SOUTHERN SHORTGRASS PRAIRIE ECOREGION

Approximately 22.2 million ac (9 million ha) or approximately 33% of the Southern Shortgrass Prairie Ecoregion occurs in New Mexico, where it is characterized by high plains plateaus broken by escarpments (TNC 2005). The shortgrass prairie was historically dominated by expanses of blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*). Within this ecoregion, two key terrestrial habitat types have been identified: The Western Great Plains Sandhill Sagebrush Shrubland, and the Western Great Plains Shortgrass Prairie (Fig. 5-6). The Western Great Plains Sandhill Sagebrush Shrubland hosts a variety of native wildlife. The lesser prairie-chicken (*Tympanuchus pallidicinctus*) and sand dune lizard (*Sceloporus arenicolus*) in particular have received much attention in this habitat type. Conservation efforts directed at the lesser prairie-chicken are excellent examples of collaborative efforts between federal, state and private land managers and environmental organizations.

The Western Great Plains Shortgrass Prairie links grasslands from Canada to Mexico and is an important system to grassland-associated species. Grassland bird populations have been declining across the North American continent for over the last 50 years (Knopf 1994, Peterjohn and Sauer 1999, Vickery and Herkert 2001) and populations of keystone species in this habitat type have been eliminated or considerably reduced.

Species of Greatest Conservation Need

The Southern Shortgrass Prairie Ecoregion is home to 30 Species of Greatest Conservation Need (SGCN), excluding arthropods other than crustaceans (Table 5-8). Twenty-nine SGCN associated with this ecoregion occur in the Western Great Plains Shortgrass Prairie. Only 15 SGCN occur in the Western Great Plains Sandhill Sagebrush Shrubland. Of the 30 SGCN, 13 (43%) are considered vulnerable, imperiled, or critically imperiled both statewide and nationally. Approximately 10 (33%) species are nationally secure, but are considered vulnerable, imperiled, or critically imperiled in New Mexico, and 7 species (23%) are secure both statewide and nationally. Conservation status codes (abundance estimates) for each SGCN are provided in Appendix H. Additional conservation concerns for taxa associated with this ecoregion are addressed in 1) Statewide Distributed Ephemeral Habitats and Perennial Tanks, 2) Statewide Distributed Riparian Habitats, or 3) Watersheds with aquatic key habitats sections.

Conservation efforts directed at the lesser prairie-chicken are excellent examples of collaborative efforts between federal, state and private land managers and environmental organizations.

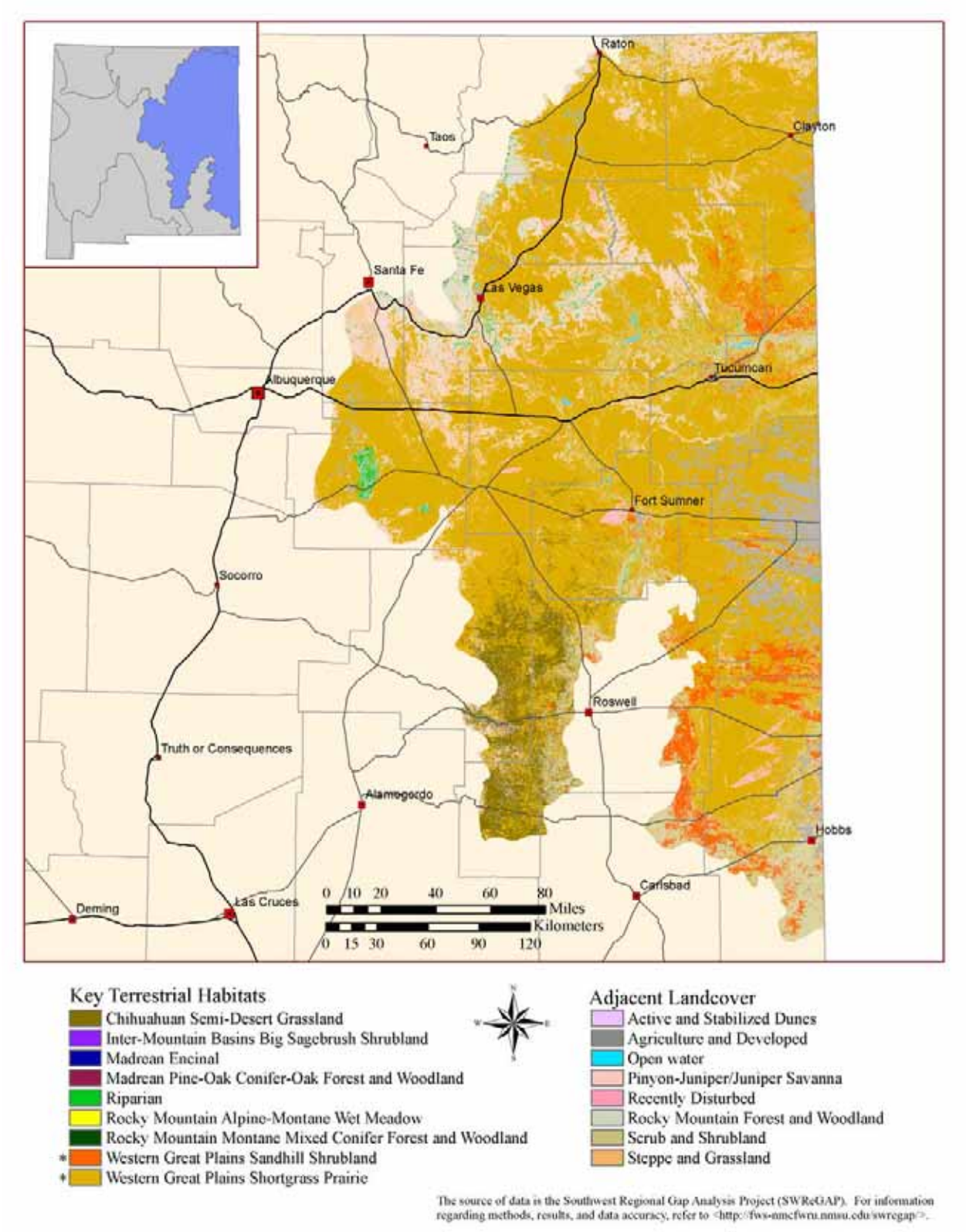

Figure 5-6. Key terrestrial habitats in the Southern Shortgrass Prairie Ecoregion in New Mexico. Adjacent land cover types are given to provide an indication of vegetation surrounding key habitats. Key habitats are designated with an asterisk (*).

Table 5-8. Species of Greatest Conservation Need in the Southern Shortgrass Prairie Ecoregion in New Mexico.

Common Name	Western Great Plains Sandhill Sagebrush Shrubland	Western Great Plains Shortgrass Prairie
Birds		
Bald Eagle		X
Golden Eagle		X
Scaled Quail		X
Sandhill Crane		X
Mountain Plover		X
Long-Billed Curlew		X
Wilson's Phalarope		X
Sprague's Pipit		X
Baird's Sparrow		X
Grasshopper Sparrow		X
Ferruginous Hawk	X	X
Lesser Prairie-Chicken	X	X
Mourning Dove	X	X
Burrowing Owl	X	X
Loggerhead Shrike	X	X
Mammals		
Least Shrew		X
Arizona Myotis Bat		X
Prairie Vole		X
Black-Tailed Prairie Dog	X	X
Swift Fox	X	X
Mule Deer	X	X
Amphibians		
Western Chorus Frog		X
Plains Leopard Frog		X
Tiger Salamander	X	X
Reptiles		
Ornate Box Turtle	X	X
Collared Lizard	X	X
Sand Dune Lizard	X	
Milk Snake	X	X
Western Diamondback Rattlesnake	X	X
Desert Massasauga	X	X

Western Great Plains Sandhill Sagebrush Shrublands

Habitat Condition

The Western Great Plains Sandhill Sagebrush Shrublands are a mosaic of hummock and coppice dunes dominated by sand sage (*Artemisia filifolia*) and/or shinnery-oak (*Quercus havardii*) with a mixed-grass composition. Grasses consist largely of little bluestem (*Schizachyrium nees*), sand bluestem (*Andropogon hallii*), sand dropseed, and needle and threadgrass (*Stipa comata*). Soils in this habitat type are typically deep and well drained. They extend to a depth of 60 in (1.5 m) or more and have surface textures consisting of fine aeolian sands or loamy aeolian sands. Their water holding capacity is low and they are highly erodible. They become unstable dunes when organic residues and vegetative cover are removed (Natural Resource Conservation Service 1997; Ecological Site Description, Sandhills). Soils in the dune areas are also sharply drained sands and at the southwestern and southern boundaries of the type, the soils grade to a shallower calcic hardpan overlaid by shallow sand. These shallow soil sites are dominated by buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*) and threeleaf sumac (*Rhus trilobata*) or littleleaf sumac (*Rhus microphylla*).

The Western Great Plains Sandhill Sagebrush Shrublands habitat is considered climax vegetation (Rosiere 2000); although there is anecdotal evidence suggesting that the dense stands of shinnery-oak and sand sage on the high plains of eastern New Mexico are a result of intense grazing pressure. Continuous year-round and season-long summer grazing (April through October) have reduced the once dominant cool season grasses such as New Mexico feathergrass (*Stipa neomexicana*), needle and thread grass, and Indian ricegrass. Large portions of this habitat type are now dominated by sand dropseed, sand sage, yucca (*Yucca elata*), and threeawn species (*Aristida* spp.) that have lower cover and productivity values (Natural Resource Conservation Service 1997, Ecological Site Description, Sandhills).

Season-long summer use by livestock has also reduced the amount of forbs and warm season grasses found in this habitat type and their contribution to the production of organic litter on the soil surface. The vulnerability of the sand dunes to wind erosion and blowouts has subsequently increased. Shrub components of this type remain important in terms of nutrient cycling and ecosystem function where sagebrush, shinnery-oak, and subdominant shrubs trap and accumulate particulates and nutrients around their bases forming “islands of fertility” (Schlesinger and Pilmanis 1998). This continuing accretion of organic matter and nutrients is especially important to insects and ultimately to the rodents, herpetofauna, and birds that consume them (Whitford *et al*. 1998).

Problems Affecting Habitats or Species

Analyses based on the scientific literature and NMDGF staff opinion suggests that abiotic resource use, habitat conversion, and consumptive biological use are the primary factors affecting Western Great Plains Sandhill Sagebrush Shrublands. The Nature Conservancy (2004) noted that fire and grazing practices constitute processes that most affect this system. Oil and gas development are also agents of change within this land cover type.

Since the early 1950s, southerly portions of this habitat have been altered by agricultural conversion and practices, oil and gas development, improper livestock grazing practices, and brush and chemical weed control activities (Jackson and DeArment 1963, Hunt and Best 2004). Habitats of the lesser prairie-chicken and sand dune lizard have subsequently diminished in extent and become increasingly fragmented.

Agriculture and Livestock Production
Improper grazing practices and increased agricultural production in the Western Great Plains Sandhill Sagebrush Shrublands may lead to habitat fragmentation and loss by promoting conditions favorable for shrub encroachment and through increased infrastructure development (roads, fences, subdivisions, agricultural lands) (Dinerstein *et al.* 2000). The effects of these land management activities are compounded by extended drought periods and altered hydrological functions. Altered fire regimes, resulting from both fire suppression and the removal of fine fuels by domestic grazers and wildlife, also promote the establishment of both woody vegetation and introduced non-native species.

Energy Development and Exploration
Oil and gas exploration and extraction activities typically have localized effects on sand dune lizard populations. Sias and Snell (1998) reported an inverse relationship between well density and abundance of sand dune lizards. Oil and gas development activities reduced populations approximately 40% when compared to control areas that were approximately 200 m distant from a well pad (Sias and Snell 1996). In addition to lowering population numbers, oil and gas development activities may cause further habitat fragmentation and loss through associated clearing, roads, and increased vehicular traffic (Dinerstein *et al.* 2000).

Invasive and Non-Native Species
Soil Bank programs of the 1950s and 1960s introduced non-native weeping and Lehmann lovegrasses (*Eragrostis curvula*, and *E. lehmanniana*) to the Western Great Plains Sandhill Sagebrush Shrublands to stabilize topsoil. In the mid-1980s, the Conservation Reserve Program (CRP) was initiated to reduce the number of cultivated grain fields. At this time, lovegrasses were again planted. Older established plantings of weeping lovegrass are particularly persistent if grazed or burned. In some instances, range fires in these established grass stands have become more frequent, further reinforcing the persistence of this fire-adapted non-native grass. Displacement of native vegetation by non-native grasses has reduced the value of this habitat to SGCN.

Chemical Shrub Control
Shinnery oak is a management concern when it grows in dense stands, particularly where it comprises 80% of the annual plant production and competes with native grasses and forbs for water and nutrients (Pettit 1986). Shrub control in the 1980s made use of the herbicide tebuthiuron and nearly 40,500 hectares (100,000 acres) of BLM lands in southeastern New Mexico were treated to reduce shinnery oak and to increase grass production for livestock grazing (Massey 2001).

The effects of tebuthiuron upon lesser prairie-chicken populations are uncertain. Lesser prairie-chickens may use stands of dense shinnery oak. However, they prefer areas dominated by

perennial mid and tall-grass species (Cannon and Knopf 1981). While Johnson (2000) found a greater concentration of lesser prairie-chickens nesting in areas that were not treated with herbicide, Olawsky and Smith (1991) reported similar densities of lesser prairie-chicken on herbicide treated and untreated areas.

The sand dune lizard appears to be confined to areas of active sand dunes vegetated by shinnery oak and to the uneven sandy terrain and wind-eroded blowouts of their peripheries (Degenhardt and Jones 1972, Degenhardt and Sena 1976, Sena 1985, Snell *et al*. 1994, NMDGF 1996). Reductions of 70 to 94% in the presence of sand dune lizards were observed in the Mescalero Sands of Chaves County where tebuthiuron was used to control shinnery oak. Some treated sites contained no lizards despite the presence of suitable populations in adjacent untreated pastures. Snell *et al*. (1993, 1994) and Gorum *et al*. (1995) noted that populations have declined since the initiation of tebuthiuron treatments and that following treatment, sand dune lizard habitat can be considered either lost or greatly reduced in quality.

The persistence of herbicide and other environmental contaminants and their effects on fish and wildlife have been reviewed by Schmitt and Bunck (1995) and Glaser (1995). However, the magnitude and effects of herbicide use in the Western Great Plains Sandhill Sagebrush Shrublands has not been well assessed (Mac *et al*. 1998).

Off-Road Vehicles
The frequency and intensity of recreational off-road vehicle use has increased in the Western Great Plains Sandhill Sagebrush Shrublands, but to an unknown extent. While the impacts on the sand sagebrush shrublands are poorly understood, off-road vehicle use may destroy and fragment habitat, cause direct mortality of wildlife, or alter wildlife behavior through stress and disturbance (Busack and Bury 1974, Brattstrom and Bondello 1983).

Information Gaps

There is little literature on the ecology of the Western Great Plains Sandhill Sagebrush Shrublands. Current literature is primarily based on habitat needs for lesser prairie-chickens and sand dune lizards. Information gaps that limit our ability to make informed conservation decisions are outlined below.

- The intensity, scale, extent, and causes of Western Great Plains Sandhill Sagebrush Shrublands fragmentation and knowledge of lands that may present opportunities for mitigation are unknown.

- Little is known on prescribed grazing management practices that maintain appropriate levels and compositions of native grasses in this habitat type.

- The response of SGCN to human disturbance is poorly understood.

- Little is known on the distribution, abundance, and population trend for several of the SGCN associated with Western Great Plains Sandhill Sagebrush Shrublands.

- Specific knowledge is needed regarding factors affecting SGCN, especially the environmental conditions or thresholds limiting populations.

- Consistent habitat health (ecological sustainability and integrity) and condition descriptions and protocols are needed to inform land management decisions for the Western Great Plains Sandhill Sagebrush Shrublands is lacking.

- The extent to which invasive and non-native species alter Western Great Plains Sandhill Sagebrush Shrublands and limit populations of SGCN is unknown.

- Short and long-term affects of land management practices or uses (such as energy exploration and development, grazing systems, invasive species and vegetation management) are unclear. Availability and distribution of this information would allow land managers to make more informed conservation decisions.

- The extent to which off-road vehicle use is impacting Western Great Plains Sandhill Sagebrush Shrublands SGCN populations is unknown.

Research, Survey, and Monitoring Needs

Research, survey, and monitoring needs for the Western Great Plains Sandhill Sagebrush Shrublands are primarily derived from our perception of factors that influence the integrity of this habitat type and associated information gaps. Research, survey, and monitoring needs that enhance our ability to make informed conservation decisions are outlined below.

- Investigate the extent to which land use activities (such as livestock grazing timing, intensity, and duration, human development, gas, oil, and water exploration, off-road vehicle use, and non-native species invasions) fragment and alter habitats in relation to patch size, edge effect, and use by SGCN. The desired product understands how land use intensity and frequency of disturbance affect SGCN.

- Conduct research to enhance our knowledge of vertebrate and invertebrate community structures, fundamental natural history requirements, and ecological relationships in the Western Great Plains Sandhill Sagebrush Shrublands. Life history and habitat needs of most of the SGCN and their use of this habitat type are poorly understood.

- Examine how global and regional climate change coupled with resource uses affect community and ecosystem-level dynamics in the Western Great Plains Sandhill Sagebrush Shrublands.

- Investigate the use of tebuthiuron for reducing shinnery oak cover and investigate SGCN response to spatially diverse applications of herbicides.

- Identify thresholds of shinnery oak and/or sand sage cover or density at which reproduction and brood success of lesser prairie-chickens and sand dune lizards are reduced or eliminated.

- Evaluate the effectiveness and utility of fire in controlling shrubs and restoring and maintaining shinnery oak habitats in Western Great Plains Sandhill Sagebrush Shrublands.

- Identify grazing management practices that maintain appropriate levels and compositions of native grasses within shinnery oak habitat types.

- Evaluate the influence of Conservation Reserve Program (CRP) activities on landscape structure and SGCN habitat.

- Evaluate the impacts of easements permitting unimpeded access to Lesser Prairie-Chicken Areas (PCAs).

- Determine the effects oil and gas development induced habitat fragmentation upon the population dynamics and persistence of SGCN.

- Identify nationally standardized indicators that could be used for inventory and monitoring the health of the Western Great Plains Sandhill Sagebrush Shrublands.

Desired Future Outcomes

Desired future outcomes for the Western Great Plains Sandhill Sagebrush Shrublands include:

- Western Great Plains Sandhill Sagebrush Shrublands persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land management uses with reduced resource use conflicts.

- Reclamation standards that ensure habitat integrity and function are established and implemented for land use practices that alter habitat condition.

- Partnerships are established with NRCS and landowners to restore CRP and abandoned croplands to functioning native shrub/grasslands.

- Land management plans for federal and state lands include sustainable grazing practices that are fully implemented and complied with.

- Natural fire cycles are restored in this habitat.

- Herbicide treatments employed to control shinnery oak result in structurally diverse habitats.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Work with land management agencies, private land managers, and the agriculture industry to identify and promote grazing systems on rangelands that ensure long-term ecological sustainability and integrity and are cost effective for livestock interests.

2. Collaborate with federal and state agencies, and private landowners in restoration of the Western Great Plains Sandhill Sagebrush Shrublands. Restoration actions may include: mitigation and reduction of impacts related to oil and gas development; restoration and return of abandoned croplands to native shrub/grassland; managed sustainable grazing on public lands that accounts for SGCN habitat concerns; and active research programs on the use of tebuthiuron coupled with controlled burns for reducing shinnery oak cover.

3. Work with federal and state agencies, private landowners, and oil and gas development companies to rehabilitate abandoned well pads and access roads. Rehabilitation efforts may include the removal of caliche and/or reseeding with a mix of native species with supplemental watering.

4. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and the Western Great Plains Sandhill Sagebrush Shrublands outlined in the Research, Survey, and Monitoring Needs section.

5. Work with federal, state, and private agencies and institutions to create financial incentives for habitat maintenance and improvement on private lands and conservation easements.

6. Work with willing landowners to increase the size and connectivity of designated prairie-chicken areas.

7. Work with federal, state, and private agencies, institutions and landowners to provide financial incentives to maintain tracts of native vegetation, as an alternative to converting land to agriculture or urban development.

8. Collaborate with federal and state agencies to designate areas for off-road vehicle activities in areas that avoid disturbance to SGCN or their habitats and to discover ways to mitigate such disturbance where it occurs.

9. Encourage Conservation Reserve Program land managers to promote use of native seed mixes for soil stabilization and increased value to SGCN.

10. Encourage land managers to establish and maintain a diverse mosaic of interspersed patches of shinnery oak and residual bunchgrasses.

11. Work with federal, state, and private agencies and institutions in developing an education and public awareness program that emphasizes the fragility of this habitat type and its importance to a wide array of species.

Western Great Plains Shortgrass Prairie

Habitat Condition

The majority of literature associated with the Western Great Plains Shortgrass Prairie describes the entire land cover type and is not specific to New Mexico. Thus, the information presented in this section should be considered within this broad context.

The current state of the shortgrass prairie is a product of both evolution and historical land use. Prairies in North America evolved with frequent disturbances, including fire, drought, grazing, and storms (Kaufman *et al.* 1988). The combined impact of these factors created a wide-reaching mosaic environment that accommodated a rich diversity of plant and animal species (Collins and Barber 1985, Plumb and Dodd 1993). Several authors (Anderson 1982, Plumb and Dodd 1993, Rickets 1999) suggest that the dominant, sod-forming perennial grassland plants of this region evolved under intensive grazing by wild ungulates. As a result, woody vegetation was suppressed and grazing tolerant plants flourished. The disturbance created by foraging bison (*Bison bison*), pronghorn (*Antilocapra Americana*) and elk (*Cervus elaphus*) significantly affected vegetation, nutrient cycles, soil structure and composition and, as some areas were heavily grazed and others left untouched, created a diversity of habitat conditions across the prairie. It is estimated that prairie dogs occupied roughly 154,441 mi^2 (400,000 km^2), or 20% of the available shortgrass and midgrass prairies (Benedict 1996). Their presence altered vegetation, created open habitat, and modified soil, nutrient, and energy cycles. Their burrowing turned the soils and allowed annual forbs and grasses a foothold in the dominant perennial grassland. This action sustained prairie biodiversity. Wild bison have since been extirpated and prairie dogs significantly reduced as the prairie ecosystem has been converted, fragmented and otherwise altered (Benedict 1996) by human activities.

Despite the shortgrass prairie's apparent evolutionary adaptation to grazing, livestock use has been an agent of change. Much of this effect occurred in the late 1880s when livestock numbers peaked and shortgrass prairies were grazed beyond their sustainable use. Barbour (1988) stated, "When the shortgrass prairie was first grazed by domestic livestock, the original grasses persisted probably because of their low stature and natural resistance to grazing pressure. As abuse occurred (due to improper grazing use) and the grasses declined, weedy perennial species of cacti (*Opuntia* spp.), snakeweed (*Gutierrezia sarothrae*) and yucca (*Yucca)* increased. Invader annuals have come from the brome (*Bromus* spp.), Russian thistle (*Salsola tragus*), barley (*Hordeum spp*.), and fescues (*Festuca* spp.) genera." The frequency of natural fires

declined first due the resultant reduction in fuels and later by intentional suppression. The compound effects fostered an invasion of shrubs into some historic shortgrass prairie areas (Brown 1982).

As for the current state of the shortgrass prairie, Dick-Peddie (1993) wrote, "The succession from plains-mesa grassland to juniper savanna will probably continue in many areas of the state. At the lower (drier) boundaries of plains-mesa grassland, many acres of grama grassland will become desert grassland, and much of the present desert grassland will become Chihuahuan or Great Basin desert shrubland. On many sites, these successional trends, which range users consider deterioration of grassland, were set in motion early in this century; subsequent range management efforts are unlikely to halt, let alone reverse the trend."

Agricultural cultivation has also affected the shortgrass prairie. The dust bowl of the 1930s originated in southeastern Colorado, southwestern Kansas, and the panhandles of Texas Oklahoma, and New Mexico, where the shortgrass prairie was plowed for dryland farming. These fields remain discernable today, decades after cultivation ceased and they were abandoned to re-vegetate naturally. The persistence of threeawn species in these areas may be the result of plowing-induced changes in the soil that require long periods of time for restoration and a reduction in soil phosphorus may leave the site more suitable for these species than for the climax plants that are so slow to reestablish (Barbour and Billings 1988). Where irrigation augments natural precipitation, high levels of crop production were and continue to be attained (Stoddart 1975). This observation is supported by Ricketts *et al.* (1999) who states, "Much of the area was severely affected by largely unsuccessful efforts to develop dryland cultivation. The dustbowl of the 1930s was centered in this ecoregion and stands as proof of the unsuitability of this area for farming, unless heavily irrigated."

The Ogallala Aquifer underlies approximately 174,000 mi^2 (4.5 million ha) across parts of South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas. Approximately 10,000 mi^2 (0.3 million ha) of the Ogallala Aquifer occurs in New Mexico. It is the primary source of water for agriculture and urban development on a large portion of those lands defined as the Western Great Plains Shortgrass Prairie. Over eons of geologic time, changing climatic conditions created erosion patterns that have separated the Ogallala Aquifer from its original supply of water and formation materials. The southern portion of the formation in Texas and New Mexico is now a plateau. Natural recharge to the Ogallala Aquifer now occurs primarily through the percolation of precipitation to the water table. Playa lakes play a significant role in recharging the aquifer. Natural recharge from land surface area outside the playa basins is possible and probable in rare events when the top 4-5 ft (1.2 to 1.5 m) of soil is wetted to capacity by irrigation or unusual precipitation. Water can also move from the surface into the aquifer through the micropores created by worms, burrows, and decayed plant roots.

In the 1930s, people began to realize the potential of the vast aquifer that lay beneath them and by 1949 about 2 million acres of the southern high plains were irrigated. Water removal for irrigation increased almost four fold from 1949 to 1980. Since water pumped from the aquifer is not replaced at the same rate that it is removed, the water table began to recede. Gleick (1993) reported that the aquifer is suffering an overdraft rate that is approximately 140% above recharge rate.

Problems Affecting Habitats or Species

Analyses of factors that influence habitats indicated that biodiversity in portions of the Western Great Plains Shortgrass Prairie may be influenced by habitat conversion, abiotic resource use, pollution, and non-consumptive biological uses.

Energy Exploration and Development
The most common form of mineral extraction in the Western Great Plains Shortgrass Prairie is oil and gas. Oil and gas leasing on federal lands follow standards established by the Bureau of Land Management and are subject to further regulation by the New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division. The infrastructure of oil and gas extraction (pads, roads, pipelines pump stations, compressors) and related human activities has resulted in habitat fragmentation, disturbance from traffic for hauling and maintenance activities, point source pollution, noise, and habitat conversion.

Wind energy facilities are not yet widespread in the Western Great Plains Shortgrass Prairie. However, as alternative sources of energy become more important and as related technology improves, there is potential for more wind energy sites to be developed. Wind-generated electrical energy is environmentally friendly in that it does not create air-polluting and climate-modifying emissions. Nevertheless, wind turbines, particularly in the large arrays, can significantly affect wildlife and habitats. Roads and pads fragment habitat and bats and birds (particularly raptors) are killed in collisions with the moving blades of the wind turbines. Lighted wind towers greater than 200 ft (61 m) tall have the same potential as communication towers to attract and kill night-flying migratory birds and bats, although collisions occur with moving blades rather than guy wires (NMDGF 2004b).

Pollution
Agricultural chemicals, livestock and dairy groundwater contamination, and solid waste have the potential to create localized pollution in portions of the Western Great Plains Shortgrass Prairie. The current sources, extent, and effects of such pollution, however, remain to be determined.

Habitat Fragmentation
The implications of habitat fragmentation have lead many ecologists to identify the process as one of the most significant factors affecting biodiversity (Harris 1984, Wilcox and Murphy 1985, Noss and Cooperrider 1994). Saunders *et al.* (1991) note that urban expansion, agriculture, power lines, and road construction have accelerated over the past century, subdividing the natural world into disjunctive remnants of native ecosystems embedded in a matrix of anthropogenic land uses. Such development has caused large areas of formerly contiguous landscapes to become increasingly fragmented and isolated (Finch 2004).

Some authors (Barbour and Billings 1988, Ricketts 1999) believe that the primary factor affecting the Western Great Plains Shortgrass Prairie is conversion to agriculture. Areas that were once difficult to cultivate may now be used due to new technologies such as four-wheel drive tractors, precision farming, herbicides, and irrigation. Urban and commercial developments also contribute to the loss of native vegetation, increased water use, ground water depletion, and increased erosion through soil compaction and runoff concentration. These

activities may ultimately increase clearing, roads, and vehicular traffic. Subsequent habitat fragmentation may affect SGCN within the shortgrass prairie by: 1) reducing the habitat area for interior species, 2) imposing barriers to dispersal, colonization, and maintenance of meta-population dynamics, 3) altering demographic and genetic structure as a result of isolation and small population size, 4) increasing habitat edge and thereby facilitating predation, parasitism, and invasion by exotic species or habitat generalists, 5) altering biotic relationships, such as plant-pollinator interactions, and 6) altering the physical environment, ecological processes, and natural disturbance regimes (Finch 2004).

Grazing Practices

Grazing practices on the Western Great Plains Shortgrass Prairie are varied and may potentially alter grassland habitats, depending on the grazing management practices used. The intensity and length of the grazing season, in combination with extant environmental conditions has the potential to change plant species composition, percent of vegetative cover, and physical habitat structure (Bock *et al.* 1984). Modifications to vegetative parameters affect associated fauna and subsequent changes in plant diversity and structure affect animal diversity. Sites subjected to improper grazing practices, those that reduce long-term plant and animal productivity (Wilson and MacLeod 1991), may lose faunal specialist species that may or may not be replaced with generalist species (Bock *et al.* 1984). Execessive livestock grazing may also encourage shrub encroachment through the reduction in grasses and the competition they provide for woody plant seedlings (Humphrey 1958), although Mack and Thompson (1982) reported that grazed areas in the shortgrass prairie tend to be recolonized by predominantly native plants. The extent and specific effects of historic and current grazing practices on the biodiversity of the Western Great Plains Shortgrass Prairie are poorly understood.

Loss of Keystone Species

The capacity of the Western Great Plains Shortgrass Prairie to sustain its composition, structure, and ecological processes has been diminished through the loss or reduction of keystone species and subsequent alteration of the historic disturbance regimes of which they were part. Free-ranging bison have been extirpated from the shortgrass prairie and domestic livestock have been introduced. Bison foraged on different plants than cattle (Peden *et al.* 1974, Plumb and Dodd 1993) and their removal of vegetation often created patches of open habitat that differed in vegetative composition from the surrounding ungrazed areas (Benedict 1996).

Disturbance from cattle grazing practices tends to produce a more uniform effect and construction of water developments for livestock has expanded grazing into historically inaccessible areas. Prairie dogs also created large patches of habitat that differed from the surrounding landscape and provided essential habitat for many other animals (Benedict 1996). Although they still exist on the landscape, prairie dogs are much reduced and are susceptible to elimination from poisonings and outbreaks of sylvatic plague (*Yersinia pestis*) (Miller *et al.* 1994). Further, their potential to maintain viable and resilient populations and to sustain the biodiversity they create is in doubt because, according to Pizzimente (1981), colonies are becoming isolated and genetic exchange through immigration is becoming less likely.

Fire Management

The current state of the shortgrass prairie is a product of both evolution and historical land use. Prairies in North America evolved with frequent disturbances, including fire, drought, grazing, and storms (Wright and Bailey 1982, Kaufman *et al.* 1988, Anderson 1990, Debano *et al.* 1998, Rickets *et al.* 1999). Fire frequency and intensity appear to be synchronized by climate conditions, physiographic, edaphic and vegetation conditions (Daubenmire 1968, Swetnam and Betancourt 1990). Historically, grassland fires were caused by lightning and Native Americans (Payne 1982, Bahre 1985). However, widespread cultivation, excessive livestock grazing, and transportation corridors reduced standing biomass of fine fuels, and fragmented the landscape in prairie ecosystems, which decreased grassland fire frequency and intensity (Ford and McPherson 1996, 1998, Hart and Hart 1997, DeBano *et al.* 1998, Frank *et al.* 1998). These changes virtually eliminated fire as an ecological process and have had a negative overall impact to prairie ecosystems (Engle and Bidwell 2000). Brockway *et al.* (2002) investigated the effects of growing season and dormant season prescribed fire on the Kiowa National Grasslands in New Mexico. Their results indicated that prescribed fire in shortgrass prairie during the growing season appears to place the plant community at a greater risk of decline. Conversely, prescribed fires during the dormant season provided several immediate benefits to the plant species present and increased species diversity. However, Launchbaugh (1964, 1972) believes fire in the shortgrass prairie to be detrimental because it lowers forage yields by diminishing the number of soil tillers and reduced water infiltration and soil moisture. The roll of fire in sustaining the shortgrass prairie has been well researched, yet results are conflicting (Stewart 1951, Launchbaugh 1973, Wilson and Shay 1990, Knoft 1994, Umbanhowar 1996, Kirchner 1997, McDaniel *et al.* 1997, Knopf 1998, Ford 1999, 2001; among others). Thus, this topic warrants additional attention by research scientists.

Invasive Species

Invasive species can be plants, animals, or other organisms (such as microbes). The US Department of State (1999) cautioned that introduction of non-native species has the potential to cause economic, environmental, or human health problems. Many ecologists have acknowledged the problems caused by invasion of non-native species into communities or ecosystems and the associated negative effects on global patterns of biodiversity (Stohlgren *et al.* 1999). Once established, invasive species have the ability to displace native plant and animal species, disrupt nutrient and fire cycles, and alter the character of the community by enhancing susceptibility to additional invasions (Cox 1999, Deloach *et al.* 2000, Zavaleta *et al.* 2001, Osborn *et al.* 2002). Lee (1999) and Mitchell (2000) noted that the invasion of non-native species is similar to a biological wildfire that is rapidly spreading at a rate of 200 acres/hour across the west. Little is known about the extent or specific effects of invasive species in the Western Great Plains Shortgrass Prairie, making it difficult to assess related problems and develop effective interventions.

Military Maneuvers

Various military entities use portions of air space over the Western Great Plains Shortgrass Prairie for tactical air training. These maneuvers involve low level fights resulting in noise issues in specific areas and may impact specific species. During the breeding season these low-level flights may impact the lesser prairie-chicken, especially while males are vocalizing on leks.

Recreational and Off-Road Vehicle Use
The *New Mexico Statewide Comprehensive Outdoor Recreation Plan* (Henkel 2004) identified a moderately increasing trend in off-road vehicle use in New Mexico from the 1996-2001. Recreational off-road vehicle use has also increased in the Western Great Plains Shortgrass Prairie along rivers, lakes and streams, wherever public access is available. Federal and state owned acreages not adjacent to water sources also receive highly dispersed and varied recreational use. On the Kiowa National Grasslands there is a single developed campground at Mills Canyon adjacent to the Canadian River. Problems associated with dispersed recreation include indiscriminate driving and parking on interior, undeveloped roads or in roadless areas. The specific effects of recreation and off-road vehicle use on the Western Great Plains Shortgrass Prairie are unknown. However, off-road vehicle travel can cause damage to soils and vegetation (Holechek *et al.* 1998) and impact wildlife by destroying and fragmenting habitat, direct mortality of wildlife, or altered behavior through stress and disturbance (Busack and Bury 1974, Brattstrom and Bondello 1983).

Information Gaps

Given the expansiveness of shortgrass prairie in New Mexico, and the variety of potential factors that may alter shortgrass prairie habitats, it is not surprising that there are a number of information gaps related to this ecoregion and SGCN. Information gaps for the Western Great Plains Shortgrass Prairie are outlined below.

- Minimum biotic and abiotic measurements to insure habitat sustainability and integrity have yet to be defined and current land cover habitat condition and SGCN information is lacking.

- Specific range or ecological condition information for the shortgrass prairie is lacking. The Bureau of Land Management (BLM) uses a standardized methodology to estimate ecological condition on BLM managed lands. However, much of the Western Great Plains Shortgrass Prairie is not federally managed, and there are no estimates of ecological condition on private lands or consistent information between the US Forest Service and BLM.

- The intensity, scale, extent, and causes of shortgrass prairie fragmentation are largely unknown.

- Information is needed on the specific effects of current grazing practices on the biodiversity of the Western Great Plains Shortgrass Prairie.

- Information is needed on grazing management practices necessary to sustain appropriate levels, composition, and structure of native grasses in the shortgrass prairie.

- Short and long-term affects of land management practices or uses (such as oil, gas, and wind development, prescribed grazing systems, lovegrass monocultures on CRP lands, invasive species and shrub encroachment management) are unclear.

- There is little information on the abundance, distribution, and trend information for most of the SGCN and the environmental conditions or thresholds that limit populations of SGCN.

- The response of SGCN to human disturbances is unclear.

- Information on the effects of habitat fragmentation and requirements for wide-ranging SGCN is lacking.

- A central clearinghouse for biological information on the Western Great Plains Shortgrass Prairie and SGCN associated with this habitat type is needed to allow all agencies and private landowners to access information to inform development of conservation actions.

- The extent to which invasive and non-native species invade and alter the Western Great Plains Shortgrass Prairie and limit populations of SGCN and the appropriate interventions is poorly understood.

- The extent to which off-road vehicle use is impacting Western Great Plains Shortgrass Prairie SGCN populations is unknown.

- There is a poor understanding of the sources of pollution and the extent to which pollution is altering the Western Great Plains Shortgrass Prairie.

- Our understanding of the role of fire in sustaining the Shortgrass prairie and appropriate fire management protocols is poor.

Research, Survey, and Monitoring Needs

Research, Survey, and Monitoring Needs for the Western Great Plains Shortgrass Prairie are primarily derived from our perception of factors that influence the integrity of this habitat type and associated information gaps. Research, survey, and monitoring needs that would enhance our understanding of this habitat type and SGCN are outlined below.

- Investigate the extent to which land use activities (such as livestock grazing timing, intensity, and duration; human development; gas, oil, and water exploration; off-road vehicle use; and non-native species invasions) fragment and alter habitats in relation to patch size, edge effect, temporal needs, and use by SGCN. This information is important in understanding how different land use intensities and frequencies of disturbances affect SGCN.

- Conduct research to enhance our knowledge of vertebrate and invertebrate community structures, fundamental natural history requirements, and ecological relationships within the Western Great Plains Sand Shortgrass Prairie. Life history and habitat needs of most of the SGCN and their use of this habitat type are poorly understood.

- Investigate the extent of the impact that wind energy facilities have on avian and bat populations. Studies should also define important migration/movement corridors for these taxa on both a landscape and local area scale.

- Identify the impacts of fire, grazing, and drought on the Western Great Plains Shortgrass Prairie. Optimal studies would define the roles, mechanisms and impacts via manipulative field-based experiments. Methods that mimic natural disturbance regimes and consider economic impact are valuable to land managers.

- Investigate the impacts, benefits, or detrimental effects of habitat restoration practices (such as shrub removal, reseeding, fire, etc.). Millions of dollars are made available annually through various grant programs to federal, state, and private land managers. All restoration methods should be closely evaluated and suggested modification of these practices made available to land managers.

- Investigate and recommend invasive species early detection protocols, methods to estimate vectors and pathways of potential invasive species, and effective interventions.

- Define spatial and temporal requirements of wide-ranging SGCN. The identification of habitat corridors is essential for long-term conservation planning.

- Investigate and monitor black-tailed prairie dog populations in terms of rates of town growth, establishment and decline, and the effects of plague and control efforts on prairie dog populations (Johnson 2003).

- Investigate options for developing a centralized database of information regarding the condition of Southern Shortgrass Prairie Ecoregion habitats. This database would allow for the identification of data gaps, comparing differing methodologies of data collection, and encourage the implementation of national monitoring standards.

- Investigate the roll of natural fire and prescribed fire in maintaining grassland habitats.

Desired Future Outcomes

Desired future outcomes for the Western Great Plains Shortgrass Prairie are focused upon achieving ecological sustainability and integrity of this land cover type. Desired future outcomes include:

- Western Great Plains Shortgrass Prairie persists in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land management uses with reduced resource use conflicts.

- Economic and social ties to the Western Great Plains Shortgrass Prairie are recognized and accommodated in the quest for ecological sustainability in order to garner public support and recognition of the importance of the shortgrass prairie in New Mexico.

- Large natural areas are designated and managed for dispersal, genetic mixing of populations, and to accommodate wide-ranging species.

- Partnerships have been established to identify and implement conservation planning, education, and technical, reclamation, survey, or research projects that ensure the future integrity and functionality of the Western Great Plains Shortgrass Prairie for SGCN.

- Consistent grassland reclamation standards are established that ensures future habitat integrity and functionality and are adopted by private landowners, counties, municipalities, and federal and state land management agencies.

- Land management plans for federal and state lands include implementation and compliance with sustainable grazing practices.

- A fully funded comprehensive statewide noxious weed control planning committee and program is established. Colonization of noxious weed species is stopped and extant weed populations are controlled or eliminated.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Collaborate with federal and state agencies and private landowners to ensure the ecological sustainability and integrity of the shortgrass prairie. Methods may include: establishing conservation agreements, agency memorandum of understanding, or land acquisition projects.

2. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide the information about SGCN and the Western Great Plains Shortgrass Prairie outlined in the Research, Survey, and Monitoring Needs section above.

3. Work with land management agencies, private land managers, and the agriculture industry to identify and promote grazing systems on rangelands that ensure long-term ecological sustainability and integrity and are cost effective for livestock interests.

4. Support actions that create incentive based or voluntary partnerships with private landowners to conserve and manage their properties to sustain SGCN.

5. Work with federal, state, and private agencies and institutions to identify sources of funding for long-term conservation of SGCN and to maintain tracts of native vegetation as an alternative to converting land to agriculture or urban development. Funding should create incentives for habitat maintenance and improvement on private lands and conservation easements. Employ existing incentive programs to facilitate partnerships with private landowners. These programs include the Conservation Reserve Program (CRP), Landowner Incentive Program, Wetland Reserve Program, Wildlife Habitat Incentives Program, State Wildlife Grants, Private Stewardship Grants Program, Safe Harbor Agreements, and Environmental Quality Incentive Program.

6. Initiate centralization of available data regarding condition of the shortgrass prairie should for the purpose of identifying data gaps, to compare current methodologies of data collection and to encourage the implementation of national monitoring standards.

7. Collaborate with federal and state agencies and affected publics to identify legislative actions, land acquisition, and easement access management protections for the Western Great Plains Shortgrass Prairie. Practices to consider for legislative attention include the regulation of toxicants to control prairie dogs, removal of prairie dogs, regulation of exploitative activities such as rattlesnake roundups, and off-road vehicle management.

8. Counter habitat fragmentation by working with federal, state, and private land managers to modify management of roadside rights-of-way and fencerows to provide useful habitat and corridors that allow wildlife to travel between existing patches of prairie.

9. Collaborate with federal, state, and private agencies and institutions in gaining support for additional open space lands, mitigation mechanisms, and management strategies.

10. Monitor and respond appropriately to proposals to modify programs, such as CRP, that support conservation management and incentives to preclude conversion of wildlife habitat to alternative uses.

11. Identify and pursue opportunities to develop agreements among state and federal agencies that clearly outline responsibilities regarding conservation of shortgrass habitats and resident SGCN.

12. Promote grassland restoration that encourages increased native herbaceous cover.

13. Collaborate with federal and state agencies and affected publics to develop management practices that would increase populations and nesting success of avian species in the shortgrass prairie. Possible management practices may include: 1) maintaining a network of grassland reserves that can act as refugia for grassland birds during periods when agricultural needs reduce the amount of land available to them; 2) maintaining areas that are not grazed or burned for at least three years to provide habitat for species that require taller, denser vegetation; 3) minimize early-season mowing or cutting of hayfields or fields on lands in the CRP; and 4) aggregate fields in CRP to create a few large grasslands.

14. Assist with implementation *of New Mexico's Strategic Plan for Managing Noxious Weeds, 2000-2001* (http://www.swstrategy.org/library/NM Strategic Plan for Managing weeds.htm). New Mexico's weed management strategy is intended to complement the objectives of agency and inter-agency weed management strategies, including the BLM, *Partners Against Weeds* action plan, the US Forest Service, *Stemming The Invasive Tide*, and the national interagency strategy, *Pulling Together*), as well as *the National Invasive Species Management Plan*, but with a specific focus on opportunities and problems in this state.

15. Collect and distribute information regarding assessments of the short and long-term effects of land management practices such as prescribed fire, habitat rehabilitation. These practices include methods of converting lovegrass monocultures on CRP lands, habitat restoration, shrub removal, wind generation site interventions, oil and gas reclamation, and invasive species management, and grazing systems.

16. Provide a general guide for landowners to restore and maintain a mosaic of vegetative structure that provide habitat for a variety of native wildlife, particularly SGCN, and which contribute to landscape-level habitat restoration.

17. Provide or facilitate public education and wildlife viewing opportunities to raise awareness and appreciation of grassland SGCN, gain support for additional open space lands, build mechanisms for mitigation, and develop management strategies.

18. Work with entities planning development of wind energy facilities in the Western Great Plains Shortgrass Prairie to reduce the potential for adverse effects on SGCN.