (Cowles 1910, Cowles 1911, Clements 1916, W. Cooper; E. Haeckel; A. Tansley, E. Warming). The second model believed that biotic communities consist of species behaving individually or—phrased differently—that a fixed environment is not necessary to the life of any individual plant (Gleason 1917, Gleason 1926, Gleason 1939, G. Negri, L. Ramensky). These two trends are compared in detail by Ponyatovskaya (1961).

Whittaker (1953) considered previous "climax" theories and developed a concept of ecological continuum. He observed that the mono-climax models (proposed by Clements [1916] and cohorts) did not adequately describe communities. Whittaker's evidence of problems in community climax theory was summarized using 1) succession, 2) convergence, 3) patterning, 4) continuity, 5) irregularity, and 6) instability. Considerable references were provided for each. He observed that the work of Gleason (1917, 1926, 1939) and L. Ramensky addressed some of these problems. Whittaker addressed scale as an ecological issue when he agrees with Cain (1939) that the difference between mono-climax and poly-climax is semantic. Whittaker (1953) writes that, "No completely rigorous definition of the climax and its distinction from succession has been found, and apparently none need be expected." The concept of ecological continuum was further described in Whittaker (1957, 1965).

During the 1970s, focus on successional development of equilibrium communities shifted to focus on the process of disturbance and the evolutionary significance of such events. Levin and Paine (1974, 1975) modeled spatio-temporal heterogeneity, incorporating variations in timing and magnitude, and variations in successional process. White (1979) fully discussed how natural systems are subject to a wide array of disturbances, on a wide array of spatio-temporal scales. These dynamic disturbances result in heterogeneous landscapes. Thus, the equilibrium model, which held that ecological systems were normally in a deterministic balance with environmental controls, underwent a shift in perspective that emphasizes the frequent non-equilibrium states and the importance of random effects (Pickett and White 1985, DeAngelis and Waterhouse 1987, McIntosh 1987, Collins and Gibson 1990, Christensen 1997, Meffe and Carrol 1997, and Wiens 1997).

Biodiversity contribution to ecosystem stability has been demonstrated empirically (Wiens et al. 1985, Collins and Gibson 1990, Naeem et. al. 1994, Tartowski et. al. 1997, Tilman 1999, D'Odorico et. al. 2006, Fuhlendorf et. al. 2009, Polyakov et al. 2008) and mathematically (Tilman 1994, Tilman et al. 1998, Tilman 1999, Doak et. al. 1998, Hanski 1999, Lehmen and Tilman 2000, Ives and Hughes 2002). Many authors have examined the causal relationship between heterogeneity and ecosystem sustainability (Pickett 1980, Sonsa 1984, Towne and Owensby 1984, Axelrod 1985, Collins and Barber 1985, Pickett and White 1985, Glitzenstein et. al. 1986, Schindler 1987, Collins 1989, Collins 1992, Collins 2000, Pickett et. al. 1989, Turner et. al. 1989, Naeem et. al. 1994, Tilman and Downing 1994, Wu and Loucks 1995, Steinauer and Collins 1996, Tartowski et.al. 1997, Wiens 1997, Wiens et al. 2002, Delcourt and Delcourt 1998, Naeem 1998, Freckleton 2004, Brawn 2006,

Fuhlendorf et. al. 2006, Dybzinski et. al. 2008). The ecological tenet that disturbance, patch dynamics, and biodiversity cause ecosystem stability has been broadly demonstrated.

Ecosystem function is maintained by compensatory changes in species composition (Schindler, 1987; Pickett et.al. 1997). Ecosystem disturbance occurs in three categories: 1) climate, 2) fire, and 3) biotic (Collins and Barber 1985). Effects of disturbances vary in scale (extent), intensity, frequency (Sousa 1985), and seasonality. Biodiversity is not simply a function of disturbances; instead, it is a response to succession and concurrent disturbances functioning in concert affecting species composition and diversity (Anderson 1982, Collins and Uno 1983, Collins and Barber 1985). A system disturbed beyond its limits of resilience will maintain a new sphere of activity (Denslow 1980, Denslow 1985, Pickett 1980, Hanski 1983, Collins and Barber 1985, Loucks et.al. 1985, Sousa 1985; Collins 1992, Collins 2000, Heino and Hanski 2001, D'Odorico et al. 2006, Beckage et. al. 2009). Perhaps the worst outcome of decreased biological diversity is a decrease in resilience and resistance to environmental change (Tartowski et. al. 1997). Departure from historic disturbance regimes affects competitive success of a species (Hanski 1983). Studying past patterns will help us understand patterns of the future (Christensen 1997). Practitioners must mimic historic disturbances to maintain existing ecosystems. Changes are persistent, and the ability to adapt, particularly at the Wichita Mountains Wildlife Refuge, is central to sustainability of ecosystem function.

3.3.1.4 Historical Habitat Description

Grasslands (as we know them) of the Interior Plains Province (including the great plains, Osage plains, rolling red plains, and all the interior grasslands of North America) are a recent development (Kapp 1970, Wells 1970, Wright 1970, Axelrod 1985, Benedict et al. 1996). Climate (Braun 1947, Coupland 1958, Bryant 1977, Krech 1999), topography (Blair and Hubbell 1938, Wells 1965, Wells 1970b, Wells 1970c), grazing (McNaughton 1979, Dyer et al. 1982, Belsky 1987, Maschinski and Whitham 1989, Scholes and Archer 1997, Stebbins 1981), and fire (Stewart 1951, Coupland 1958, Wells 1965, Wells 1970b, Wells 1970c, Scholes and Archer 1997, Krech 1999, Peterson and Reich 2001) work jointly (Sauer 1950, Wells 1970a, Wright 1974, Anderson 1982, Anderson 2006, Wright and Bailey 1982, Axelrod 1985, Anderson and Bowles 1999) to create the prairies we recognize today. Disturbance patterns created a shifting mosaic in which, at any time, the landscape may include areas recently burned or grazed (or both), as well as areas that had not been disturbed for years (Kay 1998, Fuhlendorf and Engle 2001, Fuhlendorf and Engle 2004).

Where forest and grassland meet, a transitional boundary exists. This boundary contains elements of both prairie and forest. The mosaic patterns present immediately prior to European exploration/settlement were maintained by fire (Wells 1970c, Anderson 1982, Anderson 1990, Anderson 2006, Axelrod 1985, Robertson et al. 1997, Anderson and Bowles 1999). Fire starts were natural and anthropogenic (Pyne 1982, Pyne 2004, Batek et al. 1999, Krech 1999, Vale 2002, Kay 2007, Fowler and Konopik 2007).

Crosstimbers (a mosaic of forest, woodland, and prairie) of North America comprise an estimated area of over 11 million acres and represent a unique ecoregion, bounded by grasslands to the west and deciduous forests to the east (Harrison 1974, Hoagland et al. 1999). This area supports a unique array of flora and fauna and is critical habitat for a number of threatened and endangered species, e.g., black-capped vireo.

Several explorers of the 18th and 19th centuries describe vegetation characteristics of the Crosstimbers (Bruner 1931, Dyksterhuis 1948, Francaviglia 1998). Early descriptions only roughly describe vegetation associations but provide excellent insight on vegetation structure.

Irving (1956) perhaps provides the harshest description in his *A Tour of the Prairie*. Irving describes the Crosstimbers as "…broken, hilly country covered with scrub oak, with interlacing limbs as hard as iron, and intersected by deep ravines…" and regards travel as "…toiling a dismal series of rugged forests… . It was like struggling through forest of cast iron." While this is a vivid description of the Crosstimbers as Irving saw it, others had a different impression of the area. W.B. Parker, attached to Captain R.B. Marcy's 1854 expedition, described the lower Crosstimbers as "…stunted oak, not growing in a continuous forest, but interspersed with open glades, plateaus, and vistas of prairie scenery…" (Dyksterhuis 1948). Parker's report is particularly interesting because he began his notes from the time he left Fort Smith until he returned, giving a vivid description of the Crosstimbers of that time. Describing several of his expeditions through the Crosstimbers, Marcy (1866) writes "At six different points I have passed through it, I have found it characterized by the same peculiarities; the trees consisting principally of post-oak and black-jack, standing at such intervals that wagons can without difficulty pass between them in any direction." Francaviglia (1998) references Fray Franciso Caliz (1718), stating "…it is so wooded and entangled with *cocolmecates* [vines that were twisted like a rope]" and Count de Pourtalès (1832) "…magnificent, sparsely scattered trees and twenty varieties of climbing plants…" What makes Count de Pourtalès' statement interesting is that he was on the same expedition as Irving.

Notes on the presence of cedar (*Juniperus* spp) can be found in early explorer's reports. Site descriptions include "cedar breaks" and rock outcrops (Francaviglia 1998) and rocky exposures and eroded hillsides (Bruner 1931). Descriptions of cedar in forests or grassland of the Crosstimbers are noticeably lacking. Marcy (1866) recalls camping below Mt. Scott; "To the north of Mount Scott lies one of the most beautiful valleys I ever saw. …and through it winds a lovely stream of pure water…. It is fringed with gigantic pecan, over-cup, white ash, elm, and hackberry trees. About the base of the mountains we found the post-oak, and towards their summits the red cedar grows." Surveyors, circa 1871, in Carter County, Oklahoma, recorded bearing tree data on a total of 6,886 stems. In the Public Lands Survey data, only four individuals of *Juniperus* were recorded (Shutler and Hoagland 2004). At present, *Juniperus* occupies over 25,000 hectares in Carter County (Engle et al. 1997). Government Land Office bearing tree data from 1874 and 1903 surveys of the Wichita Mountains is under analysis; findings similar to the Shutler and Hoagland (2004) paper are expected (Bruce Hoagland, pers. comm.). Nuttall, Ellsworth, and Gregg (19th century explorers) discuss the evidence of wildfire along their respective route (Francaviglia 1998). Stambaugh et al. (2009) described the pre-Euro-American mean fire interval of a site within Wichita Mountains Wildlife Refuge. The pre-1901 mean fire interval was 4.4 years. Tree ring analysis provides evidence that fire intensity and frequency, as well as topoedaphic features, restricted establishment of eastern red cedar throughout its range (Guyette 1978, Stahle 1997, Jenkins et al. 1997, Batek et al. 1999; Guyette et al. 2002, Stambaugh and Guyette 2008).

Based on descriptions by explorers of that time, it is reasonable to conclude that the Crosstimbers were a mosaic of scattered forest, woodland, scrubland, and open prairies. Forest areas were characteristic of gallery forest, occurring along streams and adjacent to mesic sites. Post oak appeared to be the most dominate species, but pecan, elm, and hackberry (and other mesophytic species) appeared to be associates. Forest areas transitioned to woodlands and scrublands with more xeric species. Post oak and blackjack oak appeared co-dominant in this transitional area. Woodland and scrubland transitioned to grassland. On rough broken areas, with poor fuel to carry fire, cedars were present. Proportions of each habitat type likely changed based on topography, climate, and fire occurrence giving a spatial and temporal component to vegetation characteristics.

3.3.1.5 Estimated Future Habitat Conditions due to Climate Change

Our global climate depends on the "greenhouse effect" of heat-trapping gases—such as water vapor, carbon dioxide (CO_2), ozone (O_3), methane (CH_4), and nitrous oxide (N_2O)—to absorb heat radiated from the Earth's surface that, in turn, radiates much of the infrared energy back toward the surface. Without these greenhouse gasses, the Earth's surface would be much cooler. Since the beginning of the industrial era (around the mid-1700s), human activity has led to increases in greenhouse gases in our lower atmosphere, intensifying the greenhouse effect (Trenbeth 1998, Folland et al. 2001, Gitay et al. 2002, Alley et al. 2007, Karl et al. 2009). The average temperature of the lower troposphere has increased during the past decades (Hense et al. 1998, Folland et al. 2001). This coincides with increased sea surface temperatures (Hense et al. 1998, Alley et al. 2007, Rahmstorf et al. 2007). Minimum temperatures have increased greater than daytime maximums, suggesting increased nighttime warming (Gitay et al. 2002, Ojima et al. 2002).

Water vapor is the most important and abundant greenhouse gas in our atmosphere (Karl et al. 2009). The physical properties (specific heat) of water allow it to collect heat during periods of high temperature and to radiate heat as temperature cools. This feature smooths temperature spikes during diurnal heating and cooling events. Warmer air can hold more water vapor. Increased greenhouse gases contribute to increased warming. Warmer temperatures increase evaporation, increasing atmospheric water vapor. Atmospheric moisture is increasing globally, creating a feedback loop leading to more warming (Hense et al. 1988, Gaffen 1991, Ojima et al. 1991, Gaffen et al. 1992, Gutzler 1992, Ross and Elliot 1996, Trenbeth 1998, Easterling et al. 2000, Alley et al. 2007, Karl et al. 2009).

Jet streams are meandering bands of high velocity winds located near the tropopause. They play a critical role in development and movement of weather systems. Increases in greenhouse gases and other climate forcing would lead to warming of the troposphere, cooling of the stratosphere (intensifying the Stratospheric Polar Vortex), elevation rise of the tropopause, weakening of tropical circulation patterns, and other climate changes, inducing a poleward shift in tropospheric jets (Ally et al. 2007, Seidel et al. 2008). Increased temperatures and water vapor affect the distribution of mass (and thus pressure) in the atmosphere, and therefore affect the strength and location of the jet streams (Trenberth 1998, Archer and Caldeira 2008). Temperature anomalies in sea surface temperatures lead to shifts of the zonal mean atmospheric circulation (Gaffen et al. 1991, Folland et al. 2001, Seidel et al. 2008). Cristina Archer and Ken Caldeira (2008) examined jet stream patterns during a 23-year span (from 1979–2001). They found that the jet streams in both hemispheres have risen in altitude and shifted toward the poles. These changes fit predictions from climate change models (Folland et al. 2001, Yin 2005).

Trenberth (1998) discusses atmospheric moisture residence time and cycling. His study documents a mismatch between rates of rainfall versus evaporation. This implies that precipitating systems feed mostly on moisture already in the atmosphere and on advection to resupply moisture to storm circulations. Advection is the transfer of heat and humidity by the horizontal movement of an air mass. Increased atmospheric moisture carried by advection contributes to increased precipitation intensities in northern latitudes because of poleward movement of the jet stream and convergence of air masses (IPCC 1996, Trenberth 1998, Meehl et al. 2005, Yin 2005). Prospects of a more vigorous hydrologic cycle translate to a change in frequency and duration of extreme events and can lead to opposing problems of deluge and drought (IPCC 1996, Trenberth 1998, Ojima et al. 2002, Meehl et al. 2005, Karl et al. 2009). Easterling et al. (2000) and Folland et al. (2001) provide evidence of a more vigorous hydrological

cycle, including particularly heavy rainfall events and increased time between rains, contributing to drought conditions even when average annual rainfall is obtained.

Predictions of vegetation response to climate change are mixed. Veteli et al. (2002) found increased leaf biomass and net primary production (NPP) with elevated CO_2 atmospheres; however, elevated temperature and CO_2 increased stem biomass, producing less palatable stem-to-leaf ratios. Coughenour and Chen (1997) and Morgan et al. (2008) predict long-term decline in available soil N, decreased N mineralization, and decreases in plant N concentration under elevated CO_2. Bachelet et al. (2001), Ojima et al. (2002), and Fischlin et al. (2007) project regional gains in woody cover through direct CO_2 fertilization. Elevated CO_2 increased C_3 plant production by 142 percent but had no effect on production in C_4 plants; however, because C_4 NPP baseline values were greater than C_3, C_4 NPP remained highest after increased CO_2 (Ward et al. 1999). McCarron and Knapp (2001) did not find functionally distinct traits in resource acquisition and use between C_3 woody shrubs and C_4 dominated grasslands. These findings suggest it is unlikely that elevated CO_2 will cause significant shifts in community diversity; however, forage nutrition quality may decrease. Changes in the hydrologic cycle (discussed previously) and mean fire return interval will likely influence vegetation communities more than elevated carbon dioxide.

It seems logical to assume that species present in any given area are generally those best suited to recent past climatic conditions. If climatic conditions change, they may be likely to create an environment better suited for other species (Walther et al. 2002). Bertin (2008) summarized studies that examined change of plant phenology and distribution. These studies provided 64 examples of phenologic change and 23 examples of distribution change. Similar findings are reported by Fitter and Fitter (2002) and Karl et al. (2009). Gitay et al. (2002) reported that the growing season in the northern hemisphere has lengthened one to four days per decade during the last 40 years. Corresponding with the extended growing season Gitay et al. (2002) reported that the phenology of plant flowing, bird arrival, breeding season, and emergence of insects is earlier. Crick (2004) completed a literature review for phenologic changes of birds. He reports substantial evidence of change in the phenology of birds, particularly the timing of migration and of nesting. Root et al. (2003) reports consistent temperature-related shifts in species distribution, ranging from mollusks to mammals and from grasses to trees. The decoupling of historic phenologic processes could contribute to phenological miscuing (responding inappropriately to a change, including a lack of response) and for phenological disjunction (in which a species becomes out of synchrony with its environment) (Gitay et al. 2002, Crick 2004). Fitter and Fitter (2002) and Bertin (2008) discuss situations where predicted changes in distribution and phenology could have major implications for evolutionary phenomena, including gene flow, ecosystem productivity, species interaction, community structure, and conservation of biodiversity.

Environmental conditions forecasted by climate change models favor disease pathogens, invasive and introduced pest species, wildfires, and modification of aquatic systems. Several publications suggest that warmer winters, longer growing seasons, and less extreme cold in winter provides opportunities for insect pests, disease pathogen outbreaks, and invasive plants to flourish (Ojima et al. 2002, Veteli et al. 2002, Morgan et al. 2008, Karl et al. 2009). Dale et al. (2000, 2001) also discusses the effect of insect and pathogen outbreaks and of introduced species but further expands his discussion to include consequences of additional natural disturbances on forest systems. Given current climate model projections, the frequency of large wildfires, intensity of fires, and the length of fire seasons will increase (Dale et al. 2001, Morgan et al. 2008, Karl et al. 2009). Rapid response of fire regimes to changes in climate could potentially overshadow the direct effects of climate change on species distribution and migration (Dale et al. 2001). By

absorbing nearly one-third of the atmospheric CO_2, the ocean reacts with other components to decrease ocean pH (Feely et al. 2008, Karl et al. 2009). Increasing acidity would have negative impacts on aquatic organisms making calcium carbonate shells. Also, warm water holds less oxygen, increasing stress on aquatic organisms.

The following climate change projections are summarized from Ojima et al. (2002), Morgan et al. (2008), Karl et al. (2009), and Oklahoma Climatological Survey (2010).

- Shifting of the temperature distribution to a hotter mean.
  - Increase in the annual mean temperature.
  - Frequency of hot extremes and heat waves will increase.
  - Fewer and less severe cold extremes.
  - Warm season becomes longer and arrives earlier.
  - Cool season warms and shortens.
  - Changes in summer temperatures are projected to be larger than those in winter.
- Jet stream is projected to move poleward.
- Increased ocean temperatures will disrupt wind that typically drew moisture from the south into the Great Plains.
- Precipitation patterns in the future are uncertain, with areas both increasing and decreasing in precipitation.
  - General increase in precipitation in northern areas, and southern areas will become drier.
  - In the Southern Plains, drought frequency and severity are projected to increase, especially during summer.

Implications for Oklahoma include but may not be limited to:

- Warmer winters may impact soil organic matter and C and N sequester.
- Changes in the timing of life-history events, or phenology, for particular species will occur.
  - Decoupling coevolved interactions, such as plant-pollinator relationships.
  - Shifting the timing of animal migrations.
  - Making spring agriculture more vulnerable to late freeze and/or snow events.
- Increased atmospheric humidity.
- Changes in hydrology likely present the largest threat in the Great Plains.
  - More intense and less predictable hydrologic cycle.
  - Extreme events such as heavy downpours and droughts are likely.
    - Rain-free periods will lengthen, but individual events will become more intense.
    - More runoff and flash flooding will occur.
    - Increased evaporation and sustained drought will occur.
  - Reduction in water availability and quality, and shallow water aquifer recharge.

  - Seasonality of rainfall to shift; relatively greater precipitation in winter and less in summer.
    - Changes in hydrologic cycle will effect stream flow timing and forage availability and quality.
- Climate change may contribute to pest outbreaks and increases in invasive species.
  - Increased spread of wildlife diseases, parasites, and zoonoses.
  - Increased spread of invasive and non-native species, including plants, animals, and pathogens.
- Increased temperatures and sustained drought periods create increased wildfire potential.

Our environment results from multiple positive and negative feedback loops. Cause-effect relationships have been researched by previously noted scientists (and assuredly many others), and models have been developed and refined. Dwyer et al. (1996) observed that changes forecast in current climate models were previously demonstrated during the Hypsithermal Period of the Holocene Epoch of recent Holocene history. Paleoclimatology has demonstrated changes in the Earth's climate. Anthropogenic actions have contributed to feedback elements more than any contribution previously recorded. Managing for the change process through maintenance of biological integrity and heterogeneity and through connectivity of available habitats is the goal.

3.3.1.6 Concerns Regarding Refuge Habitat

Through time, the structure and composition of habitat on the Refuge has changed in response to a variety of factors, both human-induced and natural, including the timing and frequency of fires, the number and density of grazers (bison, longhorn cattle, elk, deer, and prairie dogs), invasive and/or invading species, and weather related events such as wind (blow down, micro bursts, tornados), ice storms, flooding, and drought. The balance of these management actions and other natural disturbances should lead to a state where habitat goals are aligned with needs of wildlife.

Habitat Fragmentation and Loss

The fragmentation and loss of habitat is perhaps the single most important issue facing wildlife conservation worldwide. The Wichita Mountains Wildlife Refuge is surrounded by various land uses that will change over time and have an effect on wildlife that use the Refuge. As wildlife habitat is lost outside the Refuge, the functional capacity of the Refuge to support its current populations will be reduced. Furthermore, wildlife may begin to rely on corridors to connect disjunct habitat fragments and the Refuge. There is a need to protect areas adjacent to the Refuge to act as buffers to habitat fragmentation and loss.

Overgrazing or Over-Utilization

Populations of herbivores in confined areas have the potential of overusing the habitat in which they live. The grazing and utilization of grasslands has been monitored on the Refuge for decades in an effort to ensure overgrazing does not occur (Kingery 1963, Kimball 1992). The management of grazing practices on the Refuge has run the gamut of selling surplus bison and longhorn, controlled hunts, cross-fencing, separation of herds, leaving areas fallow, removing fencing, and prescribed burning to attract animals. In 2007, most of the Refuge was joined by opening fences and water gaps. This has allowed animals to freely move across the extent of the Refuge and congregate where forage is optimal.

As populations of herbivores (bison, longhorn cattle, deer, and elk) continue to prosper on the Refuge, there is a potential for overgrazing of the Refuge's grasslands. Overgrazing can lead to changes in vegetation composition, water and wind erosion of soil, and changes in the food webs that occur in the grasslands. Prudent management of the herbivores and habitat in which they live is needed to ensure perpetuation of this unique habitat.

Undergrazing or Under-Utilization

The lack of grazers in a grassland system can be just as damaging as overgrazing. If there is a pronounced lack of grazers, vegetation composition can change over time from herbaceous to a woody component. There are also effects between mutualistic herbivores that can lead to subsequent reductions in biodiversity. When grazers were excluded from a Refuge prairie dog town, the prairie dogs abandoned the town in response to changes in vegetation composition (Osborn and Allan, 1949). The Refuge has managed herbivore populations to be within acceptable limits to allow for proper utilization of grasslands.

Beginning in 1901, livestock grazing was allowed in what was then the Wichita Forest Reserve. On December 1, 1937, all permitted grazing was terminated except for the five small areas outside of the big-game fence (and fenced Refuge boundary). On those parts of the Wichita Mountains Wildlife Refuge that occur outside of the fenced portions, Special Use Permits have been issued for a limited amount of grazing to occur. Five permitees currently have grazing rights on 430 acres, not to exceed 216 Animal Unit Months (AUMs). These grazing practices were initiated to ensure these areas do not become under-utilized, thereby discouraging woody plants from invading.

Loss of Wildlife Ecosystem Engineers

The relationship between wildlife and habitat are intrinsically linked. Habitat provides food, water, and cover for wildlife, but little is noted of how wildlife affects habitat. Wildlife can create structure and complexities in habitat space, which would not occur in their absence (Jones et al. 1997). The black-tailed prairie dog is known as a keystone species, a term used to describe the critical role they play in creating burrows in which other wildlife live and prosper. Prairie dogs also maintain their towns in an early successional state, which happens to attract and benefit large herbivores (i.e., bison).

Bison and elk create wallows whose microclimate conditions benefit herptiles and invertebrates. Additionally, hoof action of herbivores can change the vegetation composition in areas that they frequent (Collins and Barber 1986). Herbivores can also injure woody plants by grazing or rubbing, further altering the composition of vegetation. Beavers can create dams, which can back up streams and create ponds and benefit a whole host of aquatic organisms. Altogether, the actions of wildlife benefit habitat just as equally as habitat benefits wildlife. The loss of ecosystem engineers on the Refuge would not only affect the habitat, but also the animals that depend on specific habitat alterations for their existence.

Loss of Pollinators

One of the greatest attributes of the Wichita Mountains Wildlife Refuge is the proliferation of wildflowers throughout the spring and summer. Directly linked to the flowering of these plants, is the occurrence and abundance of pollinators, such as the honeybee (*Apis mellifera*). The loss of pollinators can affect plants by loss of seed and fruit production, alteration of a plant's mating system, reduction of plant fitness, and possible extinction in some plants (Kearns and Inouye 1997). The numbers of honeybees have been reduced through most of Europe and North America

by a disease called Colony Collapse Disorder. This disease results in a complete abandonment of a hive, with remaining food stores in the hive going untouched for several weeks (Genersch et al. 2010). Other threats to native pollinators include habitat fragmentation, introduction of alien pollinators [i.e., African honeybees (*Apis mellifera scutellata*)], and pesticide poisoning (Kearns and Inouye 1997). Altogether, these impacts can have serious effects on native pollinators, the plants that they pollinate, and the wildlife that depends on these plants.

Invasive Fauna Species

Swine have the greatest reproductive capacity of all free-ranging large mammals in the United States (Wood and Barrett, 1979). Feral swine are prolific breeders, reaching reproductive age at eight months and producing up to two litters per year that contain an average of 5-8 piglets per litter. At this rate with adequate nutrition, feral swine could double their population every four months (Mapston 2004). High rates of reproduction and omnivorous feeding habits allow for quick assimilation into most habitats. Once a breeding population is established in an area, the population can quickly increase and negatively affect the ecosystem. Once established, feral swine populations are difficult, and sometimes impossible, to reverse.

The actions of a thriving feral swine population can cause significant vegetative impacts, including facilitation of noxious weed invasions, shifts in dominant plant species, reductions of forest regeneration, and the possible extirpation of many of the more delicate species. Feral swine degrade ecosystems through predation and competitive impacts on native fauna, grazing on native plants, and physically altering habitats by "rooting". Rooting creates large, disturbed areas that can lead to extensive erosion, displace native species, and facilitate invasion by non-native, noxious weeds (Sweitzer and Van Vuran 2002). Hall's bulrush (*Schoenoplectus halli)* is significantly damaged by the rooting actions of feral pigs in riparian areas. Feral swine alter habitat directly through rooting action that turns up the soil and destroys vegetation, harming both water and mineral cycles. This disruption has the possibility of affecting numerous species, especially in clear water ecosystems (Sweitzer and Van Vuran 2002).

Invasive Floral Species

Invasive plant species pose the greatest threat to habitat, more than any other issue on the Refuge. Invasive plant species have the potential to increase in size and density, as well as spread to new locations through transport of seed by the typical vectors of spread (wildlife, wind, water, etc.). New species of invasive plants can be introduced to the Refuge and rapidly spread and increase in population, size, and density, crowding out native plant communities. The adverse impact on native plant communities would become increasingly apparent. In general, the cover and diversity of native plant species would be reduced (Tyser and Key 1988, Belcher and Wilson 1989).

The shifting dynamics and diverse habitats of riparian areas render them particularly susceptible to invasion by invasive plants. In one study, the richest plant communities along a river system were the most vulnerable to invasion by invasive plants (Planty-Tabacchi et al. 1996). Invasive species would increasingly dominate native riparian vegetation. Eastern red cedar currently poses the greatest risk to riparian areas on the Refuge. Saltcedar has recently been found to exist in riparian areas in very limited numbers and should be controlled if treatment measures are implemented. Cheatgrass and Johnson grass are also found in some riparian areas. Invasives' impact has already been seen in some riparian zones on the Refuge and in other adjacent land ownerships. Key forage species could be reduced in rangelands if action is not taken to control invasive plants (Losensky and Lolo National Forest (Mont.) 1987). Invasive plants have little

palatability, so forage losses can adversely affect native ungulates. Non-infested vegetation would be subject to greater use by herbivores. This could increase removal of desirable vegetation and trampling of vegetation and soils. See Appendix D for more information on invasive species found on the Refuge.

Vegetation changes produced by invasive species have the potential of altering fire regimes at infested sites (Toney 1996). A greater quantity and continuity of fine fuel is produced by stands of invasive vegetation such as cheatgrass. Some invasive species cure to moisture contents lower than those of native perennials. In many areas, this results in a higher frequency of damaging fires during which native perennials may be negatively affected (Mack 1986). Predictions regarding the rate of spread of invasive plants on the Refuge cannot accurately be made. Natural Resource Conservation Service (NRCS) estimates that 852 acres a day or over 300,000 acres per year of native vegetation are lost to eastern red cedar encroachment in Oklahoma. A survey conducted by NRCS of all field offices in Oklahoma showed a 79 percent increase in eastern red cedar (in combination with ash) infestations during a nine-year period (Engle et al. 1997).

Change in Habitat Conditions/Fire Regime

It is generally agreed that species present in an area are those best adapted to conditions and disturbances (biotic and abiotic) that have occurred during the recent century. Stambaugh et al. (2009) described a pre-1901 mean fire return interval of 4.4 years. Removal of this historically significant natural disturbance has contributed to change in vegetation structure (Hoagland et al., in preparation), including canopy closure (Donnelly and Kimball 2005) and eastern red cedar encroachment (Lyndia Hammer, pers. comm., MS thesis in preparation).

3.3.2 Wildlife

In a region and transition zone where the distributions of eastern and western wildlife species overlap, the Wichita Mountains Wildlife Refuge supports habitats high in biodiversity. From the prairie habitats to oak savannas and rugged granite peaks, the Refuge offers a diversity of animal and plant communities. Vertebrate wildlife species that occur on the Refuge include: 57 species of mammals, 292 species of birds, 19 species of amphibians, 55 species of reptiles, and 33 species of fishes. Over 1,000 invertebrates have been found on the Refuge and surrounding lands including the Fort Sill Military Base. (See Appendix B)

Conservation of wildlife species on the Wichita Mountains Wildlife Refuge involves an integrated approach of balancing the habitat requirements of the large herbivores, providing habitat for rare and endangered biota, and managing these habitats as they once occurred historically. This approach requires the inventory and monitoring of wildlife and habitats, as well as applied research to support adaptive management actions.

3.3.2.1 Priority Species

Threatened and Endangered Species

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.

Black-Capped Vireo

The only federally listed species that occurs on the Refuge is the black-capped vireo (*Vireo atricapilla*) (BCV). The BCV is a federally endangered migratory bird whose largest breeding population in Oklahoma is found within the Wichita Mountains. These birds visit the Refuge from March to September each year to find a mate, rear young, and travel south to wintering habitat in Mexico.

The BCV is the focus of extensive habitat restoration and other management decisions on which this species depends. Habitat management activities such as prescribed burning and mechanical treatment restore habitats to their historic condition.

BCVs are frequent victims of brood parasitism by brown-headed cowbirds (*Molothrus ater*) (Grzybowski 1985, Stake and Cimprich 2003, Kostecke et al. 2005). To counteract this problem, the Refuge removes brown-headed cowbirds through trapping activities. The efforts at the reduction of brood parasitism are thought to have positively affected the BCV population on the Refuge.

Prior to the BCV being listed as federally endangered in 1986, there were only 35-39 birds found on the Refuge in 1985 (Grzybowski 1985). After more than 30 years of recovery, the status of the BCV is more secure. The 2009 BCV point count survey estimates the population on the Refuge at approximately 3,750 pairs.

Candidate Species

Candidate species are those species for which the Service has enough information to warrant proposing them for listing as threatened or endangered but that have not yet been proposed for listing due to other higher priority listing activities. The Service works with states and private partners to carry out conservation actions for candidate species to prevent their further decline and possibly eliminate the need to list them as endangered or threatened.

Lesser Prairie Chicken

The lesser prairie chicken (*Tympanuchus pallidicinctus*) has been identified as a candidate species for Federal listing by the U.S. Fish and Wildlife Service. This bird historically occurred on the Refuge, and attempts at restocking this Refuge native have proved unsuccessful. Recently, a multi-agency GIS project identified the Wichita Mountains Wildlife Refuge and surrounding lands as medium to high quality conservation lands for the lesser prairie chicken (Horton et al. 2010). However, past attempts at restocking were likely unsuccessful due to a lack of suitable lesser prairie chicken habitat conditions on the Refuge. The Refuge would consider additional proposed efforts to restock Lesser Prairie Chickens on the Refuge only if determined to be biologically supported and practical. In addition, the Refuge would be required to evaluate the potential impacts of any proposed restocking project on the black-capped vireo. Lesser prairie chickens have considerably different habitat needs than black-capped vireos, management actions needed to enhance habitat for lesser prairie chickens may not be compatible with black-capped vireo management needs.

Sprague's Pipit

The Sprague's pipit (*Anthus spragueii*) has been identified as a candidate species for Federal listing by the U.S. Fish and Wildlife Service. This endemic bird's summer habitat is primarily mixed-grass or shortgrass prairies in the north central Great Plains and wintering grounds in the southwestern United States and northern Mexico. Although the Sprague's pipit wintering ground does include

southern Oklahoma, most occurrences are during the spring and fall. The Refuge's mixed-grass prairie habitats can provide a valuable feeding and resting stop on its annual migrations.

Table 3-10. Wichita Mountains Wildlife Refuge Federally Listed Species

Name	Population	Status
Whooping Crane (*Grus americana*)	Except where experimental	Endangered
Piping Plover (*Charadrius melodus*)	Except Great Lakes watershed	Threatened
Least Tern (*Sterna antillarum*)	Interior population	Endangered
Lesser Prairie-Chicken (*Tympanuchus pallidinctus*)	—	Candidate
Sprague's Pipit (*Anthus spragueii*)	—	Candidate

Source: U.S. Fish and Wildlife Service, 2010b.

Migratory Waterfowl

Over 15 reservoir lakes and ponds comprising nearly 800 acres of open water have been created on the Wichita Mountains Wildlife Refuge. These reservoirs and ponds provide wintering, breeding, and resting/feeding habitat for waterfowl. Observational records contain 23 species of ducks, 4 species of geese, 3 species of grebe, 2 species of swan, and 1 species of loon, pelican, and cormorant that have utilized the lake habitats on the Refuge. Although the Refuge is managed primarily for big game such as bison and elk, the lakes, woodlands, prairies, and rocky outcroppings found here provide habitat for a variety of bird species. The mid-continent location of the Wichita Mountains is a natural transition zone for eastern and western birds, including resident and migrant species. The greatest variety of species occurs during spring and fall migration periods.

Other Species of Concern – Legislatively Mandated Considerations

Chapter 701 FW8 of the Service Manual states "By special acts of Congress or by special designation herein, five refuges are authorized to preserve and propagate remnant herds of nationally and/or historically significant animals. This chapter relates to the management of animal species now present on the refuges listed below where these species have historically occurred and where reintroduction has been authorized." The Wichita Mountains Wildlife Refuge is one of these designated refuges.

Bison

Conservation of the American bison (*Bison bison*) is often considered the central theme of the Wichita Mountains Wildlife Refuge. The need for immediate conservation action on behalf of the bison may be the reason that lands were protected from development and later established as the Wichita Mountains Wildlife Refuge.

Between 1830 and 1880, the American bison, or buffalo, was reduced in numbers from 60 million to a mere handful. By 1900, there were only two small wild herds in all of North America, numbering about 550 animals total. This change was accelerated in the last 40 years of the 19th century by the coming of the buffalo hunter and thousands of land-hungry settlers. Farsighted conservation leaders such as President Theodore Roosevelt became concerned. They realized that this native American animal could easily become extinct. In 1905, William T. Hornaday and others organized the American Bison Society and demanded that the buffalo be given care and protection. Through

the efforts of the American Bison Society and the New York Zoological Society, an offer was made to donate 15 bison to the Wichita National Forest and Game Preserve in Oklahoma. Congress set aside $15,000 for this purpose, and on October 11, 1907, 15 of the finest buffalo from the New York Zoological Park were shipped by rail to Oklahoma. Seven days later, these six bulls and nine cows had safely returned to the plains and mountains. The heavily crated animals were transferred to wagons and hauled the final 13 miles to the Wichitas, where no buffalo had grazed for 30 years. These bison were the foundation of the Wichita herd that has prospered and been used to repopulate many areas throughout the central plains.

Management of the bison herd is a careful balance of managing utilization of grasslands, conservation genetics to select for retaining bison with high levels of genetic diversity, and removing a number of bison needed to balance grazers for a given year. The bison are excessed through an annual auction that is held on the Refuge.

Photo: USFWS

Elk

The indigenous elk of the Wichita Mountains, the Merriam's elk (*C. e. merriami*), was extirpated by the late 1800s. A herd composed of primarily Rocky Mountain elk (*C. e. nelsoni*) was introduced to the Refuge from 1908 to 1912. The Wichita herd has flourished and repopulated areas within and outside the Refuge. The Refuge population was counted with an aerial census in 2009 and was estimated to contain 1,250 elk.

Management of this herd is focused on the removal of animals through controlled hunts, dependent upon the numbers estimated during aerial censuses. The Refuge strives to manage the elk herd to maintain a 1:1 bull to cow ratio to regulate herd size (Kimball 1988).

Longhorn Cattle

Historically, the Texas Longhorn waned in popularity and in numbers during the late 1800s and early 1900s due to fencing, availability and distribution of shipping points, and the introduction of

European breeds of cattle to increase beef production and disease resistance. The Wichita Mountains Wildlife Refuge herd today owes its existence to Forest Service employees such as Earl Drummond, who is credited with first suggesting the idea of preserving a remnant herd and who managed the herd from 1927 until 1950; Will C. Barnes and John H. Hatton, who worked 10 years to obtain funding for the purchase and who selected the original herd; Secretary of the Oklahoma Historical Society Joseph B. Thoburn, who actively supported and campaigned for maintaining a herd on the Wichita; and Montana Senator John B. Kendrick, a former Texas cattleman, who persuaded Congress to purchase the cattle. Specific congressional appropriation language for the establishment of the Refuge herd is found on page 989, 69th Congress, Session II, Chapter 39, 1927, as follows: "… Provided, that not to exceed $3,000 of the sum appropriated in this paragraph shall be expended for the purchase and maintenance of a herd of longhorned or Spanish breed of cattle for the Wichita National Forest in Oklahoma to the end that the present comparatively few living examples of this historic breed of cattle may be preserved from complete extinction…."

In selecting the foundation herd, Will Barnes and John Hatton traveled over 5,000 miles and looked over more than 30,000 head of cattle (only a portion of which were representative of the longhorn herd) in the brush country of South Texas and the Texas Coastal Bend area. In August 1927, some 30 Texas Longhorns were released on the Wichita National Forest (now the Wichita Mountains Wildlife Refuge). The herd consisted of 3 bulls, 3 steers, 20 cows, and 4 calves (2 bull and 2 heifer). Not all the animals were of the best type, but they were the best type obtainable at the time. A review of records indicates that 1 bull, 19 cows, and 1 of the bull calves formed the foundation herd. The others were either steers, died, or were sold due to non-conformance to type. Throughout the history of the Refuge herd, careful culling, selection, and the addition of other animals from various sources has been practiced to improve type and diversify genetics within the herd now recognized as the Wichita Refuge bloodline.

White-tailed Deer

The white-tailed deer (*Odocoileus virginianus*) herd in the Wichita Mountains Wildlife Refuge is widely known as the founder herd for many deer in Oklahoma. To reestablish deer in Oklahoma, over 4,300 were relocated from the Refuge to portions of Oklahoma from 1945 to 1965 (McCoy 1985). The population size of the Refuge deer herd is monitored using a spotlight count conducted on established routes. Population size and buck-doe ratios are estimated from these counts (Dill 1985). White-tailed deer are managed with controlled hunts to achieve a balanced 1:1 buck to doe ratio and to maintain a sustainable population.

Table 3-11. Priority Species Occurring on the Wichita Mountains Wildlife Refuge

Common Name	Scientific Name
Birds	
Black-capped Vireo[2]	*Vireo atricapilla*
Northern Pintail	*Anas acuta*
Golden Eagle[3]	*Aquila chrysaetos*
Burrowing Owl[4]	*Athene cunicularia*
Canvasback	*Aythya valisineria*
Ferruginous Hawk[4]	*Buteo regalis*
Swainson's Hawk[4]	*Buteo swainsoni*
Northern Bobwhite	*Colinus virginianus*
Trumpeter Swan	*Cygnus buccinator*
Prairie Falcon[4]	*Falco mexicanus*
Loggerhead Shrike[4]	*Lanius ludovicianus*
Wild Turkey	*Meleagris gallopavo*
Long-Billed Curlew[3]	*Numenius americanus*
Painted Bunting	*Passerina ciris*
Bell's Vireo[4]	*Vireo bellii*
Barn Owl[4]	*Tyto alba*
Mammals	
Ringtail[4]	*Bassariscus astutus*
Bison	*Bison bison*
Elk	*Cervus elaphus*
Townsend's big-eared Bat	*Corynorhinus townsendii*
Pale Lump-nosed Bat[4]	*Corynorhinus townsendii pallescens*
Black-tailed Prairie Dog[4]	*Cynomys ludovicianus*
Mountain Lion[4]	*Felis concolor*
Southern Flying Squirrel	*Glaucomys volans*
River Otter[4]	*Lutra canadensis*
Desert Shrew[4]	*Notiosorex crawfordi*
White-tailed Deer	*Odocoileus virginianus*
Eastern Spotted Skunk	*Spilogale putorius interrupta*
Brazilian Free-tailed Bat[4]	*Tadarida brasiliensis*
Reptiles	
Ouachita Map Turtle[4]	*Graptemys ouachitensis*
Prairie Earless Lizard[4]	*Holbrookia maculate perspicua*
Texas Horned Lizard[4]	*Phrynosoma cornutum*
Long-nosed Snake[4]	*Rhinocheilus lecontei*
Western Massasauga	*Sistrurus catenatus tergeminus*
Plants	
Halls Bulrush	*Schoenoplectuss hallii*
Oklahoma Beardtongue	*penstemon oklahomensis*
Fish	
Orangebelly Darter	*Etheostoma radiosum*

[2] Federally Endangered

[3] Oklahoma State listed as species of concern, category 1 (SS1).

[4] Oklahoma State listed as species of concern, category 2 (SS2).

3.3.2.2 Focal/Representative Species

Focal species are the species and their associated habitats on which the Refuge focuses its management, research, and monitoring efforts. Focal species, similar to "keystone" species or "management indicator species," provide information to refuge managers about the conditions of habitats and guilds of species utilizing those habitats. Species listed in Table 3-12 were selected as focal species by the Refuge based on the understanding that factors limiting their populations are sensitive to landscape-scale characteristics and that by addressing the needs of these focal species, other species within a guild are expected to benefit. In addition, an appropriate set of focal species includes consideration for the qualities and conditions of the respective ecoregion, availability of data and information, and programmatic obligations, as defined in the Strategic Habitat Conservation Report (USFWS 2006).

Table 3-12. Focal Species and Habitat Types within Wichita Mountains Wildlife Refuge

Habitat Type	Focal Species	Habitat Structure	Life History Requirements	Other Benefiting Species
Cross-timbers Oak Forest and Wood-land	Black-Capped Vireo	Patchy distribution of low scrubby growth made up mostly of deciduous woody shrubs and trees of irregular height	Breeding	Painted bunting, northern bobwhite, white-eyed vireo, Bewick's wren, Carolina wren, northern cardinal, blue-grey gnatcatcher, tufted titmouse, red-headed woodpecker, downy woodpecker, Mississippi kite, lark sparrow, indigo bunting, blue grosbeak, and the rufous-crowned sparrow
	Painted Bunting	Scattered strips of woodland between open areas	Breeding	Black and white warbler, summer tanager, white-eyed vireo, Bewick's wren, northern cardinal, blue-grey gnatcatcher, northern bobwhite quail, tufted titmouse, red-headed woodpecker, indigo bunting, greater roadrunner, eastern fox squirrel, eastern coachwhip, and the eastern fence lizard
Central Mixed-Grass Prairie	Black-tailed Prairie Dog	Dog towns, open prairie with sufficient drainage	Year-round	Scissor-tailed flycatcher, burrowing owl, turkey vulture, ferruginous hawk, dickcissel, eastern meadowlark, grasshopper sparrow, northern bobwhite quail, loggerhead shrike, Bell's vireo, killdeer, upland sandpiper, long billed curlew, bison, elk, coyote, prairie vole, thirteen-lined ground squirrel, western massasauga, Texas horned lizard, and Oklahoma beard tongue

Habitat Type	Focal Species	Habitat Structure	Life History Requirements	Other Benefiting Species
	Bison	Open prairie	Year-round	Scissor-tailed flycatcher, burrowing owl, ferruginous hawk, dickcissel, eastern meadowlark, grasshopper sparrow, northern bobwhite quail, loggerhead shrike, Bell's vireo, killdeer, upland sandpiper, long billed curlew, black-tailed prarie dog, elk, coyote, prairie vole, thirteen-lined ground squirrel, western massasauga, Texas horned lizard, and Oklahoma beard tongue
Rock-lands	Pale Lump-nosed Bat (Town-send's Big-eared Bat)	Caves and caverns under granite boulders	Year-round	Canyon wren, rock wren, ringtail, Brazilian free-tailed bat, western small-footed myotis, cave myotis, western pipistrelle, eastern pipistrelle, western diamondback rattlesnake, collared lizard
	Eastern Pipistrelle	Caves, crevices, and boulders	Year-round	Canyon wren, rock wren, ringtail, Brazilian free-tailed bat, western small-footed myotis, cave myotis, western pipistrelle, eastern pipistrelle, pale lump-nosed bat, western diamondback rattlesnake, collard lizard
Water	Orange-throat darter	Creeks and streams	Year-round	Belted kingfisher, lesser yellowlegs, canvasback, northern pintail, river otter, plains killfish

Table 3-13. Cooperator Plans with Focal Species Identified and Conservation Status

Habitat Types	Crosstimbers Oak Forest and Woodland		Central Mixed-Grass Prairie		Rocklands		Water
Target Species	**Black-capped vireo**	**Painted bunting**	**Black-tailed prairie dog**	**Bison**	**Pale lump-nosed bat**	**Eastern pipistrelle**	**Orange-throat darter**
OK-Comprehensive Wildlife Conservation Strategy (CWCS) – Mixed-Grass Prairie		X	X		X		
OK-CWCS – Tallgrass Prairie		X					
OK-CWCS – Post Oak/Blackjack Savannah Or Shrublands And Post Oak/Blackjack Oak/Hickory Woodlands	X	X					
OK-CWCS – Post Oak/Black/Hickory Woodland And Forest	X	X					
OK-CWCS – Sand Plum/Hawthorn/Sumac Shrublands	X	X			X		
OK-CWCS – Mesquite Savannah Or Shrublands		X	X				
OK-CWCS – Juniper Savannah Or Woodlands		X	X		X		
OK CWCS – Streams and Associated Riparian Forests		X			X		
OK-CWCS – Springs – Mixed-Grass Prairie					X		
OK-CWCS – Herbaceous Wetland					X		
The Nature Conservancy (TNC) – Crosstimbers And Southern Tallgrass Prairie	X	X	X				
TNC – Mixed-Grass Prairie	X				X		
Oaks And Prairies Bird Conservation Region (BCR) – Oak Savanna (5-30% Canopy)		X					
Oaks And Prairies BCR – Upland Forest		X					

Habitat Types	Crosstimbers Oak Forest and Woodland		Central Mixed-Grass Prairie		Rocklands		Water
Target Species	**Black-capped vireo**	**Painted bunting**	**Black-tailed prairie dog**	**Bison**	**Pale lump-nosed bat**	**Eastern pipistrelle**	**Orange-throat darter**
Oaks And Prairies BCR – Deciduous Shrub/Grasslands	X	X					
BCR 21 – Oaks And Prairie, Osage Plains	X	X					
BCR 19 – Central Mixed-Grass Prairie, Playa Lakes Joint Venture Plan	X	X					
Partners In Flight – Rolling Red Plains	X						
Partners In Flight – Osage Plains		X					
North American Grassland Priority Conservation Areas			X	X			
Federal Listing – Endangered, Threatened, Candidate, Proposed	E						
ODWC Listing – Endangered, Threatened, Species of Special Concern	E		SS2		SS2		
NatureServe State Rank – Endangered, Threatened, Candidate	S1B	S5B	S3	SX	S3	S4	S5
NatureServe Global Conservation Rank	G3	G5	G4	G4	G4T4	G5	G5
ODWC Species of Greatest Conservation Need Tiers	I	II	I		I		

Crosstimbers Oak Forest and Woodland Habitat Type

Black-Capped Vireo

The black-capped vireo (BCV) is a high-profile, Federal and State endangered species that is attracted to the high quality of nesting habitat in the Wichita Mountains. There are nine cooperator plans that have identified the BCV as a species of conservation value. The NatureServe global rank indicates that BCVs are globally vulnerable; the NatureServe state rank indicates the breeding population in Oklahoma is critically imperiled. The Oklahoma Department of Wildlife Conservation indicates that BCVs are a Tier 1 species of greatest conservation need.

The BCV has been studied extensively, and programs on the Refuge (i.e., brown-headed cowbird trapping) are thought to have reduced nest parasitism, thereby increasing the overall local

population of BCV. Additionally, the quality of the Crosstimbers Oak Forest and Woodland habitats is important to the nesting preferences of the BCV. This habitat is maintained through prescribed fire and enhanced through the removal of invasive eastern red cedars. Preference to habitat is linked to areas suitable for nesting encompassing a patchy distribution of low, scrubby growth made up mostly of deciduous woody shrubs and trees of irregular height (Graber 1961; Grzybowski et al. 1994). The forested areas of the Wichita Mountains contain these habitats in varied associations.

By managing for the BCV, other species that occur in Crosstimbers Oak Forest and Woodland habitats would also benefit such as: painted bunting, black and white warbler, white-eyed vireo, red-eyed vireo, Bewick's wren, Carolina wren, northern cardinal, blue-grey gnatcatcher, tufted titmouse, red-headed woodpecker, downy woodpecker, Mississippi kite, lark sparrow, indigo bunting, blue grosbeak, eastern fox squirrel, and the lesser earless lizard. Additionally, the forest attributes associated with BCV management would benefit a broad array of other vertebrates, invertebrates, and plant species.

Painted Bunting

Painted buntings (*Passerina ciris*) overlap some of the same micro-habitat types as the BCV in the Crosstimbers Oak Forest and Woodland habitats. The painted bunting occurs in 15 cooperator plans as a species of high conservation value. The NatureServe global rank indicates that painted buntings are globally secure; the NatureServe state rank indicates the breeding population in Oklahoma is secure. The Oklahoma Department of Wildlife Conservation indicates that painted buntings are a Tier 2, species of greatest conservation need.

Habitat requirements of the painted bunting are associated with important attributes for management and restoration of the Crosstimbers Oak Forest and Woodland habitat type. They inhabit not only the Crosstimbers habitat, but also the ecotone between Crosstimbers and central mixed-grass prairie habitats. According to Parmelee (1959), the painted bunting in Oklahoma is "common in scattered strips of woodland between open or partially overgrown fields,... [and] in agricultural areas where some land was feral; in this respect recently abandoned farms provided optimal conditions." While not exact, the basis of this description is that painted buntings inhabit a mosaic of open Crosstimbers habitat. Painted buntings have a more broad habitat requirement than the BCV, thereby benefiting a greater number of species, including black and white warbler, summer tanager, white-eyed vireo, Bewick's wren, northern cardinal, blue-grey gnatcatcher, northern bobwhite quail, tufted titmouse, red-headed woodpecker, rufous crowned sparrow, greater roadrunner, eastern fox squirrel, eastern coachwhip, and the lesser earless lizard.

Central Mixed-Grass Prairie Habitat Types

Black-tailed Prairie Dog

The role of keystone species in the central mixed-grass prairie is largely relegated to the black-tailed prairie dog *(Cynomys ludovicianus*) (Kotliar et al. 1999). Prairie dogs have been persecuted from the early 1900s to the present with the false assumption that they heavily compete with livestock for forage. It's estimated that prairie dogs have been reduced to two percent of their former range (Miller et al. 1994). There are five cooperator plans that list the black-tailed prairie dog as a species of high conservation value. NatureServe reports that prairie dogs are apparently secure globally, though rare and local in Oklahoma. The Oklahoma Department of Wildlife Conservation lists prairie dogs as Level 1, species of special concern, and as a Tier 1, species of greatest conservation need.

Prairie dogs create burrows and networks of tunnels in which many other species benefit. Because of the severe reduction of prairie dogs, black footed ferrets, mountain plovers, swift foxes, burrowing owls, and ferruginous hawks have been drastically reduced in number, some to the point of near extinction (Miller et al. 1994). Prairie dogs maintain short grasses within the town and recycle nutrients and minerals by their earth moving activities. These actions attract bison, elk, and deer that feed heavily on the new succulent growth.

Approximately 170 vertebrate species rely on prairie dog activity for survival (Miller et al. 1994). The three prairie dog towns on the Refuge contain hotspots of biodiversity; the biological impact of their demise would be felt by a whole host of species, including scissor-tailed flycatcher, burrowing owl, turkey vulture, ferruginous hawk, dickcissel, eastern meadowlark, grasshopper sparrow, northern bobwhite quail, loggerhead shrike, Bell's vireo, killdeer, upland sandpiper, long billed curlew, bison, elk, coyote, prairie vole, thirteen-lined ground squirrel, western massasauga, Texas horned lizard, and Oklahoma beard tongue.

Photo: USFWS

Bison

The Wichita Mountains Wildlife Refuge is best known for the recovery of American bison (*Bison bison*). This high-profile species has been identified as a focal species for management of the central mixed-grass prairie habitat. Bison are interesting in that their conservation status is clouded by the great number of private captive populations, along with their classifications as "livestock" by many government organizations. For instance, NatureServe considers American bison as globally apparently secure; however, within the State of Oklahoma, they are believed to be extirpated. This confusion has apparently affected their status as wild animals as seen by their description in one cooperator plan as an animal of high conservation value (see Table 3-13).

The management of the bison herd is tied to the health and diversity of the mixed-grass prairie. The grazing action of bison perpetuates the grassland ecosystem and reduces encroachment by woody plants such as eastern red cedar. In the absence of bison, widespread successional changes would occur across the mixed-grass prairie habitat. Bison play critical ecological roles in maintenance and perpetuation of grassland ecosystems (Knapp et al. 1999), as a symbiotic relationship to black-tailed prairie dogs (Krueger 1986, Fahnestock and Detling 2002), and as an ecosystem engineer in the creation of micro-habitats that exist in bison wallows (Collins and

Barber 1986). Because of the habitat needed to support bison conservation and management, many other species benefit, including scissor-tailed flycatcher, burrowing owl, ferruginous hawk, dickcissel, eastern meadowlark, grasshopper sparrow, northern bobwhite quail, loggerhead shrike, Bell's vireo, killdeer, upland sandpiper, long billed curlew, black-tailed prairie dog, elk, coyote, prairie vole, thirteen-lined ground squirrel, western massasauga, Texas horned lizard, and Oklahoma beard tongue.

The Refuge strives to maintain grassland ecosystems through the use of prescribed fire and mechanical treatment. The movement of bison and other large herbivores is influenced through the placement and timing of prescribed fires. Bison and other large herbivores tend to concentrate in areas immediately following new grass eruption from post-burn.

Rockland Habitat Types

Pale Lump-nosed Bat

The pale lump-nosed bat or Townsend's big-eared bat (*Corynorhinus townsendii pallescens*) has been identified as a focal species for the rock habitat types that occur on the Wichita Mountains Wildlife Refuge. NatureServe has identified the pale lump-nosed bat as an apparently secure species globally and in Oklahoma, though it is quite rare in parts of its range, especially at the periphery. The Oklahoma Department of Wildlife Conservation lists the pale lump-nosed bat as a Level 2, species of special concern and Tier 1, species of greatest conservation need. There are seven cooperator plans that list the pale lump-nosed bat as an animal of high conservation value (see Table 3-13).

The pale lump-nosed bat uses caves, mines, and under large boulders as roosting sites. They have a tendency to move among several roost sites, even in winter. The rock habitats of the Refuge provide these roosting habitats, in addition to adjacent areas for foraging in wooded, prairie, and riparian areas (Gruver and Keinath 2006). The management of these habitats for the pale lump-nosed bat would also benefit other species, including canyon wren, rock wren, ringtail, Brazilian free-tailed bat, western small-footed myotis, cave myotis, western pipistrelle, eastern pipistrelle, western diamondback rattlesnake, and collared lizard.

Eastern Pipistrelle

The eastern pipistrelle (*Pipistrellus subflavus*) is one of the most common and widely distributed species of bats in North America. The eastern pipistrelle occurs in moderate densities throughout the caves, boulders, rock crevices, and mine shafts within the Refuge. For a number of years, the annual monitoring of the Refuge's Pennington Mine has produced a valuable monitoring dataset of the Refuge's eastern pipistrelle population. The sanctuary that these hibernacula provide is most likely due to the wide range of temperatures and humidity that is afforded by the more than 100-foot-long mine shaft. The eastern pipistrelles have the ability to move around and maintain thermal stability during the winter (Briggler and Prather 2003).

NatureServe lists the eastern pipistrelle as a demonstrably secure species globally and in Oklahoma. Additionally, the eastern pipistrelle does not occur in any cooperator plans (see Table 3-13). However, most bat species in North America are being critically threatened by white-nose syndrome, which is moving into Oklahoma (Blehert et al. 2009). The monitoring of this seemingly common species is needed to elucidate widespread population changes, not only for the eastern pipistrelle but also as a surrogate for other communal bat species.

The management of the rock habitats for the eastern pipistrelle would also benefit other species, including canyon wren, rock wren, ringtail, Brazilian free-tailed bat, western small-footed myotis, cave myotis, western pipistrelle, eastern pipistrelle, western diamondback rattlesnake, and collared lizard.

Water Habitat Types

Orangethroat Darter

The orangethroat darter (*Etheostoma spectabile*) occurs in streams and creeks throughout the Wichita Mountains Wildlife Refuge. The orangethroat darter spawns mainly from February through May. The breeding age of females is 1-3 years. Habitat for the orangethroat darter includes slow to swift shallow gravel riffles and sometimes rocky runs and pools of headwaters, creeks, and small rivers. Eggs are laid in gravel in riffles (Lee et al. 1980). Adults eat immature flies, caddisflies, and other insects and crustaceans (Page 1983).

This native species has been identified as a focal species for water habitats on the Refuge. NatureServe identifies the orangethroat darter as apparently secure globally, though it may be quite rare in parts of its range. In Oklahoma, NatureServe reports the orangethroat darter as demonstrably secure.

Conservation and management of habitat for the orangethroat darter would also benefit other species, including belted kingfisher, lesser yellowlegs, canvasback, northern pintail, river otter, and plains killifish.

3.3.2.3 Birds

The mid-continent location of the Wichita Mountains is a transition zone for eastern and western birds, including migratory and resident species. In all, 292 avian species have been identified within the Refuge comprising of 17 orders and 54 families. There have been 80 species identified that nest on the Refuge and many others that are migratory, including Neotropical migrants and raptors (Appendix B).

The black-capped vireo is listed as federally and Oklahoma State endangered, therefore requiring actions to ensure persistence of this species on the Refuge. The golden eagle (*Aquila chrysaetos)* and long-billed curlew (*Numenius americanus)* are Oklahoma State-listed as species of concern, category 1 (SS1). The ferruginous hawk (*Buteo regalis)*, Swainson's hawk (*Buteo swainsoni)*, prairie falcon (*Falco mexicanus)*, barn owl (*Tyto alba)*, burrowing owl (*Athene cunicularia)*, Bell's vireo (*Vireo bellii)*, and loggerhead shrike (*Lanius ludovicianus)* are Oklahoma State listed as a species of concern, category 2 (SS2).

These birds occupy every habitat within the Refuge, including the wetland habitat types associated with the reservoir lakes and the terrestrial habitats of mixed-grass prairies, rocklands and Crosstimbers. The Refuge provides excellent habitat for wintering raptors, including bald eagles (*Haliaeetus leucocephalus)* and golden eagles.

The Wichita Mountains Wildlife Refuge is recognized by the National Audubon Society as an "Important Bird Area" of global significance. The Important Bird Area Program is a global effort to identify and conserve areas that are vital to birds and other biodiversity. The designation was based on the wide diversity of habitats at the Refuge that support many bird species of conservation concern. Oak woodlands support the federally endangered black-capped vireo, along with healthy populations of painted bunting and red-headed woodpecker, two global level species of concern.

Photo: USFWS

3.3.2.4 Mammals

There are 8 orders of mammals comprising 57 species on the Refuge. They utilize the upland, bottomland hardwood, grassland, and riparian habitats on the Refuge. Of the mammals that occur on the Refuge, the State of Oklahoma lists the black-tailed prairie dog (*Cynomys ludovicianus)*, desert shrew (*Notiosorex crawfordi*), pale lump-nosed bat (*Corynorhinus townsendii pallescens*), Brazilian free-tailed bat (*Tadarida brasiliensis*), ringtail (Bassariscus astutus), river otter (*Lutra canadensis*), and mountain lion (*Felis concolor*) as species of concern, category 2. See Appendix B for a complete Refuge mammal list.

Photo: USFWS

3.3.2.5 Reptiles

The mosaic of habitats found in the Wichita Mountains supports a diversity of reptile species. Across the Refuge, 55 reptiles representing 3 orders and 12 families occur in various distributions. Of the reptiles that occur on the Refuge, the ODWC has listed the prairie earless lizard (*Holbrookia maculate perspicua*), Ouachita map turtle (*Graptemys ouachitensis*), Texas horned lizard (*Phrynosoma cornutum*), and the long-nosed snake (*Rhinocheilus lecontei*) as species of concern (category 2) in the State of Oklahoma. Reptiles on the Refuge occupy both the wetland and terrestrial habitats found within the Refuge. For a list of the reptiles found on the Refuge, see Appendix B.

3.3.2.6 Amphibians

Amphibians found on the Wichita Mountains Wildlife Refuge account for 19 species representing 2 orders and 6 families. Amphibians are primarily found in the mesic and wetland habitat types. None of the known amphibians on the Refuge are State or Federal listed. A list of the known amphibians that inhabit the Refuge is found in Appendix B.

3.3.2.7 Fish

There are 7 orders of fish comprising 36 species on the Refuge. These fish inhabit lakes and streams found on the Refuge. The Wichita Mountains spotted bass (*Micropterus punctulatus wichitae*) is a State listed species of concern (category 2); however, evidence suggests that this subspecies is not divergent enough to warrant differentiation into subspecies status (Coughlin et al. 2003). Therefore, the Refuge species list includes this species as spotted bass (*M. punctulatus)* (Appendix B).

3.3.2.8 Invertebrates

Over 1,000 invertebrates have been found on the Refuge and surrounding lands. Forty-three orders of invertebrates have been observed on the Refuge alone. These invertebrates utilize upland, bottomland hardwood, grassland, and riparian habitats on the Refuge. See Appendix B for a complete Refuge species list.

3.3.2.9 Concerns Regarding Wildlife Populations

Invasive Species

One of the greatest concerns to the persistence of native wildlife populations on the Refuge is the introduction and expansion of invasive animal species.

Feral Cats

Feral cats (*Felis catus*) are responsible for a number of extinctions and extirpations worldwide across multiple taxa. Occasionally, feral cats are introduced to the Refuge either inadvertently or intentionally. Because of the landscape configuration of the Wichita Mountains, the plants and animals on the Refuge may be considered an insular system. Insular populations are more prone to have negative effects from feral cats (Manuel et al. 2004). The primary method by which feral cats affect wildlife is through direct predation.

In a study on the Refuge, the diets of 24 feral cats consisted of 54 percent mammals (chiefly rodents), 25.5 percent insects, 16 percent garbage, and 4.5 percent reptiles, along with a trace of birds (McMurry and Sperry 1941). Mice and rabbits are the primary prey species of feral cats (Catling 1988). Deer mice, plains harvest mice, and eastern cottontail rabbits are most at risk from an outbreak of feral cats on the Refuge.

Reptiles may be a main prey item of feral cats in arid and semi-arid habitats (Catling 1988). Iguanas and skinks on the Fiji islands are nearly extinct because of the presence of feral cats (Gibbons 1984). Taxonomically similar populations of the eastern collared lizard and the Southern prairie skink (*Plestiodon septentrionalis obtusirostris*) are at risk of being reduced by feral cats.

Feral cats are responsible for the extinction of a great number of bird species (Fuller 2000). Of the 291 bird species that occur on the Refuge, the most imperiled may be that of the federally endangered black-capped vireo. Because of the low-branch nesting locations, black-capped vireos may be prone to predation by feral cats. Additionally, ground nesting bird species, including Northern bobwhite quail (*Colinus virginianus*), rufous crowned sparrow (*Aimophila ruficeps*), killdeer (*Charadrius vociferous*), and ground foragers such as mourning dove (*Zenaida macroura*), eastern towhee (*Pipilo erythrophthalmus*), and American robin (*Turdus migratorius*) may especially vulnerable. Only a few feral cats are needed to significantly affect bird populations (Fuller 2000).

Bats may be another animal whose population could be reduced through feral cat predation. The roosting sites of many of the Refuge bats are within reach for feral cat predation. Feral cats also compete directly with native wildlife for food resources. The diet of avian predators such as owls, hawks, falcons, and eagles may be altered or reduced because of feral cats. Coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and raccoons (*Procyon lotor*), may shift their prey base, causing a cascade of effects because of the competition caused by a feral cat influx.

Feral cats may also affect native wildlife populations through the transmission of disease. Feral cats are known to carry a host of diseases, including parvovirus, rabies (Suzan and Ceballos 2005), and toxoplasmosis, which has been suspected as the cause of population declines for a number of species. A study on the Refuge found that feral cats harbored a host of parasites, including *Taenia taeniaeformis, Dipylidium caninum,* and *Mesocestoides latus* (Self and McKnight 1950).

Feral Dogs

Feral dogs (*Canis lupus familiaris*) could possibly be a major contribution to predation in deer, elk, and small mammal populations on the Refuge. Pack size of feral dogs usually fluctuates but is usually composed of any combination of solitary animals to groups of two to six dogs (Scott and Causey 1973). A study in Brazil found that the diet of feral dogs was made up of 75 percent mammals (Galetti and Sazima 2006). Occasionally, stray and feral dogs enter the Refuge and compete directly with coyotes; they also have been found to injure and harass wildlife such as elk.

Feral dogs are known to harbor infectious diseases such as rabies, which is dangerous to wildlife as well as humans. Feral dogs can also carry diseases such as canine distemper and parvovirus, which could affect fox, skunk, and coyote populations. Feral animals can be the main contributors of parvovirus, rabies, and toxoplasma to other wildlife [opossums (*Didelphis virginiana*), ringtails, skunks, and squirrels] (Suzan and Ceballos 2005).

Feral Swine

Feral swine (*Sus scrofa*) are perhaps one of the most harmful mammalian species worldwide (Long 2003). Swine have spread from Europe and Asia to habitats around the world via human introduction. Currently, feral swine populations are established on every continent except Antarctica and have become a major problem in most parts of the United States.

Feral swine have recently become a widespread problem on Wichita Mountains Wildlife Refuge. These animals are non-natives that cause significant environmental impacts, including facilitation

of noxious weed invasions, shifts in plant communities, reduction of forest regeneration, increased soil erosion, direct competition with native animals for food resources, and predation on native wildlife (Mack and D'Antonio 1998, Sweitzer and Van Vuran 2002). Further, they have the potential to spread zoological diseases to animals and people (Witmer et al. 2003). Feral swine are thought to be responsible for population declines in 257 plants and 8 birds through herbivory, predation, competition, and habitat effects (Gurevitch and Padilla 2004).

The feral swine's high rate of reproduction and omnivorous feeding habits allow for quick assimilation into most habitats. Once a breeding population is established in an area, the population can quickly increase and negatively affect the ecosystem.

The actions of feral swine can have catastrophic effects on the long-term persistence of the wildlife and habitat of the Wichita Mountains. Feral swine degrade ecosystems through predation and competitive impacts on native fauna, grazing on native plants, and physically altering habitats by "rooting." Rooting creates large, disturbed areas that can lead to extensive erosion, displace native species, and facilitate invasion by non-native, noxious weeds (Sweitzer and Van Vuran 2002). Facilitation of weed invasion in disturbed grasslands is a major concern on the Refuge.

Feral swine are susceptible to, and are known carriers of, a wide range of infectious diseases detrimental to wildlife populations, livestock, and humans (Choquenot et al. 1996). Pseudorabies, swine brucellosis, and bovine tuberculosis are considered the three most potent disease threats to the commercial livestock industry in the United States and can be deadly to a wide variety of wildlife, including numerous species managed on the Refuge. Feral swine also carry zoonotic diseases that can infect humans, such as brucellosis, balantidiasis, leptospirosis, salmonellosis, toxoplasmosis, trichinosis, trichostrongylosis, sarcoptic mange, tuberculosis, tularemia, anthrax, rabies, and plague (Choquenot et al. 1996; Witmer et al. 2003).

Feral swine are omnivorous, and opportunistic feeders can prey directly upon small rodents, reptiles, amphibians, invertebrates, young fawns, eggs and the young of ground-nesting birds like turkey and quail (Wood and Barrett 1979). It is expected that the federally endangered black-capped vireo could be affected due to its low nesting habits. Competition with other animals is another great concern. Swine encompass a broad feeding niche, allowing an enormous advantage over other species with more specialized diets. Feral swine compete with coyotes, eagles, and vultures for carrion, and they compete with wild turkeys, elk, and white-tailed deer for acorn and other mast resources (Wood and Barrett 1979; Choquenot et al. 1996; Roemer et al. 2002).

Zebra Mussel

The zebra mussel (*Dreissena polymorpha*) is a native of southern Russia that was first released to the Great Lakes in 1985. Since its introduction, zebra mussels have spread quickly throughout North America. The zebra mussel is an efficient invasive that removes phytoplankton and detritus from the water column and can cause a multitude of ecological problems. As well as being carried by water currents, the mussel can attach to ships, boats, waterfowl, fishing gear, and other aquatic organisms and be spread to other bodies of water. Zebra mussels affect nutrient cycles by removing dissolved nutrients, phosphorus, calcium carbonate, and other minerals. By removing primary productivity, zebra mussels reduce energy available to other aquatic organisms. Fish recruitment and growth may be negatively affected by the presence of zebra mussel colonies. Zebra mussel colonies can take contaminants from the water column and concentrate them on the edges and bottom of the water body. These pollutants can then be absorbed by wildlife such as waterfowl and amphibians, causing a host of effects (Ludyanskiy et al. 1993).

Zebra mussels are dangerous exotics that could affect Refuge lakes and ponds in the near future. This exotic has been found within 100 miles of the Refuge in Lake Texoma. The impact of the zebra mussel may be disastrous to fishes, amphibians, and other aquatic organisms on the Refuge.

Wildlife Disease

Chronic Wasting Disease

Of the wildlife diseases that could affect the Refuge, none may be more dangerous to wildlife populations than chronic wasting disease (CWD). CWD is a unique transmissible spongiform encephalopathy of mule deer, white-tailed deer, moose, and elk. The range of this disease has spread progressively into 14 U.S. states and two Canadian Provinces since it was first discovered in Colorado in 1967. Transmission of this disease is accomplished through the contamination of soil by fecal matter (Tamguney et al. 2009). Animals that are crowded and confined into small areas are at high risk for transmission when the disease is present. Transmission may be especially high in elk wallows (Vercauteren et al. 2007). The prions that cause CWD appear to persist for long periods in the environment, even after infected animals have been removed. Deer and elk that are infected with CWD may not show any symptoms in the early stages of infection. Experiments have shown that the incubation period is usually a minimum of 15 months, before clinical signs are obvious. In the later stages of the disease, affected animals will become emaciated; may walk in repetitive courses, stagger, or stand in a wide-based stance; and appear to be drowsy. Once the animal succumbs to the clinical signs, the disease is fatal. Depopulation of infected herds is the best option for control and containment of the disease (USGS 2007).

Evidence now suggests that CWD can be transmitted to other wildlife, such as rodents (Heisey et al. 2010). Of significant concern is the translocation of cervids to captive breeding facilities that occur near the Refuge boundary. It is thought that the movement of these animals gives greatest risk of CWD transmission and spread (Davidson 2006). If CWD infects one of the cervid herds on the Refuge, it will have a lasting impact on both cervids and other wildlife populations for decades. During annual Refuge elk hunts, the Oklahoma Department of Wildlife and Conservation, the Oklahoma Department of Agriculture, Food, and Forestry, and the United States Department of Agriculture routinely sample carcasses for the presence of CWD. No elk on the Refuge has ever been positively identified as being affected by CWD.

Avian Influenza

With the great number of avian fauna that use the Wichita Mountains Wildlife Refuge, avian influenza (H5N1) is a disease that could have serious impacts on the composition of bird species. This disease has caused mortality in over 40 species of wild birds in Asia. H5N1 also has characteristics that could indicate a possible transmittal to humans. The testing of migratory birds (primarily waterfowl) is the focus of efforts to keep H5N1 out of North America (USGS 2005). The transmission of this disease into the Refuge would have dramatic effects on species composition and abundance. Birds play critical ecological roles, including pollination, seed dissemination, insect control, predator-prey relationships, and habitat modification.

White-Nose Syndrome

White-Nose syndrome is a devastating disease affecting hibernating bats. This fungus (*Geomyes destructans*) was first discovered in 2005 in New York and has since spread (Blehert et al. 2009) into 12 states throughout the eastern half of the United States, including Oklahoma. An estimated 5.5 to 6.7 million bats have died due to this disease, reaching 100 percent mortality in some hibernacula. This fungus invades the skin of hibernating bats, producing ulcers, altering

hibernation patterns, and causing emaciation and death. Most bats produce few offspring and are long lived. Therefore, the release of this fungus into bat populations would have lasting negative effects on bat populations and cause cascading effects and alteration of the role of bats in the environment. The transmission of this disease is presumably through close contact; the movement of bats and people between roosting caves is likely the cause of the rapid expansion of fungus range (Blehert et al. 2009). The most obvious bat colony on the Refuge that may be affected is the eastern pipistrelle (*Pipistrellus subflavus*) colony that winters in the Pennington Mine.

Brucellosis

Brucellosis is an infectious disease caused by the bacteria of the genus *Brucella* that occurs in cattle, deer, elk, coyotes, and bison. In ruminants, abortion during the latter half of gestation is a common clinical sign of brucellosis. Chronic infections can also result in severe swelling of joints and other symptoms that result in lameness. The Wichita Mountains Wildlife Refuge has a history of brucellosis in bison and longhorn cattle from 1940 to 1967, before immunizations and testing eradicated the disease from these herds (Bartnicki 1972). Currently in North America, the only wild populations affected by brucellosis are elk and bison in the Greater Yellowstone area and bison in Wood Buffalo National Park, Canada. Scavengers appear to be dead-end hosts, whereas, the ruminants pass the bacteria through close contact through aborted fetuses (Meagher and Meyer 1994; Davidson 2006). This disease would undo the great success story of bison and elk reintroductions on the Refuge. The impacts of this disease would be lasting, resulting in devastating impacts to the elk, deer, bison, and longhorn cattle populations. The finding of brucellosis on the Refuge would alter animal management strategies because the containment of this disease is tightly controlled by the U.S. Department of Agriculture.

Tuberculosis

Bovine tuberculosis is a disease caused by the bacteria *Mycobacterium bovis*. Ruminants that are infected with tuberculosis often appear healthy; however, tuberculosis is a progressive disease that will cause emaciation, reduced locomotion, and respiratory issues. In elk, lymph nodes in the neck will develop abscesses that rupture and drain through the skin. Populations of white-tailed deer in Michigan (Schmitt et al. 1997), badgers in England, and brushtail possums in New Zealand have tuberculosis that has been maintained without involvement from infected livestock. Longhorn cattle and bison may be at the greatest risk of contracting this disease. The herds of these animals would be restrained by the U.S. Department of Agriculture if a positive case of tuberculosis were found (Davidson 2006). High densities of animals and supplemental feeding are thought to create conditions by which tuberculosis is easily spread through herds (Schmitt et al. 1997).

Hemorrhagic Disease

Hemorrhagic disease is the most widespread disease affecting white-tailed deer. The disease occurs annually, but the severity and distribution are variable. The clinical signs of this disease are highly variable and include fever, respiratory distress, swelling of the neck and head, lameness, and reduced activity (Davidson 2006). On the Refuge, white-tailed deer populations would be greatly reduced if an outbreak of hemorrhagic disease occurred.

Sylvatic Plague

Of the diseases that infect prairie dogs, none may be more destructive than sylvatic plague. Plague outbreaks frequently kill more than 99 percent of prairie dogs in infected colonies. The impacts of the plague increase the distance between extant colonies, thereby decreasing the demographic rescue effect and altering metapopulation dynamics (Cully and Williams 2001). If the disease were to occur on the Refuge, the result could be the complete extirpation of prairie dogs.

Malignant Catarrhal Fever

Malignant catarrhal fever is a sporadic but usually fatal disease of cattle and many wild ruminants. It is caused by multiple related herpes viruses and typically occurs when the virus from a latently infected carrier host infects other susceptible species (Davidson 2006). Affected animals separate from the group, become lethargic, fail to eat, develop a fever, and usually die within 4-5 days. If the disease were to occur on the Refuge, the impacts of this disease would be lasting, resulting in devastating impacts to the elk, deer, and longhorn cattle populations and complete or near complete extirpation of bison.

Climate Change

The impacts of climate change on wildlife species is of great concern. The increase in global temperatures and change in weather patterns can have catastrophic effects on wildlife distribution and ecosystem processes. Such climate-induced changes have the capacity to make dramatic alterations to floral and faunal composition, species dominance, and distribution of ecosystems. Climate change can also increase disease transmission and may cause species extinction (Harvell et al. 2002). The timing of migration, breeding dates, and nesting patterns of avian fauna can be altered due to a seasonal rise in temperature (Dunn and Winkler 1999, Crick 2004). Phenological miscues, such as migrating at the wrong time, could make long-distance migratory birds vulnerable (Crick 2004).

Another factor of climate change is changes in species range expansion or contraction and its impact on competition, predation, and trophic interactions (Sala 2006). Global climate change models suggest that mammalian diversity could be reduced in national parks because of shifts in plant community structure (Burns et al. 2003); the same may be true for national wildlife refuges.

Another concern resulting from climate change is the spread of invasive plants. The prevalence and vigor of invasive plants and the competitive advantage they have over native plants may be linked to changes in climate (Willis et al. 2010).

Amphibian Declines

Reductions in amphibian diversity and richness have increased over the past few decades and amphibians are now more threatened than either mammals or birds. The causes of these declines are not well understood, but it is thought that they are attributed to a combination of habitat destruction, widespread use of pesticides, irradiation, diseases, invasive species, exploitation, and climate change (Beebee and Griffiths 2005). The widespread reduction of amphibians on the Refuge would likely have trophic-level effects on animal community composition and reduce biodiversity.

Overpopulation of Canada Geese

Over the last decade, a growing resident population of Canada geese has been established on the Refuge. Large populations of geese cause a host of problems to water quality, habitat quality, and transmission of disease (Conover and Chasko 1985, Ankney 1996). The burgeoning Canada goose population on the Refuge could reduce the habitat available for other waterfowl, diminish water quality, and increase transmission of avian diseases.

Loss of Genetic Variation

The Wichita Mountains Wildlife Refuge is surrounded by a game fence that prevents egress and ingress of bison and longhorns. The small founder size of the bison, elk, and longhorn herds also contributes genetic effects such as population bottlenecks, which could potentially cause loss of genetic variation (Leberg 1992).

Populations of animals that are genetically isolated have a greater chance of losing substantial amounts of genetic variation when their numbers remain low. Genetic variation is positively related to population size in wildlife populations (Frankham 1996, Dixon et al. 2007). The loss of genetic variation may reduce the ability of individuals to adapt to a changing environment, cause inbreeding depression (Ebert et al. 2002), reduce survival and reproduction (Reed and Frankham 2003), and increase the probability of extinction (Newman and Pilson 1997).

Bison conservation is considered one of the main themes of the Wichita Mountains Wildlife Refuge. The protection of this herd and its genetic uniqueness is important to bison conservation across the continent. There have been several attempts to identify management techniques and minimum population sizes in order to preserve genetic variation in bison herds (Shull and Tipton 1987, Gross et al. 2006). Gross et al. (2006) recommends herd sizes greater than 1,000 to preserve 90 percent of allelic diversity at a 90 percent probability in Yellowstone bison herds. Without planned management of the Wichita animal herds, a loss of genetic variation could occur, increasing the chances of inbreeding depression.

3.4 Socioeconomic Environment

This section describes the socioeconomic environment of the Wichita Mountains Wildlife Refuge. It includes a discussion of nearby human populations and economies. It concludes with a short discussion about the Service's concerns pertaining to the socioeconomic environment.

3.4.1 Population

Population growth in Comanche County over the last two decades has been limited. However, since 1990, the City of Lawton has experienced growth of roughly 12 percent. Approximately 80 percent of the population of Comanche County resides in the City of Lawton; the remainder live in the surrounding towns of Cache, Elgin, Medicine Park, or elsewhere. The population density of Comanche County remained nearly unchanged from 1990 through 2000, with 104 people per square mile and 108 people per square mile, respectively. In 2000, the population density in the City of Lawton was 1,234 people per square mile, a 13 percent increase from 1990 levels of 1,071 persons per square mile (U.S. Census Bureau 2000). Increases in Lawton's population density improve the likelihood that alternative transportation strategies such as transit, pedestrian, and bicycle facilities will experience higher use. Table 3-14 shows population increases in Comanche County and Lawton from 1990-2008.

Table 3-14. Area Population Trends 1990-2008

Population	1990	2000	2008	% Increase 1990-2008
Comanche County	111,486	114,996	111,772	0.25
City of Lawton	80,561	92,757	90,091	12

Source: U.S. Census Bureau 2000

Census data does not account for the population growth of military personnel due to the 2005 Base Closure and Realignment Commission initiative that estimated a 50 percent increase[5], or approximately 10,000 more soldiers, families, and employees, at Fort Sill by 2011 (Lawton-Fort Sill Growth Management Plan 2008). The City of Lawton-Fort Sill Growth Management Plan indicates that the City of Lawton will experience approximately three-quarters of the expected growth, with the towns of Elgin and Cache receiving the remainder of the growth (Lawton-Fort Sill Growth Management Plan 2008). Population growth in the surrounding towns will likely increase visitation and usage of the Refuge and may provide an increase in demand that would make the new transportation alternatives that this CCP identifies feasible.

3.4.2 Economy

3.4.2.1 Regional Economic Profile

Historically an agricultural, livestock, and military economy, the focus of Comanche County's economy today is largely on retail and healthcare. In addition to the Fort Sill Military Base, the wind and solar energy, Native American gaming, and tourism sectors provide an important source of economic opportunities in the area. Table 3-15 shows the top 10 employers in Comanche County.

Table 3-15. Top 10 Employers (Comanche County)

Employer	Employees Full Time
Fort Sill	5,092
Goodyear Tire & Rubber Company	2,400
Lawton Public Schools	2,325
Comanche County Memorial Hospital	1,801
Wal-Mart/Sam's	1,180
City of Lawton	824
Southwestern Medical Center	552
Assurant Solutions	530
Cameron University	510
Fort Sill National Bank	488

Source: Lawton Fort Sill Chamber of Commerce

3.4.2.2 Economic Significance of the Refuge

Economic Benefits of Oklahoma National Wildlife Refuges

The 2006 U.S. Fish and Wildlife Service Banking on Nature study assesses and measures the relative economic benefits of visitation at national wildlife refuges in terms of demand, employment, and revenues in local communities. The report analyzes use characteristics and economic data from 80 refuges across the nation. The economic profiles use data from the Service's National Survey of Fishing, Hunting, and Wildlife Associated Recreation and the Refuge Annual Performance Plan to develop the economic profiles of refuge visitation. The report estimates visitor spending in local communities on food, lodging, transportation, and other fees (i.e., equipment rentals, guide fees, etc.). To create an approximate estimate of the national impacts that refuges have on regional economies, the report extrapolates data from a sample

[5] Based on an estimated population increase of approximately 10,000 new service personnel above the current population of approximately 20,000 service personnel.

population of refuges with more than 1,500 visitors in the lower 48 states, recognizing that numerous complex variables affect a refuge's impact on an area economy. Some of the main findings reveal that of the 34.8 million visits to refuges in the sample population, spending activities generated:

- $1.7 billion in sales tax for regional economies
- $542.8 milion in employment income
- $185.3 million in tax revenues at the Federal, State, county, and local level
- 26,798 jobs[6]

The Wichita Mountains Wildlife Refuge is not a case study in this report; however, it profiles three refuge sites within Oklahoma: the Washita National Wildlife Refuge, about 120 miles northwest of Wichita Mountains, and Sequoyah National Wildlife Refuge and Tishomingo National Wildlife Refuge, both a couple hundred miles west of the Refuge. Each site has unique characteristics that attract visitors and contextual issues that may affect visitation, and the penetration of income into the local economy (i.e., the relative availability and/or desirability of hotels, restaurants, retail, etc.) create discrepancies for direct comparison to the Refuge. However, the Banking on Nature report provides a source of information that helps to form a broad picture of the economic significance of the Refuge on its surrounding communities.

Table 3-16 illustrates the total income generation of non-resident consumers of goods and services relative to visitation at the three Oklahoma refuges. The "economic area" is defined as the county areas within 30 miles of the refuge site. "Final demand" is the total spending by consumers on all goods, or the amount of money that remains in an area after accounting for economic leakages (i.e., non-spending of income allocated to savings, taxes, and imports). In 2006, the Wichita Mountains Wildlife Refuge had approximately 1.3 million visitors, or six times the visitation of Tishomingo National Wildlife Refuge, 14 times the visitation of Sequoyah National Wildlife Refuge, 22 times the visitation of Washita National Wildlife Refuge. Extrapolating spending data at these sites leads to the estimation that Wichita Mountains Wildlife Refuge may have contributed over $30 million towards its surrounding regional economy in the same year. With visitation steadily increasing on the Refuge and the growing popularity of "eco-tourism," the Refuge's importance to the local economy is certain to continue.

Table 3-16. 2006 Banking on Nature Oklahoma Area NWR Economic Impacts

Refuge	Total Visitation	Economic Area*	Final Demand** (2006 $'s)
Tishomingo NWR	205,944	Johnston, Marshall	$5.1 M
Sequoyah NWR	88,000	Sequoyah, Haskell, Muskogee	$2.4 M
Washita NWR	58,582	Custer, Beckham, Roger Mills, Washita	$965,000

* County areas within 30 miles of the Refuge

** Total spending by consumers on all goods, or the amount of money that remains in an area after accounting for economic leakages (i.e., non-spending of income allocated to savings, taxes, and imports).

Source: Carver, Erin and James Caudill 2007.

[6] Banking On Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. U.S. Fish and Wildlife Service. 2007.

Economic Benefits of Wichita Mountains Wildlife Refuge

The socioeconomic benefits of the Wichita Mountains Wildlife Refuge consist of contributions it makes to local retail trade in the form of contracts, equipment rental and purchases, and other services. Annual salaries of Refuge employees also contribute to the tax base of Comanche County. The Refuge supports economic activities such as the annual bison and livestock auctions, interpretive tours, and other permitted uses that require a fee. Land acquired by the Service in fee title is removed from county tax rolls. To help pay for lost tax revenues, the county receives an annual payment in lieu of taxes, as provided by the Refuge Revenue Sharing Act of 1935 (16 U.S.C. 7145:48 Stat. 383, as amended). In 2010, Wichita Mountains Wildlife Refuge's payment to Comanche County was $7,891.

3.4.3 Concerns Regarding the Socioeconomic Environment

Population Growth

With an estimated 10,000 additional people at Fort Sill Military Base by 2011 (Lawton-Fort Sill Growth Management Plan 2008) and population growth in Comanche County in general, the Refuge expects visitation and public use to increase. This increased use may cause increased disturbance to physical and biological resources on the Refuge but may also present an opportunity for the Refuge to pursue new transportation alternatives, partnerships, or other options for minimizing potential impacts.

3.4.4 Archaeological, Cultural, and Historical Resources

The earliest substantiated evidence for human use of the Southern Plains region begins around 11,750 years Before Present (B.P.) in what is called the Paleo-Indian stage. The Native American people living during this stage, which lasted until 8450 B.P., were primarily large game hunters, relying on now extinct species of mammoth and bison, but also exploiting plants and smaller animals for subsistence. The following Archaic stage, which lasted until 1950 B.P., is characterized by diverse use of a wide variety of plant and animal species, though bison remained the most important resource in the region. Grinding tools, roasting ovens, and the types of projectile points found at archaeological sites set this stage apart from the Paleo-Indian.

Archaeological finds dating to the Archaic stage also indicate more restricted movement and an increase in the population of the region. The transition from the Archaic stage to the Formative (a.k.a. Plains Woodland) stage (dating from 1950 to 1150 B.P.) is marked by a number of technological changes. These include a shift from using spears and darts to the bow and arrow and the introduction of ceramics. After 1150 B.P. and lasting until contact with Euro-Americans around 409 B.P., sedentary or semi-sedentary agricultural societies occupied the region. This stage is known as the Florescent (a.k.a. Plains Village) stage and is characterized by village sites mostly along major river or stream systems with fertile soil. In addition to limited agriculture, these people relied heavily on hunting, fishing, and wild plant gathering (Procter and Kahl 2002).

Protohistoric Period

The Protohistoric Period encompasses the period following Coronado's initial exploration of the southwest in 1541 and before extensive presence of Euro-Americans in the region. During this time, many tribal groups from boundary areas (Mississippi Valley, Rocky Mountains, far Southern Plains) began to enter the western Southern Plains to exploit the vast herds of bison. Before about 1750, Apachean groups appear to have dominated the western portion of the Southern Plains.

After this time, the Wichita, Comanche, and Kiowa tribes increasingly controlled the area (Procter and Kahl 2002).

Historic Period

In 1819, the United States set the southern boundaries of the Louisiana Purchase. This land, later known as the Oklahoma Territory, was envisioned even then as a possible future home for Native Americans. Exploration of the Wichita Mountains area first occurred with the Dragoon Expedition of 1834. This expedition encountered villages of Wichita, Kiowa, and Comanche groups with populations estimated at between 3,000 and 4,000 in the area of the Wichita Mountains. (Procter and Kahl 2002)

Archaeological Sites

What is known about the archaeological sites contained within the boundaries of the Refuge comes from a survey conducted by the Museum of the Great Plains in 1964 and 1965. Twenty-nine prehistoric sites were examined and two historic crevice burials were reported. Since the 1964-1965 survey, three additional sites have been reported from the Refuge area. Most of the prehistoric sites found during the survey appear to be small, thin scatters of lithic debris with an occasional stone-lined hearth visible on the surface. The absence of diagnostic artifacts and the lack of features at most sites make it difficult to determine when the sites were occupied or what activities occurred at the sites. The list must be considered tenuous at best because of the lack of published data. The only source of information on these sites is the Oklahoma Archaeological Survey files, housed at the University of Oklahoma in Norman. These files contain only a minimal amount of information, sometimes limited to just site location information. Consequently, it is very difficult to evaluate the research potential of the archaeological resources on the Refuge (Meredith et al.).

Historic Structures

The survey of historic structures located in the Refuge area was undertaken by the Oklahoma Historic Preservation Office upon the initiative of the Service. Five structures are listed on the National Register of Historic Places because they present an "unparalleled opportunity for describing the vernacular architecture of the Wichita Mountains area of the early twentieth century" (Meredith et al. 1978). These structures are Boulder Cabin, Buffalo Lodge, the Cedar Creek Arrastra Site, Ferguson House, and Ingram House.

Boulder Cabin (site # 81000456) was constructed in 1911 by an unknown private individual. The one-story structure is 16 feet X 24 feet. It is made of cobblestone with masonry load bearing walls, and the roof is of frame construction and composition shingles. A porch extends along the west and south sides of the cabin. A distinctive feature is the cobblestone fireplace. (Meredith et al. 1978) The cabin is available for public use by reservation.

Ferguson House (site # 81000458) was constructed in 1927 by a private individual. It is 36 feet by 36 feet with one and a half stories and one-half basement. The structural system is masonry load bearing walls with a wood frame roof. The exterior is cobblestone with a composition shingle roof. It is closed to the public. (Meredith et al. 1978)

The Ingram House (site # 81000459) was built in 1928 by Earl Ingram, who lived there until 1942. The two-story house is flagstone and cobblestone with masonry load bearing walls and a wood frame roof. It is closed to the public. (Meredith et al. 1978)

The Buffalo Lodge (site # 80111457) is one of the oldest structures on the Refuge. It was constructed in 1913 by the Forest Service as an office building. It has masonry load bearing walls and wood frame roof with cobblestone exterior and composition shingles (Meredith et al. 1978). Since its retirement as an office building, the lodge has been utilized as staff housing.

The Cedar Creek Arrastra Site (site # 81000455) is listed in the National Register of Historic Places as a site of information potential for the history of architecture and industry from 1900-1924. A period of intensive gold prospecting occurred in the Wichita Mountains during the late 1800s with about 3,000 miners eventually working the area (Wilson 1983). The granite rock was dug by hand and then crushed in hand made mule- or horse-powered grinders constructed in the ground from local rocks. The Cedar Creek Arrastra Site is an example of this technology.

3.4.4.1 Concerns Regarding the Archaeological, Cultural, and Historic Resources

Archaeological and Historical Resource Surveys

To better monitor and protect archaeological or historical resources on the Refuge, an updated comprehensive survey of the area is needed. The Refuge would then be better prepared to ensure that such resources are protected from degradation and available for future study, investigative research, or preservation. After adequate documentation and protection of these resources occurs, the Refuge would be better able to offer interpretation of the history and prehistory of the area when and where appropriate.

3.5 Current Management and Administration

3.5.1 Physical Resources Management

Air Quality

Refuge management activities that may affect air quality include prescribed fire, invasive species management, construction and maintenance of roads, and emissions from vehicle exhaust. Prescribed burns are initiated according to an approved Fire Management Plan (2008) that includes smoke management criteria; and burns are implemented according to Oklahoma's Voluntary Smoke Management Guidelines (Oklahoma Forestry Services 2010). The Refuge treats invasive flora and pests wherever they occur throughout the Refuge through chemical and mechanical means. Chemical treatment is applied with a boom or wand; no aerial herbicide spraying occurs. Mechanical treatments involve hand tools, chainsaws, and, infrequently, hand shears. Habitat management activities, such as bison and longhorn roundups, are scheduled during periods when negligible fugitive dust is produced. All paved Refuge roads are heavily used by the public; most dirt roads are used sporadically by Refuge staff, resulting in low amounts of dust and vehicle emissions. The Refuge coordinates with the Services's Denver Air Quality Branch to ensure appropriate and consistent air quality monitoring at, but not limited to, the IMPROVE station to ensure protection of the Refuge's Class I Airshed status.

Water Resources

Generally, lakes are managed at full capacity with a focus on providing recreational fishing and water sources for herd management. Occasional drawdowns are conducted to control aquatic invasive species, to manage fisheries, and to improve recreational fishing opportunities as described in the current Fisheries Management Plan (2002). Drawdowns would also have the potential to provide habitat for waterbirds and migratory waterfowl and shorebird species. On

occasion, the Refuge stocks fish in the public use lakes and installs fish structures in a few lakes where appropriate.

The Refuge also utilizes modified springs for managing confined Refuge animals. Without these springs to aid in dispersal of animals, areas around lakes would become over utilized during dry periods.

Water Quality

The Refuge monitors water quality through the Blue Thumb partnership with the Oklahoma Conservation Commission, mercury monitoring through OKDEQ, the EPA long-term Mercury Deposition Network program, and other partnerships. In being cognizant of public health and safety, the Refuge provides public outreach for and warnings of mercury contamination.

Soil Resources

By far the biggest impact and contribution the Refuge makes to soil resources is from the long-term conservation and maintenance of soil-protecting vegetative cover throughout the Refuge. Maintaining and protecting the cover provided by vegetation including grasses, forbs, shrubs, and trees is the best way to conserve soils. Areas of concern for soils on the Refuge are typically developed and include construction sites or roads undergoing maintenance. Wattles or other erosion control methods are used where the ground is disturbed.

3.5.2 Biological Resources Management

3.5.2.1 Habitat Management

Range Management

The grazing and utilization of grasslands on the Refuge has been monitored for decades in an effort to ensure overgrazing and undergrazing does not occur (Kingery 1963, Kimball 1992). The management of grazing practices on the Refuge has run the gamut of selling surplus bison and longhorn, controlled hunts, cross-fencing, separation of herds, leaving areas fallow, removing fencing, and prescribed burning to attract animals. In 2007, most of the Refuge was joined by opening fences and water gaps. This has allowed animals to freely move across the extent of the Refuge and congregate where forage is optimal. Prudent management of the herbivores and habitat in which they live is a major focus of the Refuge to ensure perpetuation of this unique habitat. The Refuge has managed herbivore populations to be within acceptable limits to allow for proper utilization of grasslands.

Riparian Areas

Riparian areas are considered a component of the ecosystem they occur in and are managed in accordance with that ecosystem. Where roads cross streams, concrete low water crossings or bridges have been constructed to protect riparian resources and are maintained to prevent or minimize erosion. High priority riparian areas adjacent to the Refuge or off-Refuge have not been identified and do not receive any special protection, with the exception of some areas on the Fort Sill Military Base, where riparian and wetland protection are integrated into management and operations.

Fire Management

Prescribed burning is initiated according to the Fire Management Plan (2008) with a strategy to manage for or mimic natural fire occurrence and grazing interaction (i.e., pyric herbivory). The goal of the FMP is to promote naturally-occurring and historic habitat conditions to sustain biological diversity and heterogeneity. All wildfires are evaluated and an appropriate strategy and/or tactic is applied that considers wildfire intensity and behavior, public and firefighter safety, values at risk, possible resource benefits, and cost containment. In consultation with Service Ecological Services and in accordance with Section 7 of the Endangered Species Act, the official Biological Opinion identifies that an annual maximum of 7,200 acres of black-capped vireo habitat can be burned. A total of 14,000 acres may be burned per year (a combination of black-capped vireo and non-black-capped vireo habitat).

The heterogeneity produced by the variation in fire intensity, season of fire occurrence, grazing distribution, and vegetation response cannot be matched by any other combination of management practices. It is through heterogeneity that biological integrity and resiliency is maintained. The greater the biological resiliency, the better suited the habitat is to meet environmental changes. With increased resiliency and biodiversity comes the greater probability that an individual best suited for future conditions exists in the biome.

Fire management also includes prevention, preparedness, and suppression. Prevention and preparedness programs are both internal and external, ranging from marshalling of equipment to public meetings and environmental education. Suppression may be direct and/or indirect depending on public and firefighter safety and values at risk. These actions are detailed further in the Fire Management Plan (2008).

Invasive Species

Invasive and non-native flora and fauna will be managed according to the Refuge's Integrated Pest Management Step-Down Plan (2013). The plan will include mechanical control for treating native invasive species (e.g., juniper and mechanical and chemical treatment of non-native invasives. Treatments would primarily be conducted along roadsides and around public use areas and would occur Refuge-wide where necessary to reduce juniper densities in Crosstimbers habitat. In 2011, approximately 7,500 acres were treated for invasive and non-native flora, but acres treated would likely increase under the Integrated Pest Management Plan (IPMP).

The Refuge would also promote the health of native species on the Refuge while containing, controlling, or eradicating non-native or invasive fauna when and where possible. Non-native/invasive fauna populations would be reduced through trapping or gunning or prevented by implementing restrictions aimed to avert introductions.

Permitted Grazing

Permitted grazing occurs on five small allotments on 430 acres outside of the Refuge boundary fence. The north Refuge boundary fence was located south of the true boundary in some instances due to difficult terrain or incorrect mapping data. Grazing allotments occur on Refuge lands only where the boundary fence is incorrectly located. The Refuge permits this use, not to exceed 216 Animal Unit Months (AUMs), according to the terms of a Special Use Permit, renewable every year. The intent of this use is to promote and sustain grassland conditions outside of the Refuge boundary, reducing the opportunity for woody plant encroachment.

3.5.2.2 Wildlife Management

Native Fauna

Native fauna are managed at an established carrying capacity as described in Bison Management Plan, Deer Management Plan, and Elk Management Plan, utilizing the Soil Conservation Service forage survey and range evaluation to determine carrying capacity. The 1985 Grasslands Management Plan identifies that the Refuge utilizes a maximum of 33 percent of available forage by weight from low forage production as determined in a 1971 Range Evaluation. In accordance with the Elk Management Plan, elk are managed at no fewer than 380 individuals. White-tailed deer are kept above a minimum of approximately 450 individuals as outlined in the Deer Management Plan. Bison are managed at a minimum of 480 individuals according to the Bison Management Plan.

Bison are monitored for brucellosis and basic herd and genetic health. Public auctions for bison are held annually to remove excess animal populations; generally, 150-250 individuals are sold.

Federally-Listed Species

For management of black-capped vireo, the Refuge follows objectives identified in the 1991 Black-Capped Vireo Recovery Plan. Such objectives include working with other agencies and organizations for protection of areas, addressing cowbird threat and control, determining and developing methods for managing vireo habitat, and monitoring populations within areas deemed necessary for recovery.

Hunting

Hunting occurs throughout the Refuge and is dependent upon population management objectives. The Refuge holds white-tailed deer and elk hunts to prevent overpopulation and to alleviate habitat degradation. Hunts occur from November through January and are tightly controlled four-day events managed as a cooperative effort between the Refuge and Oklahoma Department of Wildlife Conservation. Hunters are selected by random drawing and must obtain a State issued hunting license prior to applying. The number of permits and hunt days vary each year depending on the relationship between population levels and habitat conditions. Permits average about 100 deer permits and 250 elk permits annually.

3.5.2.3 Non-Native Fauna Management

Longhorn are managed at an established carrying capacity as described in the Grasslands Management Plan and Longhorn Management Plan, utilizing the Soil Conservation Service forage survey and range evaluation to determine carrying capacity. In accordance with the Longhorn Management Plan, longhorns are managed at approximately 285 individuals. They are also monitored for brucellosis and basic herd health. Public auctions for longhorns would continue to be held annually to remove excess animal populations; 125-180 individuals are typically sold.

Feral hogs will be managed under the Refuge's Integrated Pest Management Step-Down Plan, which will cover trapping, aerial gunning, and opportunistic shooting. The Refuge will also monitor its lakes for zebra mussels; none currently occur in these lakes.

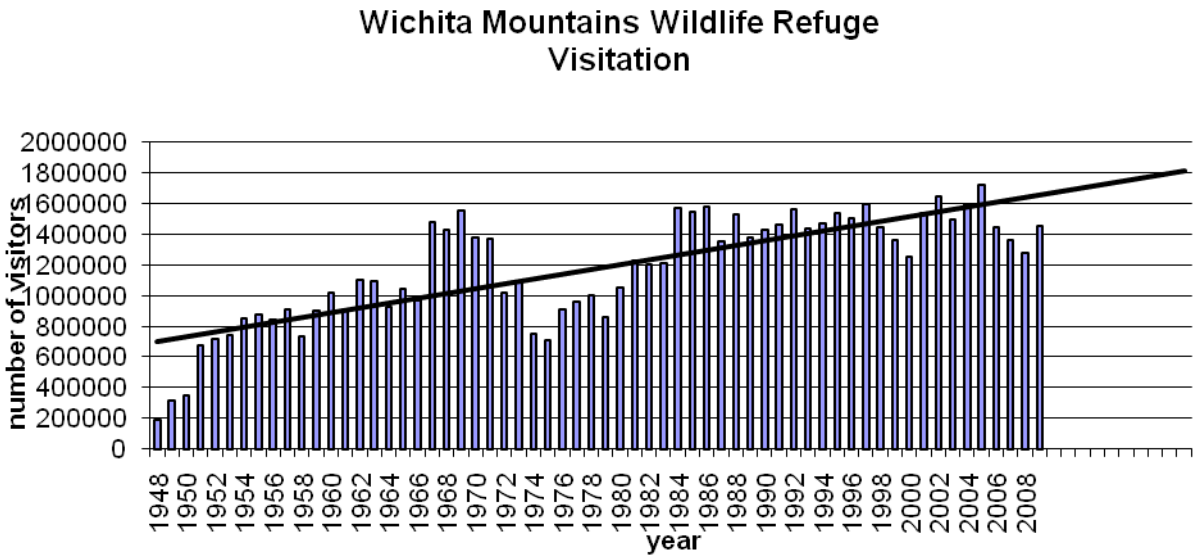
3.5.3 Public Use Opportunities

Introduction

An important aspect of managing Federal public lands, an aspect as important as maintaining healthy lands and waters, is facilitating and managing public use. The Wichita Mountains Wildlife Refuge provides the public with high quality, diverse public use (recreation) opportunities not found anywhere else in the region. Because the history of recreation on the Refuge dates back to the early 1900s, it is easy to overlook the fact that all national wildlife refuges are closed to public use unless specifically opened to a particular activity. The primary criteria for determining how much recreational use a refuge can support and what activities are acceptable, are found in the legal purpose of the refuge and in the National Wildlife Refuge System Improvement Act (1997). The refuge manager is responsible for determining which activities are acceptable uses of the particular national refuge and for conducting a Compatibility Determination (see Appendix F). The decision to allow a compatible activity to occur, or continue occurring, is influenced by the refuge purpose(s), agency mission, policy, availability of resources to manage the use, possible conflicts with other users, and public safety (Service Manual 603 FW 1 and 2). This explains why recreation opportunities on a national wildlife refuge differ from other Federal public lands such as a national park or national forest and why recreation opportunities may differ from one national wildlife refuge to another. It also explains how recreation uses can change over time at the same refuge.

Visitation at the Wichita Mountains Wildlife Refuge over the last 10 years has averaged about 1.5 million visitors a year, making it one of the most visited national wildlife refuges (USFWS 2009). While annual visitation fluctuates, the long-term trend is one of increasing visitation (Figure 3-8). It is expected that as regional population levels increase, so will the demand for recreation opportunities on the Refuge. The majority of visitors enter the Refuge from the east gate via Interstate-44. Visitor use tends to decline along an east-west gradient, with the highest visitor use density occurring on the east side of the Refuge between Mt. Scott and the Visitor Center. Visitor use density is significantly lower towards the West Gate and the Indiahoma gate.

Figure 3-8. Wichita Mountains Wildlife Refuge Annual Visitation, 1948 to 2009



Source: Wichita Mountains Wildlife Refuge, unpublished data 2010

The primary goal of visitor services is to maintain or increase the quality of the visitor experience while minimizing the negative impacts that public use can have on both wildlife and habitat. Goals, objectives, and long-term direction for the visitor services program were articulated in the Refuge Recreation Management Plan (USFWS 1986) and updated in the Public Use Management Plan (USFWS 1998).

History

The Refuge was managed by the U.S. Forest Service from its inception in 1901 until 1936. This is an important aspect of recreation management history because the Forest Service, in contrast to the U.S. Fish and Wildlife Service, is legally mandated to provide for natural resource commodities such as timber, minerals, grazing, and recreation. Much of the recreation infrastructure that we use and enjoy today was built during this period, including Mt. Scott road, hiking trails, concrete dams, and picnic areas. By the 1960s, the Refuge began to receive over one million visitors a year. Recreational use continued unchecked and, at that level of visitation, began to result in vandalism and resource damage. The sprawling recreation complex constructed by the Forest Service in the 1930s, coupled with the burgeoning and unrestricted use of the 1960s, continues to influence the public's memory and expectation of recreation on the Refuge.

Reigning in the unsustainable levels and types of recreation was a slow and divisive process. Throughout the 1970s, restrictions were phased in to protect natural resource and public use values, improve public safety, and meet national recreation management direction. By 1983, the visitor services program had been completely restructured—over half of the camping and picnicking spots had been eliminated and restored for wildlife use, swimming was banned, alcohol consumption was made illegal, and a night closure was put into place for most of the public use area. In keeping with national direction, an increased emphasis was placed on interpretation and education.

3.5.3.1 Wildlife-Dependent Recreation Opportunities

The National Wildlife Refuge System Improvement Act of 1997 recognizes six wildlife-dependent forms of recreation that are determined to be appropriate uses of a National Wildlife Refuge and receive priority consideration in refuge planning and management: hunting, fishing, wildlife observation, photography, interpretation, and environmental education. Most public use activities on the Wichita Mountains Wildlife Refuge occur in the Public Use Area (Figure 3-9).

Hunting

The Wichita Mountains Wildlife Refuge is closed to hunting except during annual big-game permit hunts. Gun hunts for elk and white-tailed deer are conducted each fall and winter in a program cooperatively managed by the Refuge and the Oklahoma Department of Wildlife Conservation (ODWC). The permit hunts are used as a management tool to meet elk and deer population management goals.

The number of permits and hunt days can vary each year depending on the relationship between population levels and habitat conditions. The permit hunts are very popular, with demand far outstripping the availability. The elk hunt is an once-in-a-lifetime hunt; once drawn, hunters may not reapply. Over the last decade, the Refuge has supported one deer hunt and at least two elk hunts per year. In turn, these hunts provide high quality hunting opportunities for about 100 deer hunters and 180 elk hunters each year.

The hunts are heavily facilitated by Refuge and ODWC personnel. Hunters attend a mandatory safety briefing and are assigned a hunt area. Hunters are not allowed to use private vehicles to

access hunt areas but are shuttled by Refuge and ODWC staff. Hunters are required to follow all Refuge restrictions, including the night-time closure. Each hunt lasts four days, with a one-day orientation and safety meeting and three days of active hunting. With almost 100 hunters afield during each hunt opening, and three to four hunt openings each year, this level of management places a heavy administrative burden on both Refuge and ODWC staff.

Potential hunt-related issues, such as wildlife and habitat disturbance, poaching by non-registered hunters, public safety, search and rescue operations, and conflicts between hunters and other members of the public, are mitigated by the limited number of hunts offered each year and by the high level of hunt facilitation and staffing.

Public access to the Refuge during a controlled hunt is restricted during the three days of active hunting. This equates to 6 to 12 days of restricted public access each year. It is this conflict between two priority users groups (hunters and wildlife observers), coupled with the large administrative workload, that has limited the hunting program to deer and elk—species that require hunting as a primary means of population management.

Fishing

All lakes on the Refuge were constructed to provide water for wildlife and fishing opportunities for the public. In the Public Use Area, 41 impoundments totaling 530 acres are open to the public for fishing 24 hours a day. However, most fishing occurs on 12 lakes (see Figure 3-9). Fishing pressure at the Refuge has averaged about 8,300 fishing visits per year over the last five years. Fishing occurs primarily from the stream or lake bank, or from impoundment structures. Largemouth bass, sunfish, crappie, and channel catfish are commonly caught. Stocking of resident fish species to enhance sport fishing opportunities occurs in cooperation with the Oklahoma Department of Wildlife Conservation. Stocking is conducted on a limited and sporadic basis as funds and fish are available. Mercury contamination has been found in Refuge lakes, and signs are posted warning anglers about mercury levels in largemouth bass.

Individuals or organizations that sponsor fishing tournaments are required to have a Special Use Permit issued by the Refuge. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur (see Commercial Recreation-Related Services).

Wildlife Observation

Wildlife observation, particularly driving observation, is the most popular public use of the Refuge. The Wichita Mountains Wildlife Refuge offers world-class wildlife viewing with opportunities to see bison, elk, white-tailed deer, turkey, and prairie dogs, as well as a host of small mammals, birds, and reptiles. The 24,088-acre Public Use Area is open to public access via foot and vehicle. Over 1.5 million wildlife observation visits per year are estimated to occur (USFWS 2009). The only restrictions to observation occur during fall and winter permit hunts, when foot travel and vehicle travel are restricted. Temporary access restrictions may be used to protect active nesting or denning sites from harassment. The Refuge is closed to observation and other public uses after sunset with the exception of Doris Campground and night fishing.

The goal of the observation program is to offer a variety of high quality opportunities to observe wildlife in their native habitats, while minimizing potential conflict between humans and wildlife or between user groups. The Interpretation Program, described in this section, supports and

facilitates the observation program by offering pertinent natural history and management information.

Given the even distribution of animals and habitats across the Refuge, high quality viewing opportunities abound throughout the Public Use Area. Approximately 50 miles of paved road, 17.7 miles of hiking trail, and 13 miles of dirt road facilitate a range of viewing experiences. The condition, location, and management of roads and trails are discussed in greater detail in the *Facilities* Section later in this document.

Because most of the wildlife species found on the Refuge are well distributed and highly mobile, few viewing facilities have been developed. A notable exception is the Turkey Creek prairie dog town and viewing area with a paved pullout, parking lot, and two interpretive signs. The accessible nature trail at Quanah Parker Lake offers waterfowl and wetland wildlife viewing and four interpretive signs. There are 89 parking areas and pullouts scattered along the Refuge road system to facilitate driving observations, one of which offers two interpretive panels.

It is expected that as the regional population grows, Refuge visitation will increase. This means the existing observation infrastructure will exceed capacity during certain times of the year. Issues are likely to arise surrounding vehicle congestion on the roadways and at popular observation points like Mt. Scott and Turkey Creek prairie dog town. Conflict between motorists occurs. There is also an issue in regard to inappropriate speeds and frequent vehicle-wildlife collisions that result in the death or crippling of Refuge animals.

Photography

Photography is also a popular public use of the Refuge. It is estimated that over the last five years, 1.2 million of the total 1.5 million public visits to the Refuge involved photography (USFWS 2009). The opportunities for photography and videography mirror those described under Wildlife Observation. The goal of the photography program is to offer a variety of high quality opportunities to photograph wildlife in their native habitats while minimizing potential conflict between user groups, and between humans and wildlife. The photography program is currently managed in conjunction with the wildlife observation program.

Individuals or organizations that bring clients to the Refuge for the purpose of wildlife observation or photography and charge a fee or tuition for their service are required to have a Special Use Permit issued by the Refuge. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur (see *Commercial Recreation-Related Services*).

Environmental Education

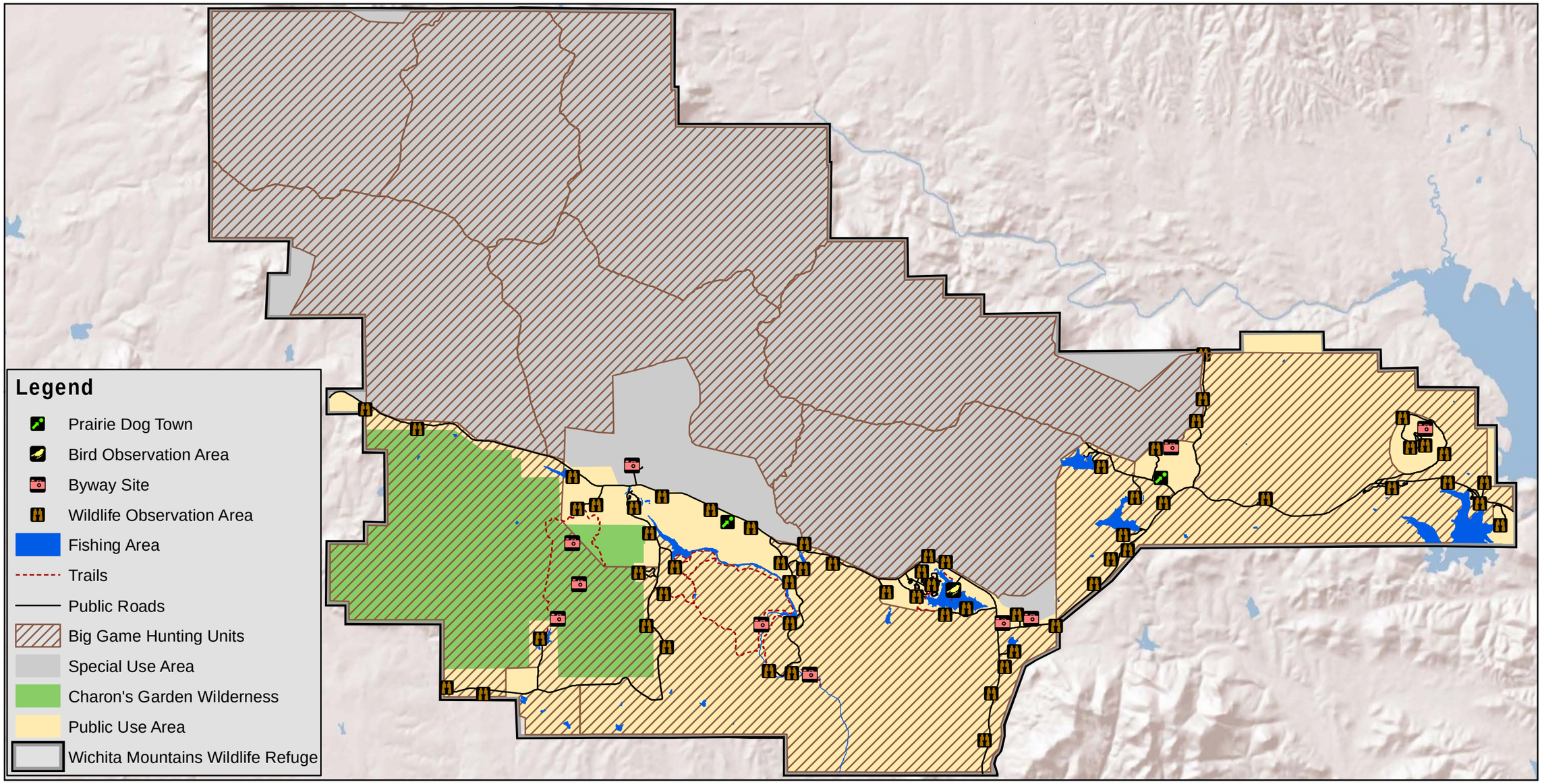
A key element that differentiates environmental education from interpretation is the journey from awareness and appreciation to personal action. Through a learning process that employs nature as teacher, visitors gain not only an appreciation of natural systems and an awareness of environmental issues, but they also apply the knowledge to their daily lives and make changes based on that knowledge. The environmental education program at the Refuge focuses on the role of personal action—*the power of one*—in the broader theme of resource conservation. Large and complex topics such as climate change, resource conservation, and endangered species are taught with a focus on what one individual can do to effect change. In contrast to interpretive contacts, environmental education contacts are generally longer (more than two hours) or involve a series of contacts that culminate in personal action. Only about six percent of the contacts made by the

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Public Use Opportunities



PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
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BASEMAP: N/A
MERIDIAN: N/A
FILE: wmw_pub_opportunities_1.19.11_shl

0 1 2 4 Miles

0 1 2 4 Kilometers

UTM ZONE 14
NAD 83

Visitor Services staff are considered environmental education (9,300), and are generally comprised of college classes and alternative education classes (USFWS 2009).

Individuals or organizations that bring clients to the Refuge for environmental education purposes and charge a fee or tuition for their services are required to have a Special Use Permit issued by the Refuge. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur (see *Commercial Recreation-Related Services*).

Interpretation

The Wichita Mountains Wildlife Refuge is home to one of the largest and busiest interpretation and outreach programs in the Refuge System. The primary goal of the interpretation program at the Refuge is to help connect people to the land, to foster an appreciation of the resource, and to facilitate outdoor, nature-based recreation. The Interpretive Management Plan (USFWS 1984) also speaks to providing an accessible and diverse array of interpretive experiences.

The Refuge currently funds three full-time environmental educators and receives volunteered services equivalent to an additional three staff people. Over 166,300 visitors experience the interpretation and environmental education programs each year. About 94 percent of these contacts are interpretive or informational in nature, and six percent of the contacts are considered environmental education. Interpretive contacts with the public are usually brief (less than two hours) or are facilitated by signage or exhibits such as those in the Refuge Visitor Center. Active interpretation (Ranger talks, nature walks, and event booths) reached almost 64,000 people in 2009. Of that total, about 15,000 were primary and secondary students who visit the Refuge as a field trip destination, and over 1,300 were participants in the popular interpretive bus and hiking tours staffed by the Friends of the Wichitas. In addition to people contacted formally by the interpretation program, over 150,000 people a year visit the Refuge Visitor Center, where most experience a passive form of interpretation provided by the many displays and exhibits. Countless thousands are contacted informally by roving staff members at popular observations areas such as Mt. Scott and Turkey Creek prairie dog town.

Individuals or organizations that bring clients to the Refuge on interpretive tours and charge a fee or tuition for their services are required to have a Special Use Permit issued by the Refuge. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur (see *Commercial Recreation-Related Services*).

3.5.3.2 Other Recreation Opportunities

The other recreation activities that occur on the Wichita Mountains Wildlife Refuge—bicycling, boating, camping, hiking, picnicking, and rock sports—are considered to be supportive of wildlife-dependent recreation. These activities are important forms of recreation and have been determined to be compatible with the purpose of the Refuge.

Bicycling

Bicycling takes place on the 50 miles of paved roads within the Refuge and on the 5.8-mile Mt. Scott mountain bike trail/access road. It is estimated that less than 0.5 percent of all Refuge visitation (about 7,500 people) involves bicycling; however, the sport is growing in popularity. Bicycling on paved roads is governed by State regulations and is closed at dark according to Refuge policy.

Bicycling offers an unparalleled opportunity to experience the Refuge and observe wildlife. However, there are public safety concerns about bicycling on the Refuge. Most Refuge roads lack adequate shoulders to allow bicyclists to move out of the active travel lane. A project is underway to widen the highway shoulders along the section of State Highways 115 and 49 from the Medicine Park gate west and south to the Cache gate. There are also concerns about the interaction between bicyclists and animals, especially longhorn cattle and bison, and about the safety of bicycles crossing cattleguards.

Boating

Boating provides a quiet, uncrowded way to observe wildlife, and it provides fishing access. Over the last five years, boating visits to the Refuge have averaged over 12,200 per year (USFWS 2009). Boating is allowed on five lakes within the public use area. Hand powered boats are permitted on Jed Johnson, Rush, Quanah Parker, and French Lakes. Electric trolling motors are permitted on boats of 14 feet or less on Jed Johnson, Rush, French, and Quanah Parker Lakes. Sailboats, and any size boat or motor are allowed on Lake Elmer Thomas with a no-wake restriction limiting the speed of the craft. Unpaved boats ramps are located at French, Quanah Parker, and Jed Johnson Lakes, and a paved boat ramp is located at Lake Elmer Thomas.

Camping

The Refuge offers year-round camping opportunities at three locations: Doris Campground, Fawn Creek Youth Campground, and in a designated area within Charons Garden Wilderness Area (Figure 3-10). The campground infrastructure is discussed in more detail in the *Facilities* section.

Doris Campground

Doris Campground is operated under contract and has 90 individual and 3 group sites. Single camp sites are open to the general public on a first come, first served basis, and the three group sites are available for reservation. Prime camping season extends from mid-March to late June, with a second peak occurring in September and October when the weather cools. Use has averaged over 31,370 campers per year for the last five years (USFWS 2009).

During the prime camping season and on holiday weekends, the demand for campsites far exceeds supply. Un-served campers are directed to the gateway communities for lodging or other area campground facilities at Lake Elmer Thomas Recreation Area, Lake Lawtonka, and Great Plains State Park.

Fawn Creek Youth Campground

The Fawn Creek Campground is reserved for organized youth groups and offers four group sites. No water or electricity is available. Public use of the youth group sites has steadily increased over the last 10 years, with an average of over 7,200 campers per year (USFWS 2009). During the prime camping season and on holiday weekends, the demand for campsites far exceeds supply. Un-served campers are directed to the Doris Campground group sites, gateway communities for lodging, or other area campground facilities at Lake Elmer Thomas Recreation Area, Lake Lawtonka, and Great Plains State Park.

Backcountry Camping

The Refuge offers the rare and unique opportunity for visitors to experience backcountry camping in a congressionally designated Wilderness – an opportunity not found anywhere else in the region. Up to 20 permits are issued weekly for a maximum stay of two nights in the Charons

Garden Wilderness Area. Public use of backcountry camping has increased over the last 10 years, with an average of almost 1,500 campers per year (USFWS 2009). As with other Refuge campsites, the demand for backcountry permits exceeds allowable limits during the prime camping season and on holidays.

Individuals or organizations that bring clients to the Refuge to camp and charge a fee or tuition for their service are required to have a Special Use Permit issued by the Refuge. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur (see *Commercial Recreation-Related Services*).

Hiking

The Public Use Area of the Refuge is open to trail and cross-country hiking unless otherwise posted. The Refuge offers hiking opportunities on 12 designated hiking trails in the Public Use Area and two designated hiking trails in the Charons Garden Wilderness Area totaling 17.7 miles in length (Figure 3-10). Trails range in length from less than one-half mile to six miles and range in difficulty from the accessible interpretive trail segment at Quanah Parker Lake to the 600-foot elevation climb up Elk Mountain. Additional hiking opportunities are available along service roads in the Public Use Area, around Mt. Scott, and along numerous local access trails to points of interest such as Osage Lake and the Cedar Planting.

A growing issue is the relationship between hiking group size and the impact on other visitors and on wildlife. Large groups (more than 15 people) tend to produce more noise, which degrades the quality of other visitors' experience and disrupts wildlife. There are currently no group size restrictions in place except for instructor-led climbing groups in the Charons Garden Wilderness Area.

Individuals or organizations that bring clients to the Refuge to hike and charge a fee or tuition for their service are required to have a Special Use Permit issued by the Refuge. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur (see *Commercial Recreation-Related Services*).

Picnicking

Picnicking has been a popular recreational pastime since the Refuge was designated in 1905. There are four general picnic areas with a total of 85 individual sites, and one group site with seven sites (Figure 3-10). The picnic areas receive a sporadic but high level of use on weekends and holidays.

Parking congestion occurs at the Sunset Picnic Area since it also serves as the trailhead for the Elk Mountain and Charons Garden trails. Group size and the accompanying disturbance (noise, congestion, and intimidation) can also be an issue in all picnic areas. This is a special concern in the Sunset Picnic Area, which borders and affects the Charons Garden Wilderness Area. There is currently no restriction on picnic group size.

Rock Sports

The granite domes, slabs, and boulders of the Wichita Mountains offer some of the finest rock sports in the southwest. Multi-pitch routes set in an undeveloped landscape provide the climbing community unparalleled opportunities to experience the wildlife and wild places of the Refuge. For the purposes of this CCP, rock sports include traditional climbing, rappelling, and

bouldering—activities that require specialized equipment such as ropes, harnesses, anchors, and pads. The more spontaneous bouldering and scrambling that many Refuge visitors engage in do not require any type of special gear and are considered hiking. Rock sports are allowed throughout the Public Use Area during daylight hours, with the notable exception of a prohibition against rappelling in the Narrows. The primary rock sport areas of the Refuge are located at Mt. Scott, the Narrows, and several locations within the Charons Garden Wilderness Area.

It is estimated that only a small fraction of all Refuge visitors engage in rock sports (fewer than 0.5 percent). A Compatibility Determination (CD) and a Finding of No Significant Impact for climbing were signed in 1995 (USFWS 1995), and the CD was revisited for the CCP process.

The Refuge works in collaboration with the Wichita Mountains Climbers Coalition (WMCC) to ensure that rock sports do not affect other user groups or the natural resource and to manage the installation and replacement of permanent anchors. A growing issue in the Public Use Area of the Refuge is the relationship between group size and the impact on other visitors and on wildlife. Large groups (more than 15 people) tend to produce more noise, which distracts from the quality of other visitors' experience and disrupts wildlife. There are currently no group size restrictions in place except for instructor-led climbing groups in the Charons Garden Wilderness Area.

Commercial or instructional operators who charge for their services while on Refuge lands are required to obtain an annual Special Use Permit from the Refuge Manager. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur. In 2010, there were seven Special Use Permits issued for rock climbing guides (see *Commercial Recreation-Related Services*).

3.5.3.3 Commercial Recreation-Related Services

All commercial entities who wish to conduct business on the Refuge must apply for a commercial Special Use Permit from the Refuge Manager. This includes instructional operators and guides who charge for their services while on Refuge lands. This requirement ensures that private businesses are not unfairly making a profit from public lands and provides a mechanism for the Refuge to regulate where and when commercial activities occur.

All public uses occurring on a national wildlife refuge must support the purpose of that refuge and the mission of the Refuge System. Members of the public can request permission for special activities or events not considered to be wildlife-dependent or supporting recreation uses. Before a Special Use Permit can be issued for a new activity or use, the proposal must pass a determination of appropriate use, be evaluated for resource impacts in a Compatibility Determination, and may need to be submitted for public review as required by the National Environmental Policy Act (NEPA). Special use activities and permits fall into three broad categories:

Refuge Management Special Uses. Administrative special uses would include research activities and specimen collections by universities. A Special Use Permit would continue to be required but not an appropriate use evaluation, a Compatibility Determination, or a NEPA document. In 2010, 13 permits were issued for research activities.

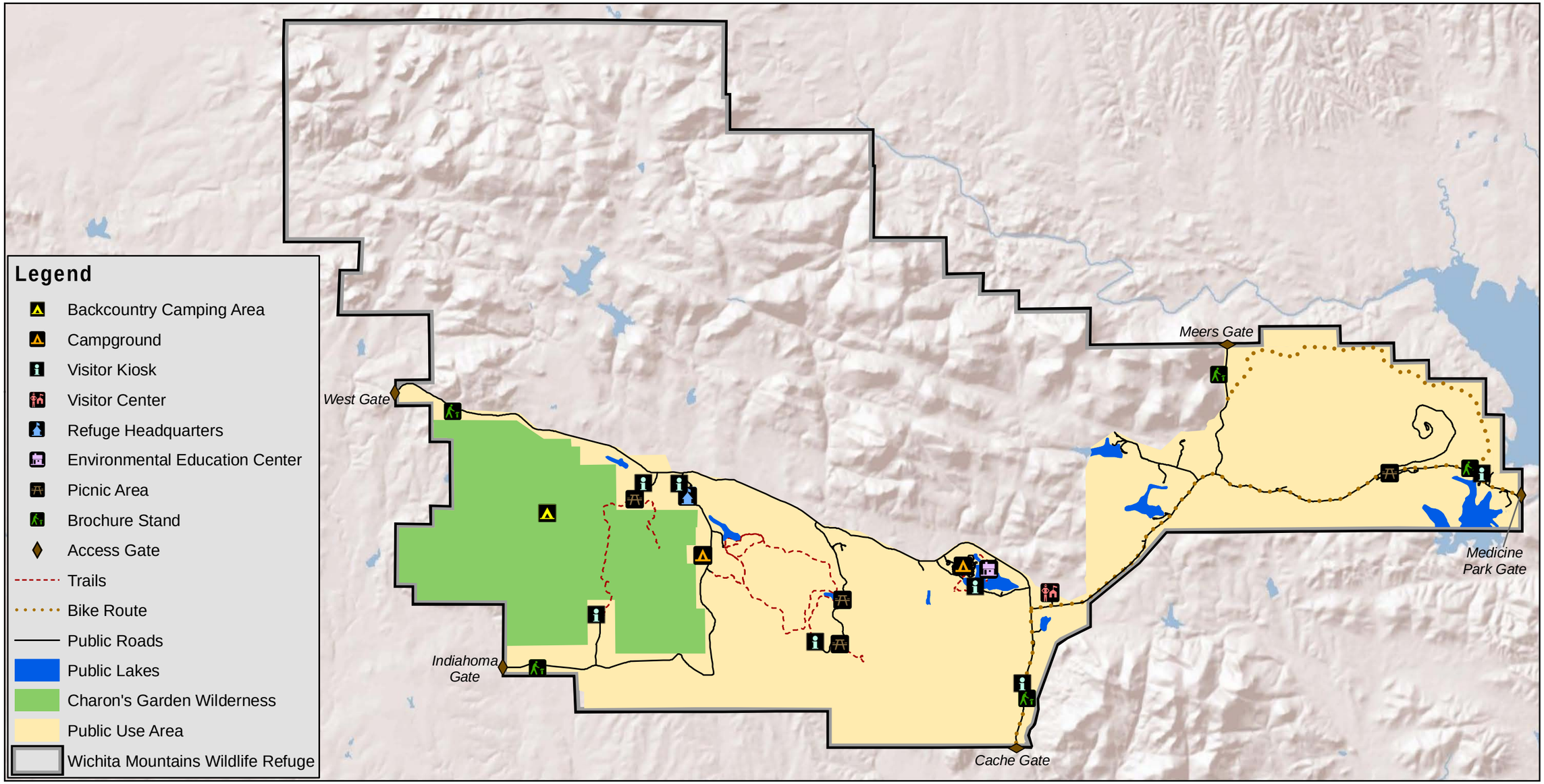
Economic or Commercial Special Uses. Economic or commercial special uses that support the purpose of the Refuge and mission of the Refuge System and that pass appropriateness, compatibility, and NEPA reviews can be allowed and permitted. There are currently 12 annual commercial Special Use Permits issued for year-round activity to commercial operators: seven

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Public Use Facilities



PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: January, 2011
BASEMAP: N/A
MERIDIAN: N/A
FILE: wmw_pub_facilities_1.19.11_shl

0 1 2 4 Miles

0 1 2 4 Kilometers

UTM ZONE 14
NAD 83

permits issued for rock climbing instruction in the Public Use Area and five permits issued for grazing of Refuge buffer lands (areas that fall outside the big-game boundary fence on the north and west boundaries of the Refuge). Other commercial activities may be occurring on the Refuge without prior approval through a Special Use Permit. Unpermitted but documented commercial activities include filming, photography, instruction for activities such as scuba and photography, fishing tournaments, and guided interpretive tours.

Non-Commercial Special Uses. Non-commercial special uses would include events for which the Refuge partners with local communities and organizations such as the Tour de Meers and the Tour of the Wichitas bicycle events. These events have been evaluated in an appropriate use review and a Compatibility Determination but historically have not been issued permits. The Refuge issued seven Special Use Permits for cultural (including tribal) and religious (Holy City) purposes in 2010.

3.5.3.4 Other Intermittent and Infrequent Recreation

The Refuge allows individual recreational pursuits such as jogging or strenuous walking, scuba diving, and amateur radio operation. Jogging or strenuous walking occurs throughout the Refuge's Public Use Area with the exception of areas specifically closed due to potential for wildlife disturbance. Scuba diving is allowed on Lake Elmer Thomas only and may occur without a Special Use Permit if the user(s) are not in an instructional class. Amateur radio operation occurs occasionally on the Refuge, particularly on Mt. Scott. This use is conducted under the terms of a Special Use Permit.

3.5.4 Public Use Access

See Figure 3-11.

3.5.4.1 Roads

Public Use

There are approximately 50 miles of paved and gravel roads (primarily State Highways 49 and 115) and 13 miles of unpaved roads in the Public Use Area (see Table 3-17). Most visitors arrive by motor vehicle, although bicycling, running, and hiking are becoming increasingly popular modes of travel on the Refuge. The Refuge also manages 27 parking areas, with space for approximately 700 vehicles that usually carry 2-4 passengers per vehicle.

Public and administrative access routes are managed as part of the Refuge Roads Program and fall under the funding and administrative domain of the Federal Highways Administration. Refuge roads are currently considered to be in good condition. A shoulder widening and re-paving project along State Highways 115 and 49 from the Cache gate to the Medicine Park gate is under way. Road related issues include increasing vehicle traffic as the regional population and Refuge visitation increases, increasing levels of non-motorized access (bicycles, runners, walkers), vehicle-wildlife collisions, and speed related accidents.

Management activities include routine road maintenance such as asphalt sealing and patching, re-paving, striping, roadside mowing and brushing, herbicide application to control the spread of invasive plants along the road right-of-way, culvert and bridge repair or replacement, road widening and straightening, shoulder expansion, blading and shaping, grading, and the placement and maintenance of directional, advisory, and regulatory signs.

Table 3-17. Refuge Public Roads

Road Name	Length	Surface Type
Hwy 49 East Side Road	7.9	Paved
Bat Cave Salt	0.2	Unpaved
Boulder Fire	1.0	Unpaved
Boulder Road	2.4	Paved
Burford Lake Road	0.2	Paved
Cedar	0.3	Unpaved
Crater Lake Road	0.1	Paved
Dog Run	0.5	Unpaved
Dog Run Hollow Road	0.1	Paved
Doris Campground Road A	0.9	Paved
Doris Campground Road B	0.1	Paved
Doris Campground Road C	0.3	Paved
Doris Campground Road D	0.2	Paved
Doris Campground Road E	0.5	Paved
Doris Campground Road EA	0.02	Paved
Doris Campground Road F	0.1	Paved
Environmental Education Road	0.4	Paved
Environmental Education Spur	0.02	Paved
Fawn Creek	0.5	Unpaved
French Lake Road	0.3	Paved
Historic Med Park Gate	0.1	Unpaved
Holy City Prairie Dog Town	0.5	Unpaved
Holy City Road	0.4	Paved
Indiahoma Road	6.1	Paved
Ingram House N Access	1.4	Unpaved
Jed Johnson Dam Road	0.3	Paved
Jed Johnson Tower Road	0.3	Paved
Lake Elmer Thomas Fishing Access	0.2	Gravel
Lake Lawtonka Fishing Access	0.2	Gravel
Lawton Lake Lawtonka Access	0.1	Unpaved
Lake Elmer Thomas Dam	0.4	Unpaved
Lake Elmer Thomas Dam	0.3	Gravel
Meers Road	1.9	Paved
Mt. Scott North	5.8	Unpaved
Mt. Scott North Spur	0.4	Unpaved
Mt. Scott Picnic Road A	0.7	Paved
Mt. Scott Picnic Road B	0.1	Paved
Mt. Scott Picnic Road C	0.04	Paved
Mt. Scott Picnic Road D	0.1	Paved
Mt. Scott Road	2.9	Paved
Osage Lake	0.1	Paved
Osage Lake Access	0.5	Unpaved
Post Oak/Treasure Lake Road	0.6	Paved
Prairie Dog Town	0.5	Unpaved
Quanah Dam Road	0.7	Paved
Quetone Point Overlook Road	0.1	Paved
Rush Lake Road	1.6	Paved
Six Mile Scenic Road (Cache Gate to Headquarters T)	7.6	Paved
Sunset east	0.3	Unpaved
Sunset picnic and trailhead	0.5	Paved
Volunteer recreational vehicle	0.1	Gravel
Westgate Road	4.5	Paved

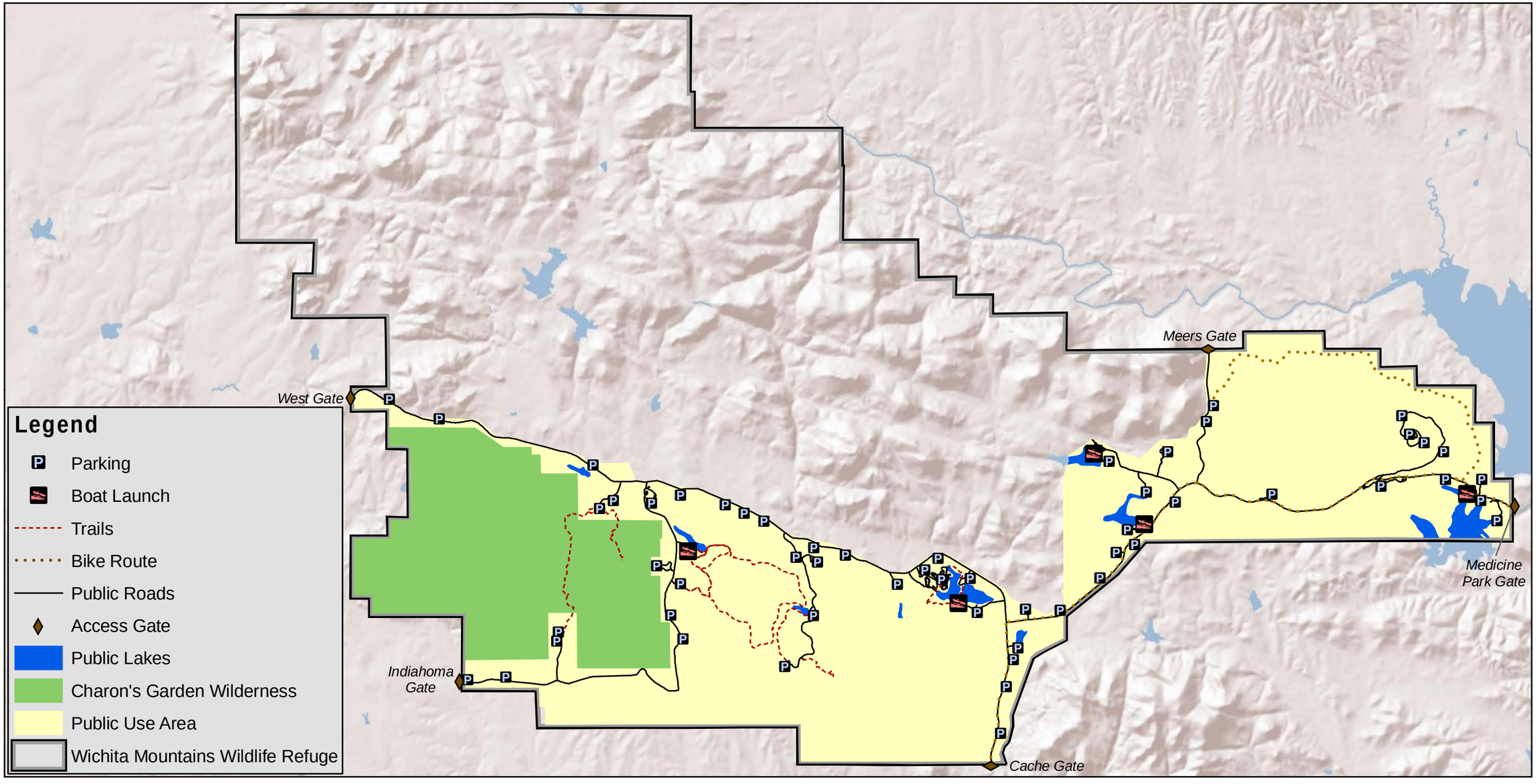
Source: Wichita Mountains Wildlife Refuge GIS database 2010

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Public Use Access



PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: May, 2011
BASEMAP: N/A
MERIDIAN: N/A
FILE: wmw_pub_access_5.17.11_shl

0 1 2 4 Miles

0 1 2 4 Kilometers

UTM ZONE 14
NAD 83

Refuge Administrative Roads

There are approximately 96 miles of unpaved administrative roads, mostly in the Special Use Area. Nearly 15 miles of the unpaved roads in the Special Use Area are accessible to the public via the Friends of the Wichitas' Refuge tours. See Figure 3-12. Refuge Roads.

3.5.4.2 Trails

The Refuge maintains 14 designated hiking trails scattered across the Public Use Area and Charons Garden Wilderness Area (Figure 3-10 and Figure 3-11). Trails range in length from less than one-half miles to six miles and ranges in difficulty from the fully accessible interpretive trail at Quanah Parker Lake to the 600-foot elevation climb up Elk Mountain (see Table 3-18). Two of the most heavily used trails on the Refuge are the Elk Mountain and Charons Garden trails, both of which are located in the Charons Garden Wilderness. The Dog Run Hollow Trail System encompasses four distinct loops (Bison, Longhorn, Elk, and Kite Trails) and was designated a National Recreation Trail in 1981. The Narrows trail is located near the Dog Run Hollow Trail System and accesses several popular climbing walls. Two trails offer easy, family-friendly walks of one mile or less: the Little Baldy trail and the trail linking the Environmental Education Center and Doris Campground, which includes a short, accessible section at the Environmental Education Center.

The designated trails on the Refuge were constructed by the Civilian Conservation Corps (CCC) in the 1930s and have received annual, although very minor, maintenance over the last two decades. Management activities are discussed in the Public Use Management Plan (1998) and include routine maintenance such as brushing, trail marking to improve wayfinding and to reduce trail braiding, and drainage control to reduce erosion and down-cutting. Because Charons Garden is a congressionally designated Wilderness area, all trail maintenance must be accomplished with hand tools to stay within the designation. The plethora of game trails and local access trails that visitors may encounter are not considered designated trails, are not signed, and do not receive scheduled maintenance.

Photo: USFWS

Table 3-18. Designated Hiking Trails

Trail Name	Mileage (miles)	Difficulty	Location
Bison	5.7	D	Public Use Area
Burford Lake	0.5	E	Public Use Area
Cedar Planting	0.3	E	Public Use Area
Charons Garden	2.4	M	Wilderness Area
Elk	0.6	E	Public Use Area
Elk Mountain	1.1	D	Wilderness Area
Jed Johnson Tower	1.0	E	Public Use Area
Kite	1.2	M	Public Use Area
Little Baldy	0.8	E	Public Use Area
Longhorn	2.4	E	Public Use Area
Osage Lake	0.4	E	Public Use Area
Narrows	0.7	E	Public Use Area
Quanah Parker EE	0.4	E	Public Use Area
Quanah Parker Interpretive Loop	.02	E	Public Use Area

D=Difficult; M=Moderate; E=Easy

Source: Wichita Mountains Wildlife Refuge GIS database

3.5.4.3 Dams and Waterways

Prior to Refuge establishment, there were no year-round sources of water on the Refuge except small springs. Today, the Refuge supports 107 impoundments that cover almost 750 acres. Most impoundments were constructed to provide a water source for wildlife and are fed by the numerous seasonal creeks that bisect the Refuge. Of these structures, 77 are earthen ponds less than one acre in size. The remaining thirty impoundments were constructed with concrete and range in size from one-quarter acre to 336 acres.

Most of the reservoirs were constructed during the Civilian Conservation Corps and the Works Progress Administration (WPA) period of the 1930s. The Lost Lake dam was completed in 1926, making it the oldest lake on the Refuge. The Refuge is responsible for dam safety and conducts monthly safety inspections and measures water levels. The Refuge conducts monthly dam safety inspections on Comanche, Elmer Thomas, Grama, Jed Johnson, and Rush Dams. The Lake Elmer Thomas dam went through a construction upgrade in 1993, and the Jed Johnson dam upgrade was completed in 2011.

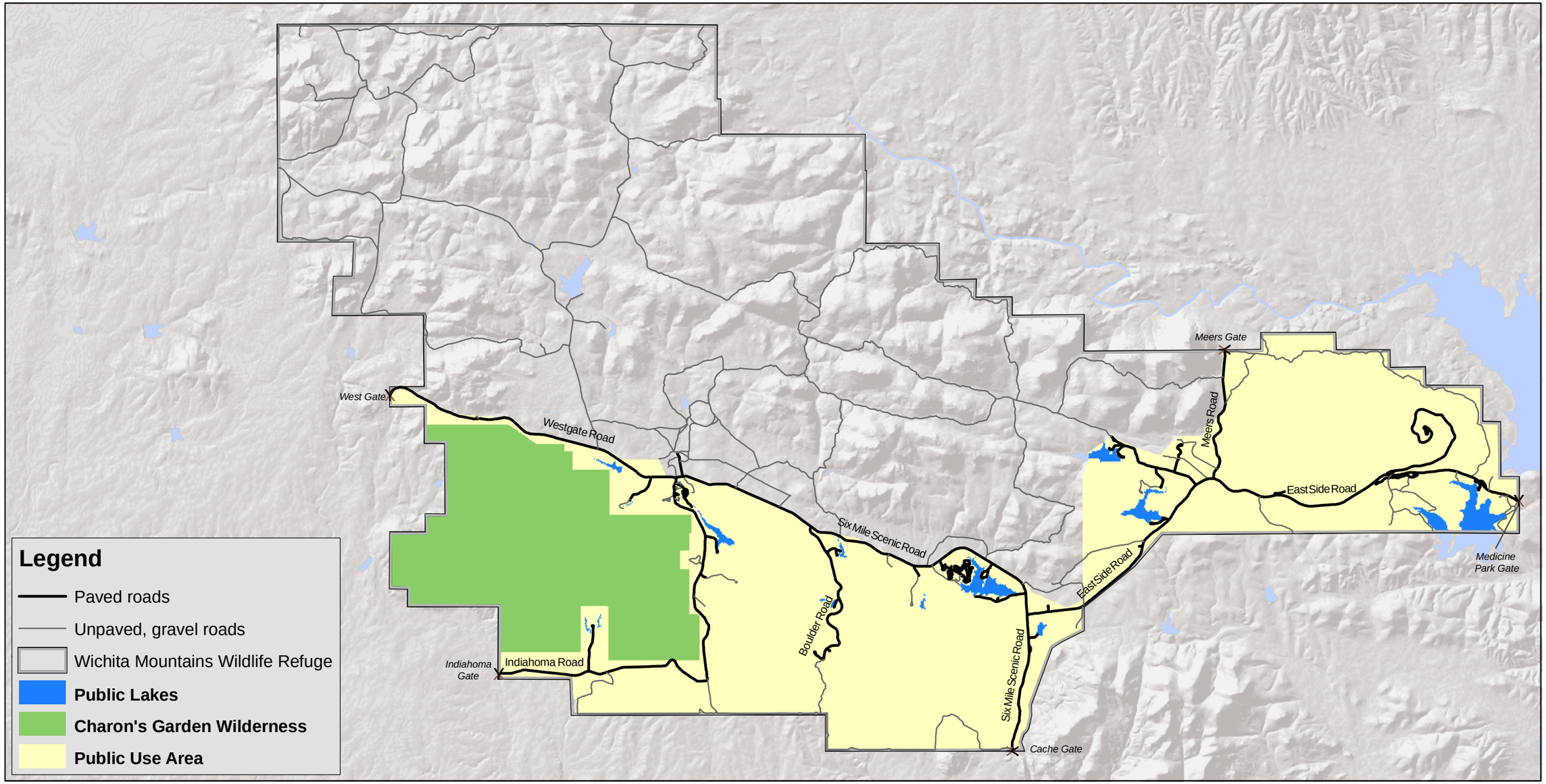
Of the impoundments, 41 (totaling 530 acres) are located in the Public Use Area and are open to the public for fishing, as are the streams that feed them. The Refuge also has boats ramps, a boat dock, and fishing piers to access fishing and boating opportunities. Boat ramps are located at French, Quanah Parker, Jed Johnson, Rush, and Elmer Thomas Lakes (see Table 3-19). State and Federal boating and fishing regulations apply.

U.S. Fish & Wildlife Service

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Refuge Roads



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Basemap: N/A
Meridian: N/A
File: CCP_roads.mxd

0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

UTM ZONE 11
NAD 83

Photo: USFWS

Table 3-19. Waterway Points of Access

Access Point	Material	Type
Elmer Thomas	concrete	boat ramp
Elmer Thomas	wood	boat dock/pier
French	dirt	boat ramp
Jed Johnson	dirt	boat ramp
Quanah Parker	concrete	fishing pier
Quanah Parker	dirt	boat ramp
Rush	concrete	boat ramp

Source: Wichita Mountains Wildlife Refuge GIS database

3.5.4.4 Fences

The Refuge supports 90.3 miles of big-game fence to manage bison and longhorn cattle. A majority of the boundary and interior fences were constructed by the CCC during the 1930s. The boundary fence consists of 51.5 miles, whereas the interior fence consists of 38.8 miles. Within the fence line, 119 gates exist, plus 61 swinging gate watergaps and 142 wire mesh watergaps. Both fences are composed on six-foot woven wire. The fences are in fair condition, but certain sections are in need of maintenance and/or replacement.

3.5.5 Facilities

See Figure 3-10.

3.5.5.1 Public Use Facilities

The Refuge maintains an array of public use facilities to support and encourage public use and to protect natural resource values. Among these facilities are the Visitor Center, Headquarters Office, two campgrounds, five picnic areas, 32 restrooms, the Environmental Education Center buildings, the Mt. Scott viewing area, the Bison and Longhorn Auction facilities, two entrance kiosks, four trailhead kiosks, and numerous directional, informational, and interpretive signs.

Headquarters

The 6,914-square-foot Headquarters building was built in 1969. The building is composed of red brick and granite stone. The facility houses the administrative offices for the Refuge staff and is open five days a week from 8 a.m. to 4:30 p.m.

Environmental Education Center

The Environmental Education Center buildings include a large classroom building (1,960 square feet) that was built in 1934, as well as a small classroom building (923 square feet) and an outdoor observation building (1,000 square feet), both built in 1937. The facility is available seven days a week for educational classes and meetings. The Environmental Education Center has a bathroom and storage building that houses a women's and a men's latrine.

Visitor Center

The 22,000-square-foot Visitor Center was open to the public in 1997. The Visitor Center is centrally located at the juncture of State Highways 115 and 49. The facility is open seven days per week, eight hours per day during the winter, and ten hours per day during the summer. Visitation averages about 150,000 people per year. The visitor can watch a short film about the history of the Refuge, follow exhibits that lead from prehistoric times to modern management, and enjoy taxidermy mounts of the most common species. Annual updates and maintenance occur for exhibits and other amenities. The information desk is staffed full time, and a bookstore is available to the public with an extensive variety of Refuge related items and books.

Campgrounds and Picnic Areas

The Refuge operates two developed campgrounds, Doris Campground and the Fawn Creek Youth Campground, and offers limited backcountry camping in the Charons Garden Wilderness Area (Figure 3-10). Potable water, a shower house, and a sanitary dump station are available in the campground. Campground use is discussed in the *Camping* section.

Picnic areas offer either individual or general parking areas, charcoal grills, and restroom facilities. Potable water is not available at picnic areas. Picnic area use is discussed in the *Picnicking* section.

Boulder Picnic Area

Boulder picnic area has 22 picnic sites. It also has two restrooms: Boulder Cabin and Central Boulder Picnic Area. The Boulder Cabin is available to groups by reservation only and has seven sites.

Doris Campground

Doris Campground is operated under permit and has 90 individual and 3 group sites. Single camp sites are open to the general public on a first come, first served basis, and the three group sites are available for reservation. Twenty-three of the individual camp sites have a recreational vehicle (RV) pad and electricity, 47 have an RV pad without electricity, and 20 are walk-in tent sites. Doris Campground has six restrooms.

Fawn Creek Campground

The Fawn Creek Campground is reserved for organized youth groups and offers four group sites. Fawn Creek Youth Campground has restrooms but no water or electricity is available.

Lost Lake Picnic Area

Lost Lake Picnic Area has 20 picnic sites. Picnic areas offer either individual or general parking areas, charcoal grills, and restroom facilities. Potable water is not available.

Mt. Scott Picnic Area

The Mt. Scott Picnic Area offers 27 picnic sites. Picnic areas offer either individual or general parking areas, charcoal grills, and restroom facilities. Potable water is not available.

Sunset Picnic Area

Sunset Picnic Area has 16 picnic sites and 2 restrooms. Picnic areas offer either individual or general parking areas, charcoal grills, and restroom facilities. Potable water is not available.

Bison and Longhorn Auction Facilities

The auction corral system (40,000 linear feet of corrals) and grandstand were built in 1987. The auction fee/registration building and the auction corral system and grandstand are open to the public twice a year—during the longhorn auction in September and the bison auction in October. The auction corrals are also used as a meeting/organizational place during the deer and elk hunts.

Photo: USFWS

Other Facilities

Elmer Thomas

The Lake Elmer Thomas fishing pier has a restroom.

Trailhead Kiosks

Trailhead kiosks are located at the north and south access points to the Charons Garden Wilderness trail, the south end of the Kite Trail, and the Little Baldy trailhead. Kiosks provide a display map, general Refuge information, climbing regulations, and any current condition information the hiker should know.

3.5.5.2 Administrative Facilities

The Wichita Mountains Wildlife Refuge administrative facilities are located in the west-central portion of the Refuge near the confluence of Headquarters Creek and West Cache Creek. The administrative buildings include the Headquarters Office building; Fire Office building; Fire Cache building; maintenance shop; vehicle, equipment, and material storage buildings, and nine residential quarters. The Visitor Center is located near the center of the Refuge and includes office space for the Public Use staff.

Corrals

There are three corral systems on the Refuge: the auction corrals, used during the bison and longhorn auctions; the Sulphur Flat corrals; and the Grace Mountain Corrals. Both the Sulphur Flat Corrals and Grace Mountain Corrals were constructed in 1989 and are composed of 10,000 linear feet of corrals. The Refuge horses, the biology staff equipment and vehicles, and sheds are located near the auction corrals. These buildings and equipment include the horse trailer and hay storage building, an open shed for vehicle storage, the corral area branding storage building, the horse barn, and the horse corral and horse round-pen.

Fire Office

The Fire Office is located adjacent to the Headquarters building and houses the administrative offices of many of the Refuge fire staff. The building was built in 1937 and is 1,998 square feet.

Maintenance Yard

The maintenance yard includes garages that store the Refuge vehicles and fire trucks, storage buildings for flammables and chemicals, and a maintenance shop. These buildings are as follows: 14-stall garage for fire vehicles, 12-stall garage for maintenance and fleet vehicles, old water storage tank house, well house, pole barn for heavy equipment, chemical storage building, flammable/oil storage building, powder storage north building, powder storage south building, vehicle and shop maintenance building, blacksmith shop/storage building, and the Fire Cache building.

Radio Repeaters

There are two radio repeaters on the Refuge: Mt. Scott radio repeater building which utilizes solar and wind power, and Bakers Peak radio repeater building, which uses electricity.

Residences

There are nine government quarters on the Refuge. The description of each residence is as follows:

- Residence 1 was built in 1938 and is 1,738 square feet.
- Residence 2 was built in 1934 and is 1,046 square feet.
- Residence 3 was built in 1937 and is 1,926 square feet. A garage is located by residences 3 and 4.
- Residence 4 was built in 1937 and is 1,926 square feet.
- Residence 5, the Buffalo Lodge, was built in 1913 and is 1,928 square feet. The Buffalo Lodge is on the National Register of Historic Places. A storage building is located behind the Buffalo Lodge.
- Residence 7 was built in 1973 and is 1,368 square feet.
- Residence 8 at Quanah Parker Lake next to the EE Center was built in 1937. The residence is 1,174 square feet. A garage is located next to the residence.
- Residence 11 is currently in use as a bunkhouse for volunteers and visiting researchers. It was built in 1932 and is 1,683 square feet. Also nearby are a storage building behind Residence 11, a garage north of residence 11, and a garage south of residence 11.
- Residence 12 was built in 1973 and is 1,381 square feet.
- Doris Campground concessionaire's trailer and Doris Campground fee booth were constructed in 2000, and the trailer is 1,200 square feet.
- The volunteer RV trailer pads house the seasonal volunteers. The volunteers also have use of the old horse barn/storage building.

Wareyard

The Wareyard located across from the Headquarters building includes the Wareyard lumber shed and the Wareyard metal storage building.

3.5.6 Administration

See CCP Chapter 5 for staffing, budget, partnerships, and other Refuge administration information.

3.5.7 Concerns Regarding Public Use on the Refuge

Increased Visitation

A major issue facing the visitor services program centers on the conflict inherent in managing for both public use and wildlife. Human use increases the occurrence of trash, vegetation trampling, excessive noise, wildlife harassment, and vehicle collisions with wildlife. As visitation increases, these impacts will increase without adequate planning and law enforcement.

Partnerships

As ecological and social pressure on the Refuge grow (invasive species, climate change, urban sprawl, and increased visitation), the need for strong partnerships becomes more apparent. Partnerships at the local, State, and Federal level can raise the awareness of emerging issues and

threats to the Refuge and can build the necessary social, political, and economic support to address them.

Special Uses

A variety of commercial and non-commercial special uses have been allowed to occur on the Refuge in the past without adequate documentation, evaluation, and administration. These activities range from weddings to organized fundraising events and include a variety of commercial activities such as scuba instruction, motor coach tours, photography, and outfitter services. All public uses occurring on a national wildlife refuge must pass a determination of appropriate use, be evaluated for resource impacts in a Compatibility Determination, and be submitted for public review as required by NEPA. All special uses must be authorized and administered under an annual Special Use Permit.

Public Use Conflict

Large groups of people have a negative impact on wildlife and lower the quality of the outdoor experience for other people. Zoning is needed to guide the long-term management of public facilities and to encourage a shift in human use patterns that reduces conflict between people and wildlife, as well as between various user groups.

Children in the Outdoors

A pervasive issue in our society today, and one of particular importance to the long-term health and survival of public lands, is the decline of children playing and recreating in the outdoors. This issue has been dubbed the "Last Child" issue in reference to a book on that subject by Louv (2005). Wild places and wildlife will be of little worth to the current generation if they don't explore the many ways a national wildlife refuge or other public lands can enrich the quality of their physical, psychological, and spiritual life. This issue is inherent in all of the public use activities on the Refuge.

Condition of Facilities

All public use facilities on the Refuge receive heavy use and require a significant investment of time and labor to maintain, repair, and upgrade. Both the use of the public facilities and the cost of maintaining them are expected to grow with increased visitation.

The demand for public use facilities already exceeds capacity during weekends and on holidays. The limited size and ecologically isolated nature of the Refuge necessitates that no more habitat be lost to development without very careful consideration.

Administrative facilities are also in need of significant maintenance, energy upgrades and expansion to accommodate the current staffing level.

3.6 Cultural Resource Management

The Refuge manages cultural resources according to law, regulation, and policy and protects known archaeological sites from human disturbance through active law enforcement. A Refuge-wide survey was conducted by the Museum of the Great Plains in 1964 and 1965, and five sites were identified as eligible and are listed on the National Register of Historic Places (NRHP). These include Boulder Cabin, Buffalo Lodge, the Cedar Creek Arrastra Site, Ferguson House, and Ingram House. Other facilities on the Refuge that (a) were evaluated but were not identified

as eligible for listing on the NRHP or (b) were not evaluated but that may be eligible for inclusion are maintained by the Refuge to preserve their historic character.

3.7 Special Management Areas

This section identifies special management areas designated within the Wichita Mountains Wildlife Refuge. In addition to Refuge status, the "special" status of lands within individual refuges may be recognized by additional designations (i.e., legislative or administrative). Special designations may also occur through 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. Wichita Mountains Wildlife Refuge contains the following special management areas (Figure 3-13. Special Management).

3.7.1 3.7.1 Wilderness Designations

Introduction

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 Wilderness 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."

Size

The 8,570-acre Wichita Mountains Wilderness Area, which was designated by Congress through Public Law 91-504 on October 23, 1970, consists of two units: the Charons Garden Unit (5,723 acres) and the North Mountain Unit (2,847 acres).

Naturalness

Naturalness is a measure of the overall composition, structure, and function of native species and ecological processes in an area. In contrast to the quality of being "untrammeled" as described in the Wilderness Act (i.e., uncontrolled or unrestricted by human actions), the natural condition of an area may sometimes be enhanced through purposeful human action (e.g., eradication of an invasive species).

The same high quality habitats found across the Refuge are also found in the Wilderness areas (see Chapter 3).

Opportunities for Solitude and/or Primitive and Unconfined Recreation

Solitude in the wilderness context is generally understood to mean freedom from sights, sounds, and other evidence of modern man (Landres et al. 2005). Encountering other people, hearing mechanized sounds, or seeing the lights of a distant population center are all examples of things that may negatively affect solitude opportunities; while remoteness, low visitor density, and vegetative or topographic screening are things that may enhance solitude opportunities. Primitive and unconfined recreation is a non-motorized, non-mechanized activity that occurs in an undeveloped setting and is relatively free from social or managerial controls. Primitive recreation is also characterized by experiential dimensions such as challenge, risk, and self-reliance.

The Charons Garden Wilderness is open to many public uses, including hiking-based opportunities for wildlife observation and photography, camping (with a permit), and rock sports. The Refuge also has a small amount of guided interpretive hikes and organized environmental education with a Leave No Trace message or theme. Two designated trails totaling about 3.5 miles are maintained by hand.

Temporary access restrictions are occasionally used to protect sensitive sites from harassment in the Charons Garden Wilderness Area. Nevertheless, as a result of increasing visitation pressures on Charons Garden Wilderness, the sense of solitude that is supposed to prevail there according to the intent of the Wilderness Act may continue to erode.

The North Mountain Wilderness Area has very limited public access for hunting, which is controlled by the Refuge due to its location inside the Special Use Area.

General Management of Designated Wilderness

Designated Wilderness is managed in accordance with the Wilderness Act of 1964; Service guidelines as found in the Refuge Manual (6 RM 8) and Part 610 of the Service Manual; and regional policy. Preserving the wilderness character of the area is the management focus for designated Wilderness. Certain activities are legislatively prohibited in Wilderness, including oil, gas, and other mineral leasing and most surface-disturbing activities. Section 4(c) of the Wilderness Act generally prohibits roads, commercial enterprises, motor vehicles, motorboats, other forms of mechanical transport, motorized equipment, the landing of aircraft, and structures and installations in Wilderness areas.

Service policy (610 FW 3) requires development of a Wilderness Stewardship Plan (WSP) for designated, proposed, and recommended Wilderness. The WSP guides the preservation, stewardship, and use of a Wilderness area, and it provides detailed strategies and implementation schedules for meeting the broader wilderness goals and objectives identified in this CCP. It also describes ongoing and needed monitoring and research, appropriate and compatible uses and associated determinations, and Minimum Requirement Analyses (MRAs) for Refuge management activities and commercial services. The MRA process involves determining if an activity should be conducted in the Wilderness area and if so, determining the minimum tool, which is the least intrusive tool, equipment, device, force, regulation, or practice determined necessary to achieve a management objective in Wilderness.

Charons Garden Unit

The Charons Garden unit (5,723 acres) is located in the southwestern portion of the Refuge, which lies in the Public Use Area. Access and public use of the Charons Garden unit is limited to nature observation, photography, and hiking. A limited number of backcountry camping permits are available for overnight visits into the Charons Garden unit. The ruggedness of the weathered granite mountainous terrain provides an experience of solitude, naturalness, and wildness.

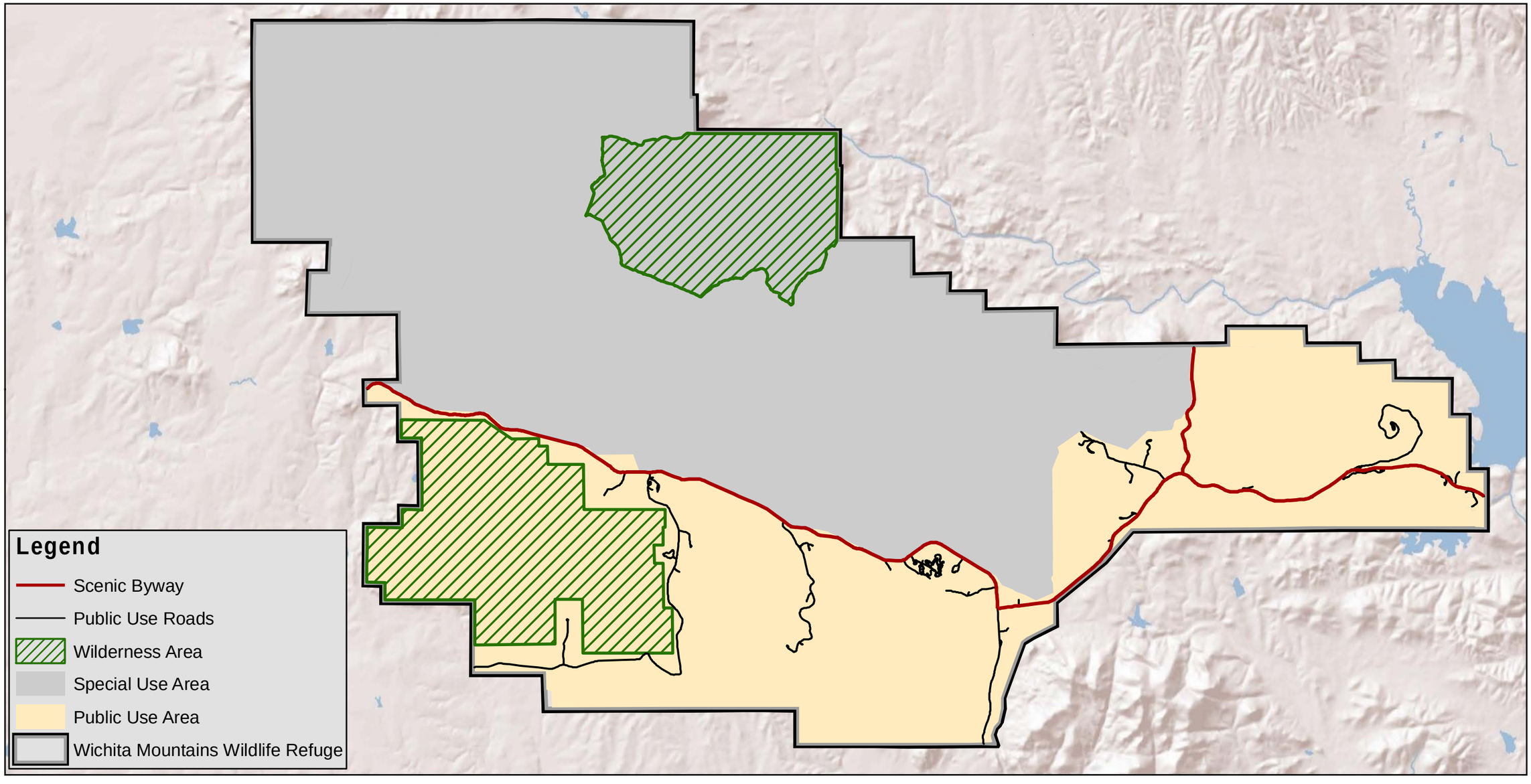
North Mountain Unit

North Mountain unit (2,847 acres) lies in the north-central part of the Refuge and is located in the Special Use Area. The North Mountain unit is also managed as a Research Natural Area (RNA), with access and use limited to mostly scientific and educational purposes.

Wichita Mountains Wildlife Refuge

Comanche County, Oklahoma

Special Management Areas



PRODUCED IN THE DIVISION OF REFUGE PLANNING
ALBUQUERQUE, NEW MEXICO
LAND STATUS CURRENT TO: 5/31/09
MAP DATE: January, 2011
BASEMAP: N/A
MERIDIAN: N/A
FILE: wmw_special_management_1.19.11_shl

0 1 2 4 Miles

0 1 2 4 Kilometers

UTM ZONE 14
NAD 83

Wilderness Review

Refuge planning policy 610 FW 4 requires a Wilderness Review as part of the comprehensive conservation planning process. After completing the inventory phase of the Wilderness Review in April 2010, the Wilderness Review Team determined that Wichita Mountains Wildlife Refuge contains 21 inventory units that meet the minimum criteria for a Wilderness Study Area (WSA). Through the study phase of the Wilderness Review, the Wilderness Review Team will evaluate these WSAs to determine their suitability for Wilderness management. The study phase will be performed after completion of the Comprehensive Conservation Plan. The Refuge's Wilderness Review is provided in Appendix E.

3.8 Administrative Designations

3.8.1 Research Natural Areas

Introduction

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 1,955,762 acres. The Service's Southwest Region administers 27 RNAs, totaling 59,940 acres on 14 national wildlife refuges. Wichita Mountains Wildlife Refuge contains one RNA: the North Mountain RNA, totaling 2,847 acres. This RNA is representative of the bluestem-gramma prairie habitat type.

General Management of RNAs

Service policy 8 RM 10.8 states that "RNAs must be reasonably protected from any influence that could alter or disrupt the characteristic phenomena for which the area was established." Activities on RNAs are limited to research, study, observation, monitoring, and educational activities that are nondestructive and non-manipulative, and those that maintain unmodified conditions. Policy encourages scientific use by responsible scientists and educators, providing their activities do not impair or threaten the features of the areas; public uses that contribute to modification of the areas should be discontinued or are expressly prohibited if such uses threaten serious impairment of research or education values. Use of RNAs should be governed by a natural area management plan that is compatible with established Refuge objectives.

3.8.2 Special Use Area

Size

The 34,932-acre Special Use Area covers the Wichita Mountains Wildlife Refuge's northwest half.

Purpose of Designation

The Special Use Area was administratively designated on the Refuge as an area with restricted public access intended to benefit natural conditions and allow for natural processes. The established area protects the natural features in over half of the Wichita Mountains Wildlife Refuge.

General Management of the Special Use Area

The northwest portion of the Refuge is reserved as a Special Use Area where public use is prohibited with the exception of facilitated hunts and interpretive tours. The Refuge reserves this area to facilitate the maintenance of an unencumbered habitat for resident and migrating wildlife; wildlife research; species management, including animal breeding; and species preservation activities, including efforts to protect the black-capped vireo.

3.8.3 Public Use Area

Size

The 24,088-acre Public Use Area covers the Wichita Mountains Wildlife Refuge's south and southeast portions.

Purpose of Designation

The Public Use Area was administratively designated on the Refuge as an area for public access facilities intended to benefit public use opportunities and promote awareness of the Refuge's wildlife and habitats.

General Management of the Special Management Area

The south-southeast portion of the Refuge is established as the Public Use Area where public use occurs through facilities that ease access and allow for opportunities for either wildlife-dependent recreation or other types of recreation that are supportive of those uses. The Refuge also works toward habitat and wildlife management in this area but still allows for public uses where appropriate and compatible (see Appendix F).

3.8.4 Wichita Mountains Scenic Byway

The Wichita Mountains Scenic Byway was designated in 2009 and includes the portions of State Highways 49 and 115 that bisect the Refuge. The designation was based on the outstanding natural and scenic qualities of the area and route. The National Scenic Byways Program is part of the U.S. Department of Transportation, Federal Highway Administration. The program is a grass-roots collaborative effort established to help recognize, preserve, and enhance selected roads throughout the United States.

3.8.5 Concerns Regarding Special Management Areas

Wilderness

The primary issue affecting the Charons Garden Wilderness Area is the high level of public use, which results in lack of solitude and loss of wilderness character. Most visitors are not aware of the wilderness designation and are seeking a hiking venue rather than a wilderness experience. Litter, large groups, and noise are frequent problems on weekends and holidays.

Special Use Area

Maintaining the Special Use Area as a closed area (with certain special exceptions) allows the Refuge to better manage habitat and wildlife in an undisturbed and more natural state. Continuation of the closure of this area is vital to ensuring that the Refuge can best maintain habitat and wildlife on the Refuge.

3.9 Administrative Areas

3.9.1 Holy City

The original Easter Pageant (a reenactment of the life of the Christian deity, Jesus Christ) started in Medicine Park, just east of the Refuge, in 1926 by Reverend Anthony Wallock. As the audience became too large for Medicine Park, Reverend Wallock was told of the current site on Federal land. The natural amphitheatre was attractive, and the Federal site could accommodate the increasing number of attendees. The construction project of the Holy City of the Wichitas was submitted by the Lawton Chamber of Commerce to the State Works Progress Administration (WPA) Administrator. Although first turned down, a powerful congressional delegation, including Senator Elmer Thomas and Congressman Jed Johnson, strongly supported the project. Construction was completed in 1934, and the first Easter Pageant was conducted on the Refuge in 1935. Subsequently, the Easter Pageant started on a Saturday night and culminated on the following Sunday morning (the Christian Easter holiday).

The Lawton Chamber of Commerce, as the sponsoring organization, signed a document at the request of the WPA, releasing the WPA from future maintenance of and/or responsibility for the site. A Special Use Permit was granted by the Department of Agriculture in 1935. Annual permits were issued in subsequent years until 1962, when a 20-year permit was issued. After expiration of that permit in 1982, a 10-year permit was issued. Since its expiration in 1992, annual permits have been issued for the pageant in 1993, 1994, and 1995 with the same stipulations as the 10-year permit, pending review of the current request.

In 1995, the Service analyzed four alternatives, including issuance of an annual Special Use Permit (No Action) and non-issuance of a permit (Denial). The preferred alternative selected was the issuance of a five-year permit with the option of renewal in five-year increments at the Refuge Manager 's discretion (not to exceed 25 years) for use of the 65-acre Holy City site. Granting the five-year permit will allow for frequent reassessment of the permit terms and conditions to adjust for environmental and other effects, whether those effects stem from use of the site by the Wallock Foundation or by other groups using this or another site. The five-year permit with renewal options is considered the most prudent means of protecting Refuge resources, while allowing the Wallock Foundation to maintain a regionally important cultural and historical event and associated facility. The Wallock Foundation accepted responsibility for the maintenance and liability for the buildings.

3.9.2 Treasure Lake Job Corps

The Treasure Lake Job Corps Center was established in 1965 on approximately 80 acres near the southwest corner of the Wichita Mountains Wildlife Refuge in Comanche County, Oklahoma, and was approved to be operated by the Bureau of Sport Fisheries and Wildlife. The purpose of the Job Corps was to provide disadvantaged youth an opportunity for education, vocational training, and useful work experience for the purpose of increasing their employment capability and preparing them for the responsibilities of citizenship. The Center is contracted for 236 students

(ages 16-24) and teaches 11 vocational training programs. The Treasure Lake Job Corps Center was administered by the U.S. Fish and Wildlife Service, but in 2006, administrative functions were transferred to the Bureau of Reclamation. Then on January 17, 2010, the administration and operation of the Center was transferred from the Bureau of Reclamation to the Forest Service.

All land, buildings, structures, fixtures at the Center remain under the jurisdiction of the Service as part of the Wichita Mountains Wildlife Refuge. The Forest Service is responsible for oversight of the operation of the Center, including utilities, materials, supplies, other goods or services, and administrative support required to carry out the Center functions, activities, and educational and vocational training programs. The Forest Service is also responsible for maintaining all lands and facilities at the Center in a condition that will assure the health and safety of students, employees, and the visiting public.

3.9.3 Concerns Regarding Administrative Areas

Holy City

Unlike other locations on the Refuge, Holy City is not directly managed by the Refuge, although it is viewed by the public and acts as a tourist attraction. The nature of visitation and the year-round operation of the Holy City affects the Refuge through invasive plant species, loud music, trash, and off-road parking in the prairie dog town. Two structures—the water tower and the statue—are highly visible. These structures are not consistent in keeping with the natural habitat and scenery of the Refuge.

Job Corps

Like the Holy City, Treasure Lake Job Corps is a source of invasive plant and animal species, especially feral cats and dogs. Litter from the garbage transfer area and the resident living area is often a problem on the Job Corps campus and the surrounding area. Refuge Law Enforcement officers often respond to a disproportionately higher level of calls to the Job Corps campus than to other areas of the Refuge. Alcohol and drug use, graffiti, littering, and inappropriate uses of the Wilderness area also occur.