U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Tympanuchus pallidicinctus*

COMMON NAME: lesser prairie-chicken

LEAD REGION: 2

INFORMATION CURRENT AS OF: April, 2010

STATUS/ACTION

___ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
___ Non-petitioned
_X_ Petitioned - Date petition received: October 5, 1995
_ 90-day positive - FR date: July 8, 1997
_ 12-month warranted but precluded - FR date: June 9, 1998
_ Did the petition request a reclassification of a listed species? NO

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? YES
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? YES
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
Higher priority listing actions, including court-approved settlements, court-ordered statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for the species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current CNOR (*http://endangered.fws.gov/*) provides information on listing actions taken during the last 12 months.

___ Listing priority change
Former LP: ___
New LP: ___

Date when the species first became a Candidate (as currently defined): June 9, 1998

___ Candidate removal: Former LPN: ___
___ A – Taxon is more abundant or widespread than previously believed or not subject to

the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on biological vulnerability and threats to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Birds; Phasianidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Colorado, Kansas, New Mexico, Oklahoma, Texas

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Colorado, Kansas, New Mexico, Oklahoma, Texas

LAND OWNERSHIP: Currently, about 95 percent (61,163 square kilometers (sq km); 23,615 square miles (sq mi)) of occupied range is privately owned; 4 percent (3,251 sq km; 1,255 sq mi) is managed by the Bureau of Land Management (BLM) in New Mexico, and the U.S. Forest Service (USFS) in Colorado, Kansas, Oklahoma, and New Mexico; 1 percent is State owned land.

LEAD REGION CONTACT: Sarah Quamme, (505) 248-6788

LEAD FIELD OFFICE CONTACT: Ecological Services, Tulsa, Oklahoma, Kenneth Collins; (918) 382-4510; Ken_Collins@fws.gov

BIOLOGICAL INFORMATION

Species Description

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) (LEPC) is a species of prairie grouse endemic to the southern high plains of the United States, commonly recognized for its feathered feet, stout build, ground-dwelling habit, and mating behavior. Plumage of the lesser prairie-chicken is characterized by a cryptic pattern of alternating brown and buff-colored barring, and is similar in appearance and mating behavior to greater prairie-chicken (*T. cupido pinnatus*), although somewhat lighter in color. LEPC body length ranges from 38-41 centimeters (cm) (15-16 inches (in)) (Johnsgard 1973, p. 275). Males have long tufts of feathers (pinnae) on the sides of the neck that are erected during courtship displays. Males also display brilliant yellow supraorbital eyecombs and reddish esophageal air sacs during courtship displays (Copelin 1963, p. 12; Johnsgard 1983, p. 318).

LEPC are polygynous (a mating pattern in which a male mates with more than one female in a

single breeding season) and exhibit a lek mating system. The lek is a place where males gather to conduct a competitive mating display. Male LEPC gather to display on leks at dusk and dawn beginning in late February through early May (Copelin 1963, p. 26; Hoffman 1963, p. 730; Crawford and Bolen 1976, p. 97). Dominant older males occupy the center of the lek, while younger males occupy the periphery and compete for central access (Ehrlich *et al*. 1988, p. 259). Females arrive at the lek in early spring; peak hen attendance at leks is during mid-April (Copelin 1963, p. 26; Haukos 1988, p. 49). The sequence of vocalizations and posturing of males, often described as "booming, gobbling, yodeling, bubbling, or duetting," has been described by Johnsgard (1983, p. 336) and Haukos (1988, pp. 44-45).

After mating, the hen selects a nest site, usually 1 to 3 km (0.6 to 2 mi) from the lek (Giesen 1994a, p. 97), constructs a nest, and lays an average clutch of 10-14 eggs (Bent 1932, p. 282). Nests generally consist of bowl shaped depressions in the soil (Giesen 1998, p. 9). Nests are lined with dried grasses, leaves, and feathers and there is no evidence that nests are reused in subsequent years (Giesen 1998, p. 9). Second nests may occur when the first attempt is unsuccessful. Incubation lasts 23-26 days and young leave the nest within hours of hatching (Coats 1955, p. 5). Broods may remain with females for 6-8 weeks. Giesen (1998, pp. 2-9) provides a comprehensive summary of LEPC breeding behavior, habitat, and phenology (relationship between periodic biological phenomena and climatic conditions).

Home range varies both by sex and by season. Males tend to have smaller home ranges than do females, with the males generally remaining closer to the leks than do the females (Giesen 1998, p. 11). In Colorado, Giesen (1998, p. 11) observed that spring and summer home ranges for males were 211 hectares (ha) (512 acres (ac)) and for females were 596 ha (1,473 ac). In Texas, Taylor and Guthery (1980a, p. 522) found that winter monthly home ranges for males could be as large as 1,945 ha (4,806 ac) and that subadults tended to have larger home ranges than did adults. Based on observations from New Mexico and Oklahoma, LEPC home ranges increase during periods of drought (Giesen 1998, p. 11). Davis (2005, p. 3) states that the combined home range of all LEPC at a single lek is about 49 sq km (19 sq mi or 12,100 ac).

Diet of the LEPC consists primarily of insects, seeds, leaves, buds, and cultivated grains (Giesen 1998, p. 4). Juveniles tend to forage primarily on insects such as grasshoppers and beetles while adults tend to consume a higher percentage of vegetative material (Giesen 1998, p. 4). This is particularly true in the fall and winter when insects are less abundant. More detailed information on LEPC diet can be found in Jones (1963, pp. 764-765), Crawford and Bolen (1976, p. 143,), Davis *et al*. (1980, pp. 76-78) and Riley *et al*. (1993, pp. 188).

LEPC have a relatively short life span and high annual mortality. Campbell (1972, p. 689), using nine years of band recovery data, estimated annual mortality for males to be 65 percent. Hagen *et al*. (2005, p. 82) specifically examined survival in male LEPC and found apparent survival varied by year and declined with age. Annual mortality was estimated to be 0.55 (Hagen *et al*. 2005, p. 83). In female LEPC, Hagen *et al*. (2007, p. 522) estimated that annual mortality in Kansas was about 0.5 at Site I and about 0.65 at Site II. Juvenile mortality from hatching to first breeding season was estimated to be about 0.88, but was not considered to be representative of juvenile mortality in other Kansas LEPC populations (Pitman *et al*. 2006, p. 679-680). Campbell (1972, p. 694) estimated a 5-year maximum life span, although an

individual nearly 7 years old has been documented in the wild by the Sutton Avian Research Center (Wolfe 2010).

Taxonomy

The LEPC is in the Order Galliformes, Family Phasianidae, subfamily Tetraoninae, and is recognized as a species separate from the greater prairie-chicken (American Ornithologist's Union 1998, p. 122; Jones 1964, pp. 65-73). The LEPC was first described as a subspecies of the greater prairie-chicken (Ridgway 1873, p. 199), but was named a full species in 1885 (Ridgway 1885). A more thorough discussion of LEPC taxonomy is found in Giesen (1998, pp. 2, 3).

Habitat

The preferred habitat of the LEPC is native short- and mixed-grass prairies having a shrub component dominated by sand sagebrush (*Artemesia filifolia*) or shinnery oak (*Quercus havardii*) (hereafter described as native rangeland) (Taylor and Guthery 1980b, p. 6; Giesen 1998, pp. 3-4). Small shrubs are important for summer shade, winter protection, and as supplemental foods (Johnsgard 1979, p. 112). Trees and other tall woody vegetation are typically absent from these grassland ecosystems, except along water courses. Landscapes supporting less than 63 percent native rangeland appear incapable of supporting self-sustaining LEPC populations (Giesen 1998, p. 4). Correspondingly, Crawford and Bolen (1976, p. 102) found that landscapes having greater than 20 to 37 percent cultivation may not support stable LEPC populations.

The shinnery oak vegetation type is endemic to the southern great plains and is estimated to have historically covered an area of 2.3 million ha (over 5.6 million ac), although its current range has been considerably reduced through eradication (Mayes *et al*. 1998, p. 1609). The distribution of shinnery oak overlaps much of the historic LEPC range in New Mexico, Oklahoma, and Texas (Peterson and Boyd 1998, p. 2). Shinnery oak is a rhizomatous (a horizontal, usually underground stem that often sends out roots and shoots from its nodes) shrub that reproduces slowly and does not invade previously unoccupied areas (Dhillion *et al*. 1994, p. 52). Mayes *et al*. (1998, p. 1611) documented that a single rhizomatous shinnery oak can occupy an area exceeding 7,000 sq meters (m) (1.7 ac). While not confirmed through extensive research throughout the plant's range, it has been observed that shinnery oak in some areas multiplies by slow rhizomatous spread and eventual fracturing of underground stems from the original plant. In this way, single clones have been documented to occupy up to 81 ha (200 ac) over an estimated timeframe of 13,000 years (Cook 1985, p. 264; Anonymous 1997, p. 483), making shinnery oak possibly the largest and longest-lived plant species in the world.

The importance of shinnery oak as a component of LEPC habitat has been demonstrated by several studies (Fuhlendorf *et al*. 2002, pp. 624-626; Bell 2005 pp. 15, 19-25). In a study conducted in west Texas, Haukos and Smith (1989, p. 625) documented strong nesting avoidance by LEPC of shinnery oak rangelands that had been treated with the herbicide tebuthiuron (also see "Herbicide" discussion under Factor E). Similar behavior was confirmed by three recent studies in New Mexico examining aspects of LEPC habitat use, survival, and reproduction relative to shinnery oak density and herbicide application to control shinnery oak. First, Bell (2005, pp. 20-21) documented strong thermal selection for, and dependency of LEPC broods on,

dominance of shinnery oak in shrubland habitats. In this study, LEPC hens and broods used sites within the shinnery oak community that had statistically higher percent cover and greater density of shrubs. Within these sites, microclimate differed statistically between occupied and random sites, and LEPC survival was statistically higher in microhabitat that was cooler, more humid, and less exposed to the wind. Survivorship was statistically higher for LEPC that used sites with greater than 20 percent cover of shrubs than for those choosing 10–20 percent cover; in turn, survivorship was statistically higher for LEPC choosing 10–20 percent cover than for those choosing less than 10 percent cover.

In a second study, Johnson *et al*. (2004, pp. 338-342) observed through telemetry methods that shinnery oak was the most common vegetation type in LEPC hen home ranges. Hens were detected more often than randomly in or near pastures that had not been treated to control shinnery oak. Although hens were detected in both treated and untreated habitats in this study, 13 of 14 nests were located in untreated pastures, and all nests were located in areas dominated by shinnery oak. Areas immediately surrounding nests also had higher shrub composition than the surrounding pastures. This study suggested that herbicide treatment to control shinnery oak adversely impacts nesting LEPC.

Finally, a third study conducted by the Sutton Avian Research Center (Sutton Center), in cooperation with New Mexico Department of Game and Fish (NMDGF), showed that over the course of four years and five nesting seasons, LEPC in the core of occupied range in New Mexico distributed themselves non-randomly among shinnery oak rangelands treated and untreated with tebuthiuron (Patten *et al*. 2005a, 1273-1274). They demonstrated statistically that LEPC strongly avoided habitat blocks treated with tebuthiuron, but were not influenced by presence of cattle grazing. Further, herbicide treatment explained nearly 90 percent of the variation in occurrence among treated and untreated areas. Over time, radio-collared LEPC spent progressively less time in treated habitat blocks, with almost no use of treated pastures in the fourth year following herbicide application (25 percent in 2001, 16 percent in 2002, 3 percent in 2003, and 1 percent in 2004).

Leks are characterized by sparse vegetation and are generally located on elevated features such as ridges or grassy knolls (Giesen 1998, p. 4). Vegetative cover characteristics, primarily height and density, may have a greater influence on lek establishment than elevation (Giesen 1998, p. 4). Copelin (1963, p. 26) observed display grounds within short grass meadows of valleys where sand sagebrush was tall and dense on the adjacent ridges. Early spring fires also encouraged lek establishment when residual vegetation likely was too high (0.6-1.0 m (2.0-3.3 feet (ft))) to facilitate displays (Cannon and Knopf 1979, pp. 44-45). Several authors, as discussed in Giesen (1998, p. 4), observed that roads, oil and gas pads, and similar forms of human disturbance create habitat conditions which may encourage lek establishment. However, Taylor (1979, p. 707) emphasized that human disturbance, which is often associated with these artificial lek sites, is detrimental during the breeding season and did not encourage construction of potential lek sites in areas subject to human disturbance. Giesen (1998, p. 9) reported that hens usually nest and rear broods within 3 km (1.7 mi) of leks and usually nest near a lek other than the one on which they mated.

Typical nesting habitat can be described as native rangeland, although there is some evidence

that the height and density of forbs (broad-leaved herb other than a grass) and residual grasses is greater at nesting locations than on adjacent rangeland (Giesen 1998, p. 9). Nests are often located on north and northeast facing slopes as protection from direct sunlight and the prevailing southwest winds (Giesen 1998, p. 9). Giesen (1998, p. 9) reports that habitat used by young is similar to that of adults and the daily movements of the broods is usually 300 m (984 ft) or less. After the broods break up, the juveniles form mixed flocks with adult birds (Giesen 1998, p. 9) and juvenile habitat use is similar to that of adult birds. Giesen (1998, p. 4) reports that wintering habitat is similar to that used for breeding with the exception that small grain fields are used more heavily during this period than during the breeding season.

Prairie grouse, including the LEPC, require large expanses (i.e., 1,024-10,000 ha (2,530-24,710 ac)) of unfragmented, ecologically diverse native rangelands to complete their life cycles (Woodward *et al*. 2001, p. 261; Flock 2002, p. 130; Fuhlendorf *et al*. 2002, p. 618; Davis 2005, p. 3), more so than almost any other grassland bird (Johnsgard 2002, p. 124). Although precise values have yet to be quantified, home range size and movements of individual animals help provide a rough estimate of the extent of land that may be required to sustain a population of LEPC. As reported by Giesen (1998, p. 11) and Taylor and Guthery (1980a, p. 522), a single LEPC may have a home range of 211 ha (512 ac) to 1,945 ha (4,806 ac). More recently, studies in Kansas demonstrated some birds may move as much as 50 km (31 mi) from their point of capture (Hagen *et al*. 2004, p. 71). While some overlap in home ranges is expected, rarely would those home ranges be expected to overlap completely. Taylor and Guthery (1980b, p. 11) used LEPC movements in west Texas to estimate the area needed to meet the minimum requirements of a lek population. They determined that a contiguous area of at least 32 sq km (3,200 ha; 7,900 ac) and having no less than 63 percent rangeland habitat are need to support a LEPC population long-term. More recently, observations by scientists involved in LEPC conservation have speculated that over 16,000 ha (40,000 ac) may actually be needed to sustain a single LEPC lek (Wolfe 2008). Because LEPC typically nest and rear their broods in proximity to a lek other than the one used for mating (Giesen 1998, p. 9), a complex of two or more leks is likely required to sustain a viable population of LEPC. Hagen *et al*. (2004, p. 76) recommended that LEPC management areas be at least 4,096 sq km (1,581 sq mi) in size. A population viability analysis for the LEPC, once conducted, would allow a more precise estimation of the amount of suitable habitat needed to sustain a single, viable LEPC population.

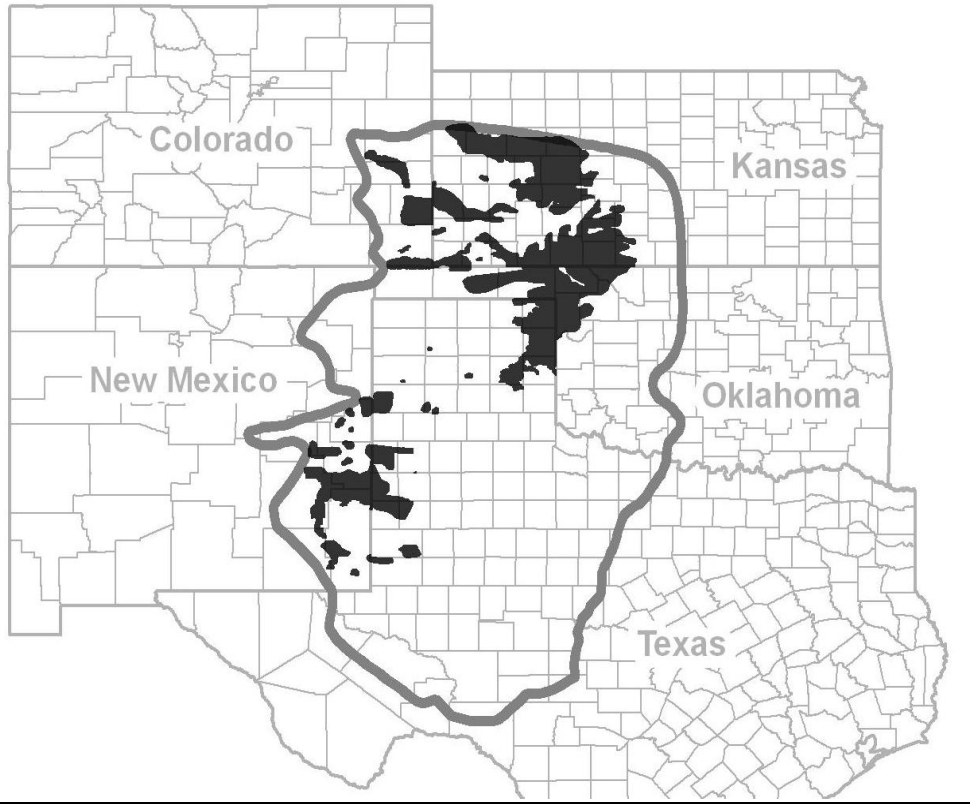
Historical Range/Distribution

Historically, the LEPC occupied native rangeland in portions of southeastern Colorado (Giesen 1994b, pp. 175-182), southwestern Kansas (Schwilling 1955, p. 10), western Oklahoma (Duck and Fletcher 1944, p. 68), the Texas panhandle (Henika 1940, p. 15; Oberholser 1974, p. 268), and eastern New Mexico (Ligon 1927, pp. 123-127). Johnsgard (2002, p. 32) estimates the maximum historical range encompassed some 260,000 to 388,500 sq km (100,000 to 150,000 sq mi), with about two-thirds of the range occurring in Texas. In 2007, cooperative mapping efforts by the Colorado Division of Wildlife (CDOW), Kansas Department of Wildlife and Parks (KDWP), NMGDF, Oklahoma Department of Wildlife Conservation (ODWC), and Texas Parks and Wildlife Department (TPWD), in cooperation with the Playa Lakes Joint Venture, re-estimated the maximum historical and occupied ranges (see Figure 1). They determined the maximum occupied range, prior to European settlement, to have been approximately 456,087 sq km (176,096 sq mi) (Playa Lakes Joint Venture 2007, p. 1). The approximate historical range,

by state, based on this cooperative mapping effort is 21,911 sq km (8,460 sq mi) in Colorado, 76,757 sq km (29,640 sq mi) in Kansas, 52,571 sq km (20,300 sq mi) in New Mexico, 68,452 sq km (26,430 sq mi) in Oklahoma, and 236,398 sq km (91,280 sq mi) in Texas.

By the 1880s, the area occupied by LEPC was estimated at 358,000 sq km (138,225 sq mi), and by 1969, the occupied range had declined to an estimated 125,000 sq km (48,263 sq mi) due to wide scale conversion of native prairie to cultivated cropland (Taylor and Guthery 1980b, p. 1, based on Aldrich 1963, p. 537). By 1980, occupied range was estimated at 27,300 sq km (10,541 sq mi) (Taylor and Guthery 1980b, p. 4).

Figure 1. Estimated historic (perimeter circle) and current (black polygons) occupied LEPC range in Colorado, Kansas, New Mexico, Oklahoma, and Texas. Current (2007) range map layer courtesy of TPWD.



Current Range/Distribution

LEPC still occur within each state (Giesen 1998, p. 3). During the 2007 mapping effort (Playa Lakes Joint Venture 2007, p. 1), the State wildlife agencies estimated the current LEPC occupied range encompassed 64,414 sq km (24,871 sq mi) (Fig. 1). The approximate occupied range, by state, based on this cooperative mapping effort is 4,216 sq km (1,630 sq mi) in Colorado, 29,130 sq km (11,250 sq mi) in Kansas, 8,570 sq km (3,310 sq mi) in New Mexico, 10,969 sq km (4,235 sq mi) in Oklahoma, and 12,126 sq km (4,680 sq mi) in Texas.

The overall distribution of LEPC within all states except Kansas has declined sharply, and the species is generally restricted to limited parcels of untilled native rangeland (Taylor and Guthery 1980b, pp. 2-5) or areas with significant Conservation Reserve Program (CRP) enrollments that were initially seeded with native grasses (Rodgers and Hoffman 2005, pp. 122-123). The estimated current occupied range represents an 86 percent reduction in overall occupied range since pre-European settlement.

Population Estimates

Little information is available on LEPC population size prior to 1900. Litton (1978, p. 1) suggested that as many as two million birds may have occurred in Texas alone prior to 1900. Although, we are not aware of any independent analysis to corroborate Litton's estimate, and the basis for his estimate is unknown, the LEPC was reportedly quite common throughout its range in Colorado, Kansas, New Mexico, Oklahoma, and Texas in the early twentieth century (Bent 1932, pp. 280-281,283; Baker 1953, p. 8; Bailey and Niedrach 1965, p. 51; Sands 1968, p. 454; Fleharty 1995, pp. 38-44). By the 1930s, the species had begun to disappear from areas where it had been considered abundant and the decline was attributed to extensive cultivation, overgrazing by livestock, and drought (Bent 1932, pp. 283-284; Baker 1953, p. 8; Bailey and Niedrach 1965, p. 51; Davison 1940, p. 58; Lee 1950, p. 475; Oberholser 1974, p. 268; Sands 1968, p. 454). LEPC abundance appeared to fluctuate somewhat during the 1940s and 1950s (Copelin 1963, p. 24; Snyder 1967, p. 121; Crawford 1980, p. 2), and by the early 1970s the total fall population may have been reduced to about 60,000 birds (Crawford 1980, p. 2). By 1980, the estimate of the total fall population was approximately 44,000 to 53,000 birds (Crawford 1980, p. 3).

State-by-State Information on Population Status

Each of the State wildlife agencies within the occupied range of the LEPC provided us with information regarding the current status of the LEPC within their respective states, and most of the following information was taken directly from agency reports, memos, and other status documents. Population survey data are collected from spring lek surveys in the form of one or both of the following indices: average lek size (*i.e.*, number of males or total birds per lek); or density of birds or leks within a given area. Most typically the data are collected along fixed survey routes where the number of displaying males counted is assumed to be proportional to the population size or the number of leks heard is assumed to be an index of population size or occupied range. These techniques are useful in detecting trends and determining occupancy/distribution but are very limited in their usefulness for reliably determining population size. However, in the absence of more reliable estimators of bird density, total counts of active leks over large areas was recommended as the most reliable trend index for prairie grouse populations (Cannon and Knopf 1981, p. 777; Hagen *et al*. 2004, p. 79). Texas is currently evaluating the usefulness of aerial surveys as a means of detecting leks and counting the number of birds attending the identified lek (McRoberts 2009, pp. 9-10)

Colorado. LEPC were likely resident in six counties in Colorado prior to European settlement (Giesen 2000, p. 140). At present, LEPC are known to occupy portions of Baca, Cheyenne, Prowers, and Kiowa counties, but are not known to persist in Bent and Kit Carson counties. Populations in Kiowa and Cheyenne counties number less than 100 individuals and appear to be isolated from other populations in Colorado and adjacent states (Giesen 2000, p. 144). The

LEPC has been state-listed as threatened in Colorado since 1973. CDOW estimated 800 to 1,000 LEPC in the state in 1997. Giesen (2000, p. 137) estimated the population size, as of 2000, to be less than 1,500 breeding individuals.

A new survey method was initiated in 2004 designed to cover a much broader range of habitat types and a larger geographic area, particularly to include lands enrolled in the CRP (see Factor A., section on conversion to cultivated agriculture). The new methodology resulted in the discovery of more leks and the documented use of CRP fields by LEPC in Colorado. The number of LEPC counted in 2005 was 203 birds, with high-count totals of 151 males, 21 females, and 31 of unknown sex (Yost 2005, p. 1). In 2005, 32 active leks were found--13 in Baca County, 1 in Kiowa County, and 18 in Prowers County, including 7 new leks. No known leks in Cheyenne County were surveyed in 2005 (Yost 2005, p. 2). Results in 2006 suggest that the population in Baca County continued to decline while the Prowers County population is increasing, with three new lek sites discovered there. Limited data suggest LEPC populations in Kiowa and Cheyenne counties are stable to increasing.

LEPC numbers in Colorado declined 75 percent from 2006 to 2007, from 296 birds observed to only 74. Active leks also declined from 34 in 2006 to 18 in 2007 (Verquer 2007, p. 2). Due to heavy snowfall, no cover and little food existed in southern Kiowa, Prowers, and most of Baca counties for over 60 days. The impacts of drought conditions in 2006, coupled with the severe winter weather, probably account for the decline in the number of LEPC observed in 2007 (Verquer 2007, pp. 2-3).

In 2008, Colorado adopted a dual-frame sampling methodology consisting of a list frame and an area frame (Verquer 2008, p. 1). The list frame consisted of known lek locations that have been active at least once within the past ten years. The area frame consisted of areas of unknown LEPC occupancy within the potential range in southeastern Colorado. Opportunistic searches also were conducted, as time permitted, in areas where the public had reported LEPC sightings or in CRP grasslands outside of the area frame.

Total LEPC detected in 2009 was 75 birds, down from 116 birds detected in 2008 and almost identical to the number (74) of LEPC that were detected in 2007 using a different methodology. (Verquer 2009, p. 2; Verquer 2008, pp. 1-2). The total number of active leks detected was 13, down slightly from 17 in 2008 and 18 in 2007. In 2009, 6 leks were detected from Baca County, 1 in Cheyenne County, and 6 in Prowers County. As in 2008, no active leks were counted in Kiowa County during standard survey efforts. Access restrictions prohibited searches of every known lek and active leks may have been present but undetected. An active lek was detected in Kiowa County in 2008 (Verquer 2008, p. 1). Nesting and brood rearing conditions in the spring of 2008 were not favorable due to drought conditions in southeastern Colorado. Habitat and moisture conditions improved in 2009. CRP lands continue to be important for LEPC, particularly in Prowers County.

As a compliment to CDOW surveys, counts are completed on the USFS Comanche National Grassland in Baca County. On the Comanche National Grassland, surveys revealed that the estimated area occupied by the LEPC over the past 20 years was approximately 27,373 ha (65,168 ac) (Augustine 2005, p. 2). Surveys conducted during 1984 - 2005 identified 53

different leks on or immediately adjacent to USFS lands. Leks were identified based on the presence of at least three birds on the lek. Lek censuses conducted from 1980 to 2005 showed the number of males counted per lek since 1989 has steadily declined (Augustine 2006, p. 4). The corresponding population estimate, based on number of males observed at leks, on the Comanche National Grassland was highest in 1988 with 348 birds and the lowest in 2005 with approximately 64 birds and only 8 active leks (Augustine 2006, p. 4). The estimate of males per lek in 2005 declined over 80 percent from that of 1988, from 174 males per lek to 32 males per lek, respectively. In 2009, each historic lek was surveyed 2-3 times and 4 active leks were observed (Shively 2009b, p. 1). A lek is considered active when at least three males are observed displaying on the lek. A high count of 25 males were observed using these four leks. In the spring of 2008, five active leks and 34 birds were observed (Shively 2009a, p. 3).

Kansas. In the early part of the last century, LEPC historical range included all or a part of 38 counties, but by 1977 (Waddell and Hanzlick 1978, pp. 22-23) the species was known to exist in only 17 counties. Since 1999, biologists have documented LEPC expansion and reoccupation of 16 counties north of the Arkansas River, primarily attributable to favorable habitat conditions (e.g., native grasslands) created by implementation of the CRP in those counties. Currently, LEPC occupy approximately 29,130 sq km (11,247 sq mi) within all or portions of 35 counties in western Kansas. Greater prairie-chickens in Kansas also have expanded their range and as a result, mixed leks of both LEPC and greater prairie-chickens occur within an overlap zone covering portions of 7 counties (2,500 sq km (965 sq mi)) in western Kansas (Bain and Farley 2002, p. 684). Within this zone, apparent hybridization between LEPC and greater prairie-chickens is now evident (Bain and Farley 2002, p. 684). Two survey routes used by KDWP are located within this overlap zone; however, hybrids have been observed on only one of those routes. Although hybrid individuals are included in the counts, the number of hybrids observed is typically less than one percent, 2-7 birds, of the total number of birds observed on the surveyed areas.

Since inception of standard LEPC survey routes in 1964, the number of standard survey routes has gradually increased. The number of standard routes currently surveyed in Kansas for LEPC is 15 and encompass an area of 722 sq km (279 sq mi). Only three routes have been consistently surveyed since 1966. Flush counts are taken twice at each lek located during the standard survey routes. An estimated population density is calculated for each route by taking the highest of the two flush counts, doubling that count primarily to account for females, and then dividing the estimated number of birds by the total area surveyed per route.

In 2009, KDWP surveys along the 15 LEPC survey routes estimated a mean of 1.5 LEPC per sq km (3.8 per sq mi), down slightly from 2008 (Rodgers 2009, p. 3). KDWP surveys along the 15 LEPC survey routes in both 2008 and 2007 estimated a mean of 1.5 LEPC per sq km (3.9 per sq mi) (Rodgers 2008, p. 3). In 2006, LEPC densities were estimated to be 2.4 LEPC per sq km (6.1 per sq mi), which was not statistically different from the 2005 estimate of 2.1 LEPC per sq km (5.3 per sq mi) (Rodgers 2006, p. 3). The average number of LEPC per lek increased slightly from 12.7 in 2008 to 12.8 in 2009 (Rodgers 2009, p. 3). In 2007, the average number of LEPC per lek was 10.6. KDWP estimated the 2006 breeding population of LEPC in the state at between 19,700 and 31,100 individuals (Rodgers 2007a, p. 1). The total breeding population estimates were derived using the National Gap Analysis Program whereby the population indices

from each habitat type along the 15 survey routes were extrapolated for similar habitat types throughout total occupied LEPC range statewide.

On the USFS Cimarron National Grassland in Morton County, Kansas, LEPC are present primarily south of the Cimarron River. Surveys conducted on the Cimarron National Grassland during 1988-1997 identified 44 leks and indicated that all National Grassland areas south of the Cimarron River (64,387 acres) were occupied (Augustine 2005, p. 1). From 1995 to 1999, Smith and Smith (1999, p. 1) attempted a complete census of leks used by LEPC. During this period, they observed as many as 27 different leks being used and flush counts varied from a low of 91 in 1997 to a high of 149 in 1999. This survey method was repeated again in 2005 and population estimates were derived from these surveys. Between 1995 to 1999, the population was estimated to number between 173 and 283 birds; the 2005 population estimate was 249 birds (Augustine 2005, p. 4). These results were believed to be indicative of a stable population over that 10 year period (Augustine 2005, p. 4).

Since 2005, the Cimarron National Grassland has continued to survey all known leks within their administrative boundary and obtain flush counts for each active lek. Based on those surveys, LEPC populations on the Cimarron National Grassland appear to have declined, although the numbers of LEPC observed can fluctuate considerably from year to year. The average total number of birds flushed in 2005 was 131 birds and in 2006, 139 birds were flushed from active leks (Augustine 2006, p. 3). In 2007, 86 LEPC were flushed from active leks (Chappell 2010, p. 2). The average number LEPC observed on the Cimarron National Grassland in 2008 did not change significantly from 2007. An average total of 89 birds were observed (Chappell 2009a, p. 2) from a total of 9 active leks. In 2009, an average total of 53 birds were observed from a total of 6 active leks (Chappell 2009b, p. 2). A lek was considered active if at least three males were present on the lek. Exceptional drought conditions are thought primarily responsible for these recent declines.

New Mexico. In the 1920s and 1930s, the former range of the LEPC in New Mexico was described as all of the sand hill rangeland of eastern New Mexico, from Texas to Colorado, and as far west as Buchanan in DeBaca County. Ligon (1927, pp. 123-127) mapped the breeding range at that time as encompassing portions of seven counties, a small subset of what he described as former range. Ligon (1927, pp. 123-127) depicted the historic range in New Mexico as encompassing all or portions of 12 counties. In the 1950s and 1960s, occupied range was more extensive than what was the known occupied range in 1927 (Davis 2005, p. 6), indicating reoccupation of some areas since the late 1920s. Presently, the NMDGF reports that LEPC are known or suspected from portions of seven counties and the occupied range of LEPC in New Mexico is conservatively estimated to encompass approximately 5,698 sq km (2,200 sq mi) (Davis 2006, p. 7) compared with its historic range of 22,390 sq km (8,645 sq mi). Based on the cooperative mapping efforts (Fig. 1), occupied range in New Mexico was estimated to be 8,570 sq km (3,309 sq mi), considerably larger than the conservative estimate used by Davis. One possible reason for the difference in occupied range is that Davis (2006, p. 7) did not consider the known distribution to encompass any portion of Eddy County or southern Lea County. Approximately 59 percent of the historic LEPC range in New Mexico is privately held, with the remaining historic and occupied range occurring on lands managed by the BLM, USFS, and New Mexico State Land Office (Davis 2005, p. 12).

In the 1950s, the LEPC population was estimated at 40,000 to 50,000 individuals, but by 1968, had declined to an estimated 8,000 to 10,000 individuals (Sands 1968, p. 456). Johnsgard (2002, p. 51) estimated the number of LEPC in New Mexico to number fewer than 1,000 individuals by 2001. Similarly, the Sutton Center, based on observations made over a 7 year period, estimate the New Mexico LEPC population to number between 1,500-3,000 individuals (Wolfe 2008). Using lek survey data, NMDGF currently estimates the statewide LEPC population to be about 4,968 birds (Beauprez 2009, p. 17). The 2009 population estimate represents a 47 percent decrease from the 2008 estimate and is the lowest estimated population since 2004 when the population was estimated to number 5,004 individuals. The dry spring and summer of 2008 and a large hailstorm which occurred in May of 2008 during the peak of nesting season is considered to be at least partially responsible for the observed decline (Beauprez 2009, p. 19).

Roadside listening routes were first established to survey LEPC in New Mexico in 1998. Survey routes were located within known occupied and potential range. The original survey boundary included 182 townships which were comprised of habitats consisting of sandy and deep sand range sites supporting shinnery oak and native grasses. In 1999, the survey boundary was adjusted to include 150 townships. The survey boundary was expanded in 2004 to include 382 townships and 80 survey routes (Beauprez 2009, p. 6). The current survey uses 29 standard routes established since 1999, 10 additional routes established in 2003 within the northeastern part of LEPC historical range, and 41 routes randomly selected from within the survey boundary townships.

Since initiating the 10 additional northeastern routes in 2003, NMDGF reports that no leks have been detected in northeastern New Mexico. Results provide strong evidence that LEPC no longer occupy their historical range within Union, Harding, and portions of northern Quay counties (Beauprez 2009, p. 8). However, a solitary male LEPC was observed and photographed in northeastern New Mexico by a local wildlife law enforcement agent in December 2007. Habitat in northeastern New Mexico appears capable of supporting LEPC but the lack of any known leks in this region since 2003 suggests LEPC populations in northeastern New Mexico, if still present, are very small.

The core of occupied LEPC range lies in east-central New Mexico (Chaves, Curry, DeBaca, Lea, and Roosevelt counties). In 2009, 27 roadside routes within the core of occupied range in east central New Mexico were surveyed. Sixteen of those routes occur within Curry, northern Roosevelt, and eastern DeBaca counties where LEPC populations are considered sparse and scattered. Eleven routes occur within the core of New Mexico LEPC range in northeastern Chaves, northern Lea, and southern Roosevelt counties. Surveys on these 27 routes detected a total of 87 leks, down from 121 leks detected in 2008 (Beauprez 2009, p. 11). In 2007, 92 leks were detected but surveys were not conducted on one of those routes (Beauprez 2009, p. 11).

Data from the two NMDGF survey routes in southeastern New Mexico, defined as the area below U.S. Highway 380, suggest LEPC populations in this region remain low and continue to decline. The majority of historically occupied LEPC habitat in southeastern New Mexico is located south of Highway 380 and occurs primarily on BLM land. Snyder (1967, p. 121) suggested that this region is only marginally populated except during favorable climatic periods.

In 2009, four leks were detected, down only slightly from 2008 (Beauprez 2009, p. 11). Best *et al*. (2003, p. 232) concluded anthropogenic factors have, in part, rendered LEPC habitat south of Highway 380 inhospitable for long-term survival of LEPC in southeastern New Mexico. Similarly, NMDGF suggests that habitat quality likely limits recovery of these populations (Beauprez 2009, p. 13).

Of the 29 standard routes, 15 have been surveyed repeatedly since 1998. On the original 15 routes, the number of leks detected has fluctuated, ranging from a low of 22 in 1998 to a high of 90 in 2008 (Beauprez 2009, p. 8). Overall, when the 29 routes are considered collectively, the number of leks detected over the 12 years has increased significantly but there has been no significant trend in the average numbers of LEPC per lek (Beauprez 2009, p. 9).

The New Mexico State Game Commission owns and manages 29 Prairie-chicken Areas ranging in size from 10 to 3,171 ha (29 to 7,800 ac) within the core of occupied range in east central New Mexico. These Prairie-chicken Areas total 109 sq km (42 sq mi), or roughly 1.6 percent of the total occupied LEPC range in New Mexico. Instead of the typical roadside counts, the NMDGF conducts "saturation" surveys on each individual Prairie-chicken Area to determine the presence of LEPC leks and individual birds over the entire Prairie-chicken Area (Beauprez 2009, p. 7). Adjacent lands are included within these surveys including other State Trust Lands, some adjacent BLM lands, and adjacent private lands. In 2009, 125 leks were detected, either audibly or visually (Beauprez 2009, p. 13), down from the 171 leks detected in 2008 (Beauprez 2008, p. 15). However, only 28 Prairie-chicken Areas were surveyed in 2008. In 2007, 26 Prairie-chicken Areas were surveyed with 164 leks detected, either audibly or visually, on or near the Prairie-chicken Areas and in 2006, 27 Prairie-chicken Areas were surveyed, with 183 leks detected (Beauprez 2008, p. 15). The number of LEPC observed and counted in 2009 was 639 birds distributed over a total of 80 leks (Beauprez 2009, p. 13). In comparison, the number of LEPC observed and counted in 2008, 2007, and 2006 were 844, 1,117, and 757, respectively (Beauprez 2008, p. 15). The Prairie-chicken Areas are obviously important to persistence of the LEPC in New Mexico. However, considering the overall areal extent of the Prairie-chicken Areas and that many Prairie-chicken Areas are small and isolated, continued management of the surrounding private and federal lands is integral to viability of the LEPC in New Mexico.

The Nature Conservancy in New Mexico surveyed about 11,331 ha (28,000 ac) of their Milnesand Prairie Preserve, located in southern Roosevelt County, in 2009 (Beauprez 2009, p. 16). A total of 54 active leks and 441 LEPC were reported.

Oklahoma. LEPC historically occurred in 22 Oklahoma counties. By 1961, Copelin (1963, p. 53) reported LEPC from only 12 counties. By 1979, LEPC were verified in eight counties, and the remaining population fragments encompassed an estimated area totaling 2,792 sq km (1,078 sq mi), a decrease of approximately 72 percent since 1944. At present, the ODWC reports LEPC continue to persist in eight counties with an estimated occupied range of approximately 950 sq km (367 sq mi). Horton (2000, p. 189) estimated the entire Oklahoma LEPC population numbered fewer than 3,000 birds by 2000. A more recent estimate has not been conducted.

Long-term abundance estimates suggest a history of dramatic population fluctuations. Between 1968 and 2001, mean number of males per active lek varied from a high of 16.5 in 1975 to a low

of 2.3 in 1995 (ODWC 2007, p. 6). Despite the wide fluctuation in numbers of males per active lek, the counts demonstrate a downward trend. During the period from 1968 to 1978, the mean number of males per lek averaged 12.5. From 1979 to 1989, the mean number of males per lek averaged 8.5. During the period from 1990 to 2001, the mean number of males per lek averaged 5.1. Beginning with the 2002 survey, male counts at leks were replaced with flush counts, which did not differentiate between the sexes of birds flushed from the surveyed lek (ODWC 2007, pp. 2, 6).

The number of roadside listening routes currently surveyed annually in Oklahoma has varied from 5 to 7 over the last 20 years. Between 1987 and 2008, the estimated density of active leks within occupied habitat varied from a high of 0.12 leks per sq km (0.33 per sq mi) in 1988 to a low of 0.02 leks per sq km (0.05 per sq mi) in 2004 and again in 2006. In 2009, the estimated density of LEPC leks in Oklahoma was 0.02 leks per sq km (0.05 per sq mi) down slightly from 2008 (Schoeling 2010, p. 3). Over the last 10 years the density of active leks has varied from a low of 0.02 leks per sq km (0.05 leks per sq mi) in 2004, 2006, and 2009, to a high of 0.03 leks per sq km (0.09 leks per sq mi) in 2005 and 2007 (Schoeling 2010, p. 3).

The ODWC is aware of 96 known historic and currently occupied leks in Oklahoma. During the mid-1990's all of these leks were active. Recent survey efforts are lacking for most of these known lek locations and the exact number of currently active or occupied leks in Oklahoma is unknown.

Texas. Systematic surveys to identify Texas counties inhabited by LEPC began in 1940 (Henika 1940, p. 4). From the early (Henika 1940, p. 15; Sullivan *et al*. 2000) to mid 1940's (Litton 1978, pp. 11-12) to the early 1950's (Seyffert 2001, pp. 108-112), the range of the LEPC in Texas was estimated to encompass all or portions of 34 counties. Species experts considered the occupied range at that time to be a reduction from the pre-settlement range. By 1989, TPWD estimated occupied range encompassed all or portions of only 12 counties (Sullivan *et al*. 2000, p. 179). In 2005, TPWD reported that the number of occupied counties likely has not changed since the 1989 estimate. In March 2007, TPWD reported that LEPC were confirmed from portions of 13 counties (Ochiltree, Lipscomb, Roberts, Hemphill, Gray, Wheeler, Donley, Bailey, Lamb, Cochran, Hockley, Yoakum, and Terry) and suspected in portions of another 8 counties (Moore, Carson, Oldham, Deaf Smith, Randall, Swisher, Gaines, and Andrews).

Maximum occupied acreage in Texas, as of September 2007, was estimated to be 12,787 sq km (4,937.1 sq mi) based on habitat conditions in 20 panhandle counties (Davis *et al*. 2008, p 23). Conservatively, based on those portions of the 13 counties where LEPC are known to persist, the area occupied by LEPC in Texas is 7,234.2 sq km (2,793.1 sq mi). Using an estimated mean density of 0.0088 LEPC per ac (range 0.0034-0.0135 LEPC per ac), the Texas population is estimated at a mean of 15,730 with a broad range in the estimate of 6,077 to 24,132 LEPC in the 13 counties where LEPC are known to occur (Davis *et al*. 2008, p. 24). LEPC populations in Texas currently persist in two disjunctive regions; the Permian Basin/Western Panhandle region and the Northeastern Panhandle region (see Fig. 1).

Annual surveys to determine population trends of LEPC in Texas were initiated in 1952 on two study areas, one encompassing 40,469 ha (100,000 ac) in Hemphill County and another

encompassing 2,630 ha (6,500 ac) in Wheeler County (Lionberger 2009, p. 1). Survey efforts were expanded in 1986 in an effort to locate leks throughout LEPC range in the Texas panhandle. LEPC survey methodology was modified in 1997 to incorporate the Study Area methodology (Lionberger 2009, p. 1). Several minor modifications, primarily the addition or modification of locations of the study areas, have occurred since 1997, but the same methodology has been used since that time. In addition, efforts to locate additional leks using driving routes continue as time and resources allow.

Annual LEPC lek surveys are currently conducted by TPWD within both the Permian Basin/Western Panhandle (study areas in Bailey, Gaines, and Yoakum counties) and in the Northeastern Panhandle (study areas in Gray, Hemphill, and Wheeler counties) regions. All of these study areas are located on private land and together encompass over 43,000 ha (107,211 ac) (Lionberger 2008, p. 1). In 2008, surveys at the Bailey County Study Area were not conducted due to a change in land ownership (Lionberger 2009, p. 1). Consequently the size of the study areas surveyed was reduced to 39,655 ha (97,990 ac).

In 2008, the Permian Basin/Western Panhandle surveys estimated 3.4 males per lek, down from the estimate of 5.3 males per lek in 2007 and 7.9 males per lek in 2006 (Lionberger 2009, p. 10). Lek density in 2008 was estimated at 0.27 leks per sq km (0.70 leks per sq mi), moderately improved from the 2007 estimate of 0.19 leks per sq km (0.50 leks per sq mi) and comparable with the 2006 estimate of 0.29 leks per sq km (0.74 per sq mi). However, in 2008, the Bailey County study area was not sampled and in 2006, the Gaines County study area was not sampled. Lack of sampling at these two locations likely influenced estimated lek densities in those years. Additionally, a new study area was established in Gaines County in 2007 which replaced the previous Gaines County site sampled in 2006. Evaluation of the Yoakum County Study Area, which was consistently sampled all three years, revealed that males per lek declined from 7.9 in 2006, to 5.4 in 2007 to 3.4 in 2008 (Lionberger 2009, p. 9). The average number of males per lek observed in Yoakam County between 2000 and 2008 is 6.2.

Annual lek surveys in the Northeastern Panhandle in 2008 found an estimated 5.4 males per lek, slightly higher than the 4.5 males per lek observed in 2007 and moderately lower than the 7.7 males per lek reported for 2006 (Lionberger 2009, p. 11).

Summary of State Information.
LEPC populations are distributed over a relatively large area and these populations can fluctuate considerably from year to year, a natural response to variable weather and habitat conditions. Although each state conducts standard surveys for LEPC, the application of survey methods and effort varies by state. Such factors complicate interpretation of population indices for the LEPC and may not reliably represent actual populations. Caution should be used in evaluating population trends, particularly short-term trends. For example, short-term analyses could reveal statistically significant changes from one year to the next, but actually represent a stable population when evaluated over longer periods of time. But estimates of historical population size also can be unreliable and lead to inaccurate inferences about the populations of interest. However, the loss and alteration of LEPC habitat throughout its historical range over the past several decades is apparent and likely may be more indicative of the status of the LEPC (Table 1). Certainly species cannot persist in areas where habitat conditions are no longer capable of

supporting that species.

Table 1. Range and current population estimates for LEPC by state.

State	Historical Range	Current Range	Extent (based on Figure 1) Historical	Current	Current Population Estimates
Colorado	6 counties	4 counties	21,910.9 sq km (8,459.8 sq mi)	4,216.5 sq km (1,628.0 sq mi)	1,500 (in 2000)
Kansas	38 counties	35 counties	76,757.4 sq km (29,636.2 sq mi)	29,130.2 sq km (11,247.2 sq mi)	19,700 – 31,100 (in 2006)
New Mexico	7 counties	7 counties	52,571.2 sq km (20,297.9 sq mi)	8,570.1 sq km (3,308.9 sq mi)	4,968 (in 2009)
Oklahoma	22 counties	8 counties	68,452.1 sq km (26,429.5 sq mi)	10,969.1 sq km (4,235.2 sq mi)	< 3,000 (in 2000)
Texas	34 counties (1940's-50's)	13 counties	236,396.2 sq km (91,273.1 sq mi)	12,126.5 sq km (4,682.1 sq mi)	6,077 – 24, 132 (in 2007)
TOTAL	107 counties	67 counties	456,087.8 sq km (176,096.5 sq mi)	65,012.4 sq km (25,101.4 sq mi)	

THREATS

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

Conversion to Cultivated Agriculture

Because LEPC require large areas (i.e., 1,024-10,000 ha) of intact landscapes of mixed-grass, short-grass, and shrubland habitats (Giesen 1998, pp. 3-4; Bidwell *et al*. 2002, pp. 1-3; Hagen *et al*. 2004, pp. 71,77), fragmentation and conversion of these mixed-grass, short-grass, and shrubland habitats have contributed to a significant reduction in the extent of LEPC occupied range. Woodward *et al*. (2001, p. 271) concluded that habitat stability, particularly in shrublands, was extremely important to persistence of LEPC within the landscape. Many habitats, once converted to other uses such as cultivated cropland, no longer provide suitable reproductive habitat for the LEPC and restoration of ecologically meaningful amounts of converted rangeland is doubtful in the short term.

Several LEPC experts have identified conversion of native sand sagebrush and shinnery oak rangeland to cultivation as an important factor in the decline of LEPC populations (Copelin 1963, p. 8; Jackson and DeArment 1963, p. 733; Crawford and Bolen 1976, p. 102; Crawford 1980, p. 2; Taylor and Guthery 1980b, p. 2; Braun *et al*. 1994, pp. 429, 432-433; LEPC Interstate Working Group 1997, p. 3). Between 1915 and 1925, considerable areas of prairie sod were plowed in the Great Plains to grow wheat (Laycock 1987, p. 4). By the 1930s, Bent (1932, pp. 283-284) speculated that extensive cultivation and overgrazing had already caused the species to disappear from areas where it had once been abundant. Because cultivated grain crops may have provided increased or more dependable winter food supplies (Braun *et al*. 1994, p. 429), the initial conversion of some native prairie to cultivation may have been beneficial to the species. However, landscapes having greater than 20 to 37 percent cultivation may not support stable LEPC populations (Crawford and Bolen 1976, p. 102). In the 1940s, 1970s, and 1980s, additional acres of previously unbroken grassland were brought into cultivation (Laycock 1987,

pp. 4-5). Bragg and Steuter (1996, p. 61) estimated that by 1993, only 8 percent of the bluestem-grama association and 58 percent of the mesquite-buffalo grass association as described by Kuchler (1985) remained.

In the U.S. Fish and Wildlife Service's (Service) June 7, 1998, 12-month finding for the LEPC (63 FR 31400), the Service assessed the loss of native rangeland using the National Resources Inventory of the U. S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The 1992 National Resources Inventory Summary Report provided estimates of change in rangeland acreage between 1982 and 1992, for each state. When considered state-wide, each of the five states with LEPC showed a decline in the amount of rangeland acreage over that time period, indicating that loss of important LEPC habitat may have continued to occur since the 1980s. However, estimates of rangeland between 1982 and 1992, for counties specifically within LEPC range, showed no statistically significant change, possibly due to small sample size and large variation about the mean.

The CRP was authorized in the 1985 Food Security Act and since that time has facilitated restoration of millions of acres of marginal and highly erosive cropland to grassland, shrubland, and forest habitats (Riffell and Burger 2006, p. 6). The CRP is a program administered by the USDA's Farm Service Agency and was established to control soil erosion on cropland by converting cropped areas to a vegetative cover such as perennial grassland. Farmers receive an annual rental payment for the duration of a multi-year CRP contract. Cost sharing is provided to assist in the establishment of the vegetative cover practices. Once the CRP contract expires, typically after 10 to 15 years, landowners must decide if the land should be re-enrolled in the program, converted back to cropland, or left in permanent vegetative cover.

CRP habitat encompasses a very significant portion of currently occupied range in most LEPC states, but particularly in Kansas where expansion of the LEPC population is directly related to the amount of land enrolled in the CRP. Estimates of the extent of CRP lands in habitat occupied by LEPC, as derived from the cooperative mapping effort delineated in Figure 1, is available for Kansas, Oklahoma, and Texas. Kansas has just over 363,000 ha (897,000 ac), Oklahoma has over 91,600 ha (226,000 ac), and Texas some 167,600 ha (414,000 ac) in CRP. Based on the estimated amount of occupied habitat remaining in these states (Figure 1), CRP fields in Kansas comprise some 12.5 percent of the occupied LEPC range, 8.3 percent of the occupied range in Oklahoma, and 13.8 percent of the occupied range in Texas.

The importance of CRP habitat to the status and survival of LEPC was recently emphasized by Rodgers and Hoffman (2005, pp. 122-123). They determined that the presence of CRP lands which had been planted to native species of grasses facilitated the expansion of LEPC range in Colorado, Kansas, and New Mexico. The range expansion in Kansas resulted in strong population increases there (Rodgers and Hoffman 2005, pp. 122-123). In Oklahoma and Texas, and some portions of New Mexico, CRP fields were planted with a monoculture of introduced grasses. Where introduced grasses were planted, LEPC did not demonstrate a range expansion or an increase in population size (Rodgers and Hoffman 2005, p. 123). Reductions in CRP acreages, either by reduced enrollments or by conversion back to cultivation upon expiration of existing contracts, would further diminish the amount of suitable LEPC habitat. This is particularly relevant in Kansas where CRP acreages planted to native grass mixtures facilitated

an expansion of LEPC range in that state. A reduction in CRP acreage could lead to contraction of the currently occupied range and reduced numbers of LEPC rangewide.

The possibility exists that escalating grain prices due to the recent emphasis on generating domestic energy from biofuels, such as ethanol from corn, grain sorghum, and switchgrass, combined with recent federal budget proposals that would reduce or eliminate CRP enrollments and renewals through Fiscal Year 2010, will result in an unprecedented conversion of existing CRP acreage within the Great Plains (Babcock and Hart 2008, p. 6). In 2006, the USDA's Farm Service Agency provided a small percentage of current CRP contract holders whose contracts are set to expire during 2007-2010 period with an opportunity (termed REX) to re-enroll (10-15 year terms) or extend (2-5 year terms) their contracts. The opportunity to re-enroll or extend their contracts was based on the relative environmental benefits of each contract. The Farm Service Agency conducted REX offers in two parts. The first part targeted contracts expiring in 2007 and was held in spring 2006. The second, for 2008-2010 expiring contracts, was held in summer of 2006. The Farm Service Agency required that holders of contracts set to expire in 2007 make known to the Farm Service Agency, by September 30, 2006, their intention to either re-enroll their existing contract or allow it to expire. The Farm Service Agency also requested that holders of 2008-2010 expiring contracts make their intentions known to the Farm Service Agency by December 31, 2006. In March of 2007, the USDA expected that some 9.7 million ha (23.9 million ac) out of the total 11.3 million ha (28 million ac) of eligible CRP contracts would be re-enrolled. The remaining 1.7 million ha (4.1 million ac) would be eligible for conversion to crop production or other uses.

Although the large scale loss of CRP habitat poses a threat to the status of existing LEPC populations, some eventual benefits have been identified. In particular, an analysis of LEPC habitat quality within a subsample of 1,019 CRP contracts across all five LEPC states was recently conducted by the Rocky Mountain Bird Observatory (Ripper and VerCauteren 2007, pp. 1-42). They found that, particularly in Oklahoma and Texas, early signup contracts allowed planting of exotic monoculture grasses, such as old-world bluestem (*Bothriochloa* sp.) and weeping lovegrass (*Eragrostis curvula*), which provides poor quality habitat for LEPC (Ripper and VerCauteren 2007, p. 11). While the report identified areas for habitat improvement among all CRP areas in all states, converting exotic grass fields to taller native grass species and enhancing the diversity of native forbs and shrubs within these contracts was recommended as a top priority for LEPC recovery. Consequently, conversion of exotic fields to short-term farming activities, but eventual re-enrollment in native CRP, could improve local habitat quality in the long term above current conditions. However, the extent to which this might occur is currently unknown.

Livestock Grazing

Habitats used by LEPC are largely dominated by a diversity of drought tolerant perennial grasses and shrubs. Grazing has long been an ecological driving force within the ecosystems of the Great Plains (Stebbins 1981, p. 84). The evolutionary history of the mixed-grass prairie has resulted in endemic bird species adapted to an ever-changing mosaic of lightly to severely grazed grasslands (Bragg and Steuter 1996, p. 54; Knopf and Samson 1997, pp. 277-279, 283). Domestic livestock grazing regimes tend to favor more uniform utilization and are typically

confined to specific pastures. While livestock grazing is not inherently harmful to LEPC, levels of grazing that alter the composition and structure of mixed grass habitats historically used by the LEPC can be detrimental. Much of the remaining remnants of mixed-grass prairie and rangeland, while still important to LEPC, differ from conditions prior to European settlement. The present grazing, fire (usually to promote forage quality for livestock), and water management regimes (usually for livestock watering) are vastly different and less variable than historic conditions. These changes have considerably altered the composition and structure of mixed grass habitats historically used by the LEPC. While native rangeland still persists in many areas of LEPC historic range, modification of that rangeland has altered the suitability of those areas for LEPC.

Because LEPC depend on medium and tall grass species that are preferentially grazed by cattle, in regions of low rainfall, LEPC habitat is easily overgrazed (Hamerstrom and Hamerstrom 1961, p. 290). Livestock grazing, particularly overgrazing or overutilization, and related deteriorated range condition is most readily observed through changes in plant composition and other vegetative characteristics (Fleischner 1994, pp 630-631; Stoddart *et al*. 1975, p. 267). Typical vegetative indicators include changes in the composition and proportion of desired plant species, leading to overall reduction in forage. Plant height and density may decline, particularly when plant regeneration is hindered, and composition shifts to increased proportions of less desirable species. When grasslands are in a deteriorated condition due to overgrazing and overutilization, the soils have less water-holding capacity, and the availability of succulent vegetation and insects utilized by LEPC chicks are reduced. The effects of overgrazing and overutilization on habitat quality are similar to drought and are likely exacerbated by actual drought conditions (Davis *et al*. 1979, p. 122; Merchant 1982, pp. 31-33) (see Factor E).

Grazing management favorable to persistence of LEPC must ensure that a diversity of plants and cover types, including shrubs, remain on the landscape (Taylor and Guthery 1980b, p. 7; Bell 2005, p. 4) and that utilization levels leave sufficient cover in the spring to ensure that LEPC nests are adequately concealed from predators. Information on the extent of overgrazing and overutilization throughout LEPC habitat is lacking. However, some studies have shown that overgrazing in portions of LEPC occupied range has been detrimental to the LEPC. Taylor and Guthery (1980b, p. 2) believed overgrazing explained the demise of the LEPC in Texas but thought LEPC could maintain low populations in some areas with high intensity, long-term grazing. In New Mexico, Patten *et al*. (2006, pp. 11, 16) found that grazing did not have an overall influence on where LEPC occurred within their study areas, but there was evidence that LEPC did not nest in portions of the study area subjected to cattle grazing. In some areas within LEPC range, long-term high intensity grazing results in reduced availability of lightly grazed habitat available to support successful nesting (Jackson and DeArment 1963, p. 737; Davis *et al*. 1979, pp. 56, 116; Taylor and Guthery 1980b, p. 12; Davies 1992, pp. 8, 13). Grazing of native rangelands with domestic livestock often differs from grazing regimes historically present when these areas were grazed by free roaming herds of bison. Grazing by domestic livestock tends to be less patchy, particularly when livestock are confined to specific pastures. Where uniform grazing regimes leave inadequate residual cover in the spring, the effects are detrimental to LEPC populations (Bent 1932, p. 280; Davis *et al*. 1979, pp. 56, 116; Cannon and Knopf 1980, pp. 73-74; Crawford 1980, p. 3; Bidwell and Peoples 1991, pp. 1-2; Riley *et al*. 1992, p. 387; Giesen 1994a, p. 97) because grass height is reduced below that necessary to provide adequate

nesting cover and desirable food plants are markedly reduced. Superior cover at and around nests is thought to increase nest success because the nest is better concealed from predators (Davis *et al*. 1979, p. 49; Wisdom 1980, p. 33; Riley *et al*. 1992, p. 386; Giesen 1994a, p. 98). Fencing to facilitate livestock management, while often necessary, leads to structural fragmentation of the landscape. Fencing and related structural fragmentation can be particularly detrimental to LEPC in areas, such as western Oklahoma, where initial settlement patterns favored larger numbers of smaller parcels for individual settlers (Patten *et al*. 2005b, p. 245). Additional information on fragmentation and the effects of fencing can be found in the section below and in the discussion under Factor E.

Fragmentation

Fragmentation results when processes transform a large expanse of habitat into a number of smaller habitat patches which are isolated from each other by a matrix of habitat unlike the original (Wilcove *et al*. 1986, p. 237). Because much suitable habitat for LEPC has been destroyed due to agricultural conversion, and many remaining habitats negatively modified through grazing practices, fire suppression, and other land uses that result in habitat conditions unsuitable for LEPC, fragmentation of the remaining suitable habitat contributes to further alteration of LEPC range (Crawford 1980, p. 5; Braun *et al*. 1994, pp. 432-433; Knopf 1996, p 146; Patten *et al*. 2005b, pp. 235-236). Spatial habitat fragmentation often has a negative impact on population persistence and may exacerbate the species extinction process through several mechanisms (Wilcove *et al*. 1986, p. 246). Once fragmented, the remaining fragments may be inadequate to support crucial life history requirements (Samson 1980, p. 297). Habitat between remaining suitable fragments may support high densities of predators or brood parasites (organisms which rely on the nesting organism to raise their young); and the probability of recolonization of unoccupied fragments decreases as distance from the nearest suitable habitat increases (Wilcove *et al*. 1986, p. 248). As a group, grouse are considered to be particularly intolerant of extensive habitat fragmentation due to their short dispersal distances and other life history characteristics, such as specialized food habits and generalized anti-predator strategies (Braun *et al*. 1994, p. 432). Patten *et al*. (2005b, p. 245), based on observations of radio tracked LEPC in Oklahoma and New Mexico, suggested that increased fragmentation in Oklahoma resulted in higher rates of mortality than in the less fragmented habitat in New Mexico. In summarizing much of the literature on LEPC conservation, Hagen *et al*. (2004, pp. 76-77) stated that most experts agree that LEPC are area sensitive species and that large quantities of suitable habitat are essential for population growth.

In addition to spatial habitat fragmentation, structural habitat fragmentation has been shown to be detrimental to LEPC and forces avoidance or abandonment of otherwise suitable habitats (Hagen *et al*. 2004, pp. 74-75; Robel *et al*. 2004, pp. 260-262). Structural habitat fragmentation is caused by the construction and operation of vertical structures, including towers, utility lines, fences, wind turbines, oil and gas wells, buildings, and compressor stations. Ongoing research increasingly indicates that vertical features and structural habitat fragmentation may have significant negative impacts, such as general habitat avoidance and displacement, on LEPC and other prairie grouse.

Most large remaining tracts of untilled native rangeland, and hence LEPC habitat, occur on

topographic ridges. Leks, the traditional mating grounds of prairie grouse, are consistently located on elevated grassland sites with few vertical obstructions (Flock 2002, p. 35). Because of the increased elevation, these ridges also are prime sites for wind turbine development. Telemetry research on LEPC (Pitman *et al*. 2005, pp. 1267-1268) indicate that prairie grouse exhibit strong avoidance of tall vertical features such as utility transmission lines. Robel (2002, p. 23) estimates that a single commercial-scale wind turbine creates a habitat avoidance zone for the greater prairie-chicken that extends as far as 1.6 km (1 mi) from the structure.

In a recent study (Pitman *et al*. 2005, pp. 1267-1268), avoidance of elevated structures by LEPCs has been identified, with no nesting or brood rearing within 300 m (984 ft) of power lines. This research also found no LEPC nesting or lekking within 0.8 km (0.5 mi) of a gas line compressor station. LEPC generally avoided human activity and seldom nested within 0.4 km (0.25 mi) of inhabited dwellings; LEPC also were documented to avoid habitat within a 1.6 km (1 mi) radius of a coal-fired power plant (Pitman *et al*. 2005, pp. 1267-1268).

Oil and gas development activities, particularly drilling, and road and highway construction also contributes to surface fragmentation of LEPC habitat for many of the same reasons observed with other artificial structures (Hunt and Best 2004, p. 92). The incidence of oil and gas exploration has been rapidly expanding within the range of the LEPC. A more thorough discussion of oil and gas activities within the range of the LEPC is discussed below.

Wind Energy Development

Wind power is a form of renewable energy that is increasingly being utilized to meet electricity demands in the United States. The tubular towers of most commercial, utility scale onshore wind turbines are between 65 m (213 ft) and 100 m (328 ft) tall. The most common system utilizes three rotor blades and can have a diameter of as much as 100 m (328 ft). The total height of the system is measured when a turbine blade is in the 12 o'clock position and will vary depending on the length of the blade. With blades in place, a typical system will easily exceed 100 m (328 ft) in height. A wind farm will vary in size depending on the size of the turbines and amount of land available. Spacing between turbines is usually 5 to 10 rotor diameters to avoid interference between turbines.

Commercial wind energy developments cannot be a viable enterprise without the ability to transmit the power to the users. Any discussion of the effects of wind energy development on the LEPC also must take into consideration the influence of the transmission lines critical to distribution of the energy generated by these structures. Transmission lines can traverse long distances across the landscape and can be both above ground and underground. Most of the impacts associated with transmission lines are with the above ground systems. Support structures vary in height depending on the size of the line. Most high voltage powerline towers are 30 to 38 m (98 to 125 ft) high but can be higher if the need arises. Local distribution lines are usually much shorter in height but all contribute to vertical fragmentation of the landscape.

As discussed in the previous section on structural habitat fragmentation, prairie grouse, including the LEPC, did not evolve with tall vertical structures present on the landscape. The addition of wind turbines and their supporting infrastructure represents a significant change in the species'

environment. Placement of vertical structures is a relatively new phenomenon over the evolutionary history of these species and the effects of these structures on their life history are only beginning to be evaluated. However, some information on the behavioral response of prairie grouse to these structures is available.

In general, prairie grouse have low tolerance to tall structures. Anderson (1969, pp. 640-641) observed that greater prairie-chickens abandoned lek territories when a 4 m (13 ft) tall wind break was artificially erected 52 m (170 ft) from an active lek. Robel (2002, p. 23) estimates that a single commercial-scale wind turbine creates a habitat avoidance zone for the greater prairie-chicken that extends as far as 1.6 km (1 mi) from the structure. Structural habitat fragmentation caused by energy development also has been shown to cause LEPC to avoid or abandon otherwise suitable habitats due to potential for increased predation by raptors or due to visual obstructions on the landscape (Hagen *et al*. 2004, pp. 74-75). Pitman (2005, pp. 1267-1268) observed that female LEPC selected nest sites that were significantly further from powerlines, roads, buildings, and oil and gas wellheads than would be expected at random. Specifically, they seldom found LEPC nests within 400 m (1,312 ft) of transmission lines and improved roads. Similarly, Hagen *et al* (2004, p. 75) indicated that areas used by LEPC were significantly further from these same types of features than areas that were not used by LEPC. The Service has recommended that, due to behavioral avoidance of wind turbines, an 8 km (5 mi) voluntary no construction buffer be established around prairie grouse leks (Manville 2004, p. 1). Although considerably more study is needed, the available information clearly demonstrates that vertical structures are avoided by LEPC and likely render otherwise suitable habitat unsuitable.

Wind energy development and its associated infrastructure is already occurring within the historic range of the LEPC, some of which has impacted occupied habitat. At the close of 1999, the installed capacity, in megawatts (MW), of wind power facilities within the five LEPC states was 209 MW, the majority, 184 MW, was provided by the state of Texas (U.S. Department of Energy, National Renewable Energy Laboratory 2010a p. 1). By the close of 2009, the installed capacity within the five LEPC states had grown to 13,296 MW (U.S. Department of Energy, National Renewable Energy Laboratory 2010a, p. 1). The five LEPC states are all within the top 20 states nationally for installed wind capacity (American Wind Energy Association (AWEA) 2010a, pp. 1-2). Although not all of this installed capacity is located within the historic range of the LEPC, there is considerable overlap with the historic range and those areas having good to excellent wind potential.

Identification of the actual number of proposed wind energy projects that will be built in any future timeframe is difficult to accurately discern. An analysis of the Federal Aviation Administration's obstacle database provides some insight into the number of existing and proposed wind generation towers. The Federal Aviation Administration is responsible for ensuring wind towers and other vertical structures are constructed in a manner that ensures the safety and efficient use of the navigable airspace. In accomplishing this mission, they evaluate applications submitted by the party responsible for the proposed construction and alteration of these structures. Included in the application is information on the precise location of the proposed structure. This information can be used, in conjunction with other electronic databases, to determine the number of existing and proposed wind generation towers within the historical and occupied range of the LEPC. Analysis of this information, as available in April 2010,

reveals that there are 6,279 constructed towers within the historical range of the LEPC. Some 8,501 towers have been approved for construction and another 1,693 towers are pending approval within the historical range of the LEPC. While not all of these structures are wind generation towers, the vast majority are.

A similar analysis was conducted on LEPC occupied range. Within the occupied range, as of April of 2010, 173 towers have been constructed. Some 1,950 towers have been approved for construction and another 250 towers are awaiting approval. Additionally, the Southwest Power Pool (SPP) provides public access to its Generation Interconnection Queue (https://studies.spp.org/GenInterHomePage.cfm), which provides all of the active requests for connection from new energy generation sources requiring SPP approval prior to connecting with the transmission grid. Currently, in the SPP portion of Kansas, New Mexico, Oklahoma, and Texas, there are 177 wind generation interconnection study requests totaling 31,883 MW. A maximum development scenario, assuming all of these projects are built and they all install 2.3 MW wind turbines, would result in approximately 13,862 wind turbines being erected in these four states.

All five LEPC states are within the top 15 states nationally for potential wind capacity, with Texas ranking as number 2 for potential wind energy capacity and Kansas ranking as number 3 (AWEAb 2010, p. 1). The potential for wind development within the historical range of the LEPC is apparent from the wind potential estimates developed by the U.S. Department of Energy's National Renewable Energy Laboratory and AWS Truewind. These estimates present the predicted mean annual wind speeds at a height of 80 m (262 ft). Areas with an average wind speed of 6.5 m/s (21.3 ft/s) and greater at a height of 80 m (262 ft) are generally considered to have a suitable wind resource for development. All of the historical and current range of the LEPC occurs in determined to have 6.5 m/s (21.3 ft/s) or higher average wind speed (U.S. Department of Energy, National Renewable Energy Laboratory 2010b p. 1). The vast majority of the occupied range lies within areas of 7.5 m/s (24.6 ft/s) or higher.

The potential influence of anticipated wind energy development on the status of the LEPC can readily be evaluated for Oklahoma. In cooperation with ODWC, Service personnel in 2005 quantified the potential degree of wind energy development in relation to existing populations of LEPC in Oklahoma. Using ArcView mapping software, all active and historic LEPC lek locations in Oklahoma, as of the mid 1990s (n = 96), and the current occupied range, were compared with the Oklahoma Neural Net Wind Power Development Potential Model map created by the Oklahoma Wind Power Assessment project. The mapping analysis revealed that 35 percent of the recently occupied range in Oklahoma is within areas designated by the Oklahoma Wind Power Assessment as "excellent" for wind energy development. When both the "excellent" and "good" wind energy development classes are combined, some 55 percent of the occupied range lies within those two classes.

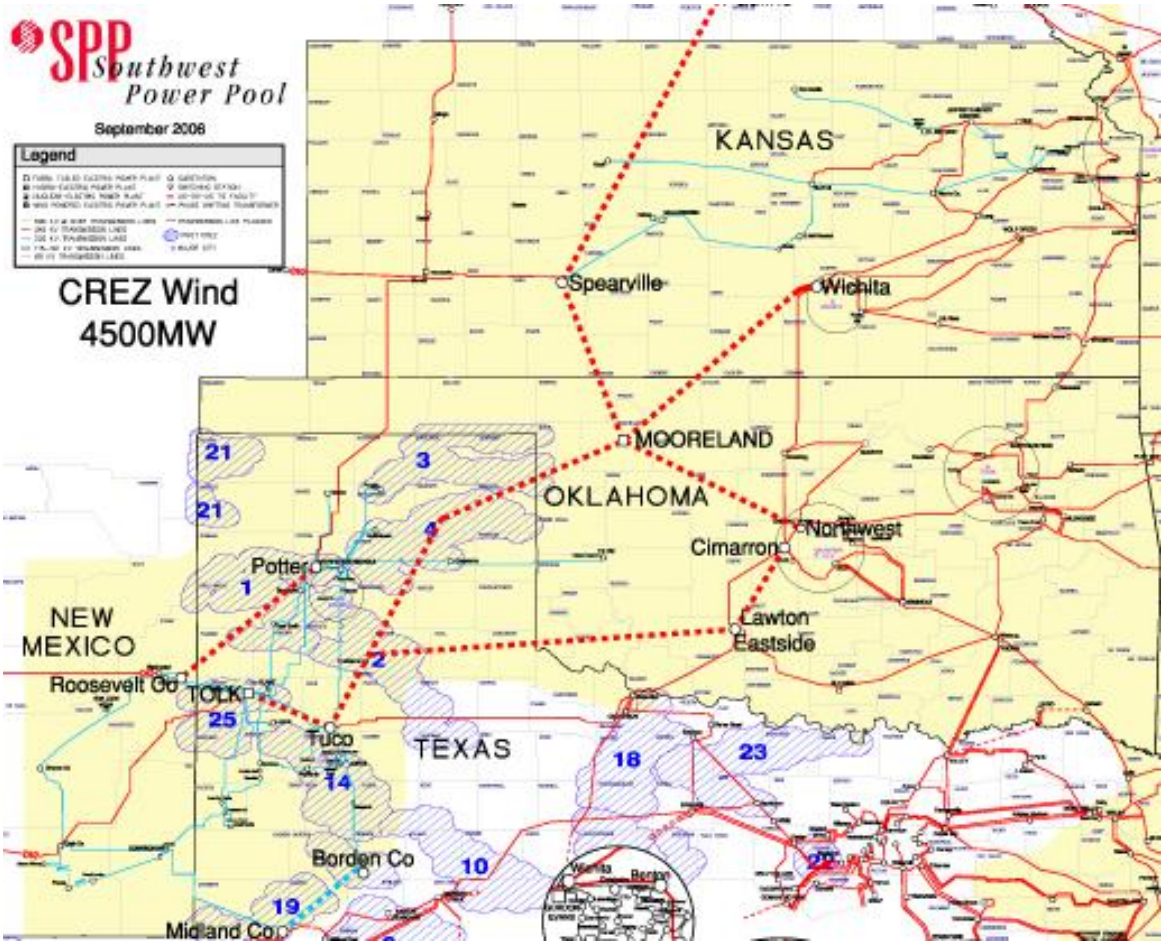
When leks were examined, the same analysis revealed a nearly complete overlap on all known active and historic lek locations, based on the known active leks during the mid 1990s. Roughly 91 percent of the known LEPC lek sites in Oklahoma are within 8 km (5 mi) of land classified as "excellent" for wind development (O'Meilia 2005). The analysis revealed that over half (53 percent) of all known lek sites occur within 1.6 km (1 mi) of lands classified as "excellent" for

commercial wind energy development. This second metric is particularly relevant given the average home range for a LEPC is about 10 sq km (4 sq mi) and that a majority of LEPC nesting generally occurs, on average, within 1.2 and 3.4 km (0.7 and 2.1 mi) of active leks (Hagen and Giesen 2005, p. 2). Using Robel's (2002) estimate derived for the greater prairie chicken of the zone of avoidance for a single commercial-scale wind turbine (1.6 km or 1 mi), development of commercial wind farms likely will have a significant adverse influence on reproduction of the LEPC.

Unfortunately, similar analyses are not available for the other states due to a lack of appropriate data layers for those states. However, southwestern Kansas currently supports the largest population and distribution of LEPC of all states. The influence of wind energy development on the LEPC in Kansas would likely be no less severe than in Oklahoma. In 2006, the Governor of Kansas initiated the Governor's 2015 Renewable Energy Challenge, an objective of which is to have 1,000 megawatts (MW) of renewable energy capacity in Kansas by 2015 (Cita *et al*. 2008, p. 1). A cost-benefit study (Cita *et al*. 2008, Appendix B) found that wind was the most cost effective and likely renewable energy resource for Kansas. Modestly assuming an average of 2 MW per turbine—most commercial scale turbines are between 1.5 and 2.5 MW—some 500 turbines would be erected in Kansas if this goal is to be met. While not all of those turbines would directly overlap occupied range, the best wind potential in Kansas occurs in the western portions of the state which largely overlaps currently occupied LEPC range (U.S. Department of Energy, National Renewable energy Laboratory 2010b, p. 1). Inappropriate siting of wind energy facilities and associated facilities, including electrical transmission lines, appears to be a serious threat to LEPC in western Kansas within the near future (Rodgers 2007a).

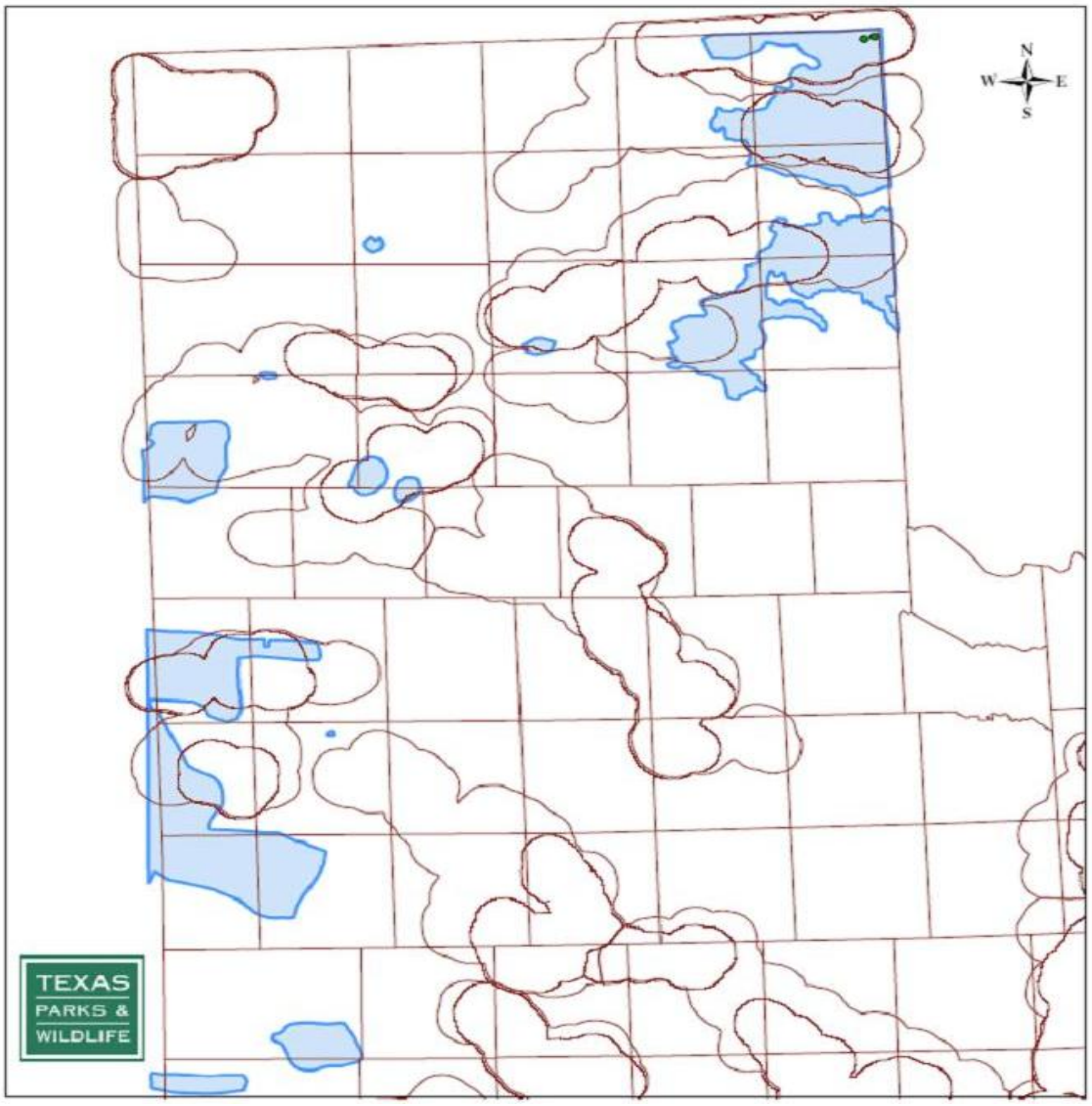
In Texas, the Public Utility Commission of Texas recently directed the Electric Reliability Council of Texas (ERCOT) to develop transmission plans for wind capacity to accommodate between 10,000 and 25,000 MW of power (AWEA 2007b, pp. 2-3). ERCOT is a regional transmission organization with jurisdiction over most of Texas. The remainder of Texas, largely the Texas panhandle, lies within the jurisdiction of the Southwest Power Pool (SPP). A recent assessment from ERCOT identified more than 130,000 MW of high-quality wind sites in Texas, more electricity than the entire state currently uses. The establishment of Competitive Renewable Energy Zones by ERCOT within the state of Texas will facilitate wind energy development throughout western Texas (see Figure 2). The Competitive Renewable Energy Zones, as shown on Figure 2, are identified by a number that indicates the development priority of each zone. The top four zones are located within occupied and historic LEPC habitat in the Texas panhandle.

Figure 2. Competitive Renewable Energy Zones (in blue) and planned transmission lines (dashed red lines) in portions of New Mexico, Texas, Oklahoma, and Kansas.



The TPWD reports that commercial wind energy development, based on the existing Competitive Renewable Energy Zones, threatens remaining LEPC populations in both the Permian Basin/Western Panhandle and the Northeastern Panhandle regions of Texas (Whitlaw 2007, p. 4; see Figure 2). The high level of overlap between the LEPC currently occupied range in Texas and the Competitive Renewable Energy Zones which are designated for future wind energy development in the Texas panhandle is shown in Figure 3.

Figure 3. Map depicting the degree of overlap between occupied LEPC habitat in Texas (shaded) and Competitive Renewable Energy Zones designated for future wind energy development in the Texas panhandle.



Development of high capacity transmission lines is critical to the development of the anticipated wind energy resources. According to ERCOT (AWEA 2007a, p. 9), every $1 billion invested in new transmission capacity enables the construction of $6 billion of new wind farms. Depicted on Figure 2 are the proposed electric transmission line upgrades which were provided to the Service by the SPP. The SPP is a Regional Transmission Organization which overlaps all or portions of nine states and functions to ensure reliable supplies of power, adequate transmission infrastructure and competitive wholesale prices of electricity. This map identifies approximately 423 km (263 mi) of proposed new transmission lines, commonly referred to as the "X Plan", that were being evaluated during the transmission planning process. Transmission planning continues to move forward and numerous alternatives are being evaluated, much of which will connect transmission capacity throughout all or portions of occupied LEPC range and serve to catalyze extensive wind energy development throughout much of the remaining occupied LEPC range in Kansas, Oklahoma, and Texas. Some recent priority transmission expansion projects identified by the SPP include: a 765 kV line from Spearville, Kansas to a planned substation in Comanche County, Kansas; a 345 kv line from Wichita, Kansas through a planned substation at

Medicine Lodge, Kansas to the planned substation in Comanche County, Kansas; a 765 kV line from the planned Comanche County, Kansas substation to a planned substation near Woodward, Oklahoma; and a 345 kV double circuit line from the proposed Woodward substation through the panhandle of Oklahoma to an existing substation located south of Guymon, Oklahoma (Pennel 2009, p.1).

Wind energy development in the Texas panhandle and portions of west Texas represents a serious threat to extant LEPC populations in the state. Once established, wind farms and associated transmission features would severely hamper future efforts to restore population connectivity and gene flow (transfer of genetic information from one population to another) between existing populations which are currently separated by unfavorable land use in the Texas panhandle.

In Colorado, the U.S. Department of Energy, National Renewable Energy Laboratory (2010b, p. 1) rated the southeastern corner of Colorado as having good wind resources, the largest area of Colorado with that ranking. The area almost completely overlaps the currently occupied range of the LEPC in Colorado. CDOW reported that commercial wind development is occurring in Colorado, but that most of the effort is currently centered north of the occupied range of LEPC in southeastern Colorado.

Wind energy development in New Mexico is a lower priority than other states within the range of the LEPC. In New Mexico, the suitability for wind energy development in the currently occupied range of the LEPC is only rated as fair (U.S. Department of Energy, National Renewable Energy Laboratory 2010b, p. 1). However some parts of northeastern New Mexico within LEPC historical range have been rated as excellent. Northeastern New Mexico is important to LEPC conservation because this area is vital to efforts to re-establish or re-connect the New Mexico LEPC population to those in Colorado and the Texas panhandle.

In summary, wind energy and associated infrastructure development is occurring within occupied portions of LEPC habitat. Where such development has occurred, these areas are no longer suitable for LEPC even though many of the typical habitat components used by LEPC remain. Proposed transmission line improvements will serve to facilitate further development of additional wind energy resources. Future wind energy developments, based on the known locations of areas with excellent to good wind energy development potential, likely will have substantial overlap with known LEPC populations. Additional areas that are currently unoccupied but lie within the historic range and provide suitable habitat for the LEPC also could be developed. These areas of unfragmented habitat are crucial to ongoing efforts to conserve the LEPC. Fragmentation of these areas would further modify or curtail the range of the LEPC and hamper efforts to conserve the species. Therefore, the Service considers the ongoing and large-scale potential for commercial wind power development, particularly in western Kansas, northwestern Oklahoma, and the Texas panhandle, to be a high-level threat to the survival of the species in the near future. Siting of wind farms and transmission lines in a manner that avoids fragmentation of LEPC habitat is important and some wind power developers appear sensitive to concerns about siting such facilities.

Oil and Gas Development

Oil and gas development affects LEPC by disrupting reproductive behavior (Hunt and Best 2004, p. 41) and through habitat fragmentation and conversion (Hunt and Best 2004, p. 92). Smith *et al*. (1998, p. 3) observed that almost one-half, 13 of 29, of the abandoned leks examined in southeastern New Mexico had a moderate to high level of noise. Hunt and Best (2004, p. 92) found that abandoned leks in southeastern New Mexico had more active wells, more total wells, and greater length of access road than active leks. They concluded that petroleum development at intensive levels is likely not compatible with populations of LEPC (Hunt and Best 2004, p. 92)

Impacts from oil and gas development and exploration are two reasons thought to be responsible for the species' near absence throughout previously occupied portions of the Carlsbad BLM unit in southeastern New Mexico (Belinda 2003, p. 3). This is supported by research examining LEPC losses over the past twenty years on Carlsbad BLM lands (Hunt and Best 2004, pp. 114-115). In this study, factor analysis (a statistical method used to describe variability among observed variables in reference to a number of unobserved variables) of characters associated with active and abandoned leks was conducted to determine which potential causes were associated with the population decline. Those variables associated with oil and gas development explained 32 percent of observed lek abandonment (Hunt and Best 2004) and the consequent population extirpation.

Well densities are increasing dramatically throughout many portions of LEPC range. Although the Service presently lacks the information to specifically quantify and analyze drilling activity throughout the entire historic and occupied range of the LEPC, known activity within certain areas of the historic range demonstrates the magnitude of the threat. For example, the amount of habitat fragmentation due to oil and gas extraction in the Texas panhandle and western Oklahoma associated with the Buffalo Wallow oil and gas field within the Granite Wash formation of the Anadarko Basin has steadily increased over time. In 1982, the rules for the Buffalo Wallow field allowed one well per 130 ha (320 ac). In May of 2005, the Texas Railroad Commission changed the field rule regulations for the Buffalo Wallow oil and gas field to allow oil and gas well spacing to a maximum density of one well per 8 ha (20 ac) (Texas Railroad Commission 2007). When fully developed at this density, the region will have experienced a 16 fold increase in habitat fragmentation in comparison with the rates allowed prior to 2005. Since 2005, TPWD and Service biologists report that new oil and gas well development within prime occupied habitat in the northeastern portion of the Texas panhandle within portions of Hemphill, Lipscomb, and Wheeler counties, Texas is occurring at a rapid rate (Whitlaw 2007. p. 4; Hughes 2008). Although the specific rate of expansion is unquantified, at least one company has reported that they have drilled 150 wells in this formation since 2005 (Forest Oil Corporation 2008).

In the BLM's special status species record of decision and approved resource management plan amendment (RMPA) some limited protections for the LEPC in New Mexico are provided by reducing the number of drilling locations, decreasing the size of well pads, reducing the number and length of roads, reducing the number of powerlines and pipelines, and implementing best management practices for development and reclamation (BLM 2008, pp. 5-31). The RMPA provides guidance for management of approximately 344,000 ha (850,000 ac) of public land and 121,000 ha (300,000 ac) of federal minerals in Chaves, Eddy, Lea, and Roosevelt counties in

New Mexico. Implementation of these restrictions, particularly curtailment of new mineral leases, would be greatest in the Core Management and Primary Population Areas (BLM 2008, pp. 9-11). The Core Management and Primary Population Areas are located in the core of the LEPC occupied range in New Mexico. The effect of these best management practices on the status of the LEPC is unknown, particularly considering about 60,000 ha (149,000 ac) have already been leased in those areas (BLM 2008, p. 8). The plan does stipulate that measures designed to protect the LEPC and sand dune lizard (*Sceloporus arenicolus*) may not allow approval of all spacing unit locations or full development of the lease (BLM 2008, p. 8).

Oil and gas development and exploration is ongoing in the remaining states although the precise extent is currently unknown. Some development is anticipated in Baca County, Colorado, although the timeframe for initiation of those activities is uncertain (CDOW 2007, p. 2). In Oklahoma, oil and gas exploration statewide continues at a high level. Since 2002, the average number of active drilling rigs in Oklahoma has steadily risen (Boyd 2009, p. 1). Since 2004, the number of active drilling rigs has remained above 150, reflecting the highest level of sustained activity since the 'boom' years from the late 1970s through the mid-1980s in Oklahoma (Boyd 2007, p. 1).

Fire Suppression

The frequency and intensity of disturbances are critical to ecological processes, biological diversity, and heterogeneity across multiple spatial scales in grassland ecosystems which evolved with fire and ungulate grazing, such as those in the Great Plains where LEPC occur (Collins 1992, pp. 2003-2005; Fuhlendorf and Smeins 1999, pp. 732, 737). North American grasslands and shrub lands evolved under, and are maintained by, ungulate grazing and frequent fire. Both grazing patterns (discussed in section on "Livestock Grazing" above) and fire frequency have been drastically altered since European settlement of the Great Plains. With few exceptions, burning of native rangelands was, and continues to be, perceived by landowners as destructive to rangelands, undesirable for maximizing cattle production, and likely to create wind erosion or "blowouts" in sandy soils. As a result, virtually all wildfires throughout LEPC range were historically suppressed, and relatively little prescribed burning now occurs on private land.

While prescribed burning is now recognized as the preferred method to control and prevent tree invasion of native rangeland, prescribed fire is generally employed only after significant invasion has already occurred and landowners believe that forage production for cattle is becoming diminished. The threshold of tree invasion at which forage production is significantly reduced is far greater than the threshold at which grassland dependent and grassland obligate birds such as LEPC can survive. For example, Coppedge *et al*. (2001, pp. 51-57) examined bird response to eastern red cedar (*Juniperus virginianus*) invasion into native and CRP grasslands in western Oklahoma using Breeding Bird Survey data spanning from the time period 1965 to 1995. They found that grassland bird populations declined or exhibited negative associations with woody vegetation gradients. In particular, western meadowlark (*Sturnella neglecta*) populations declined across a gradient of increasing encroachment, and were extirpated from areas with the most eastern red cedar. Woody plant invasion also affected habitat patch size, and areas with the least amount of woody cover retained core areas suitable for species associated with core patch size.

Because LEPC habitat is characterized by extensive patches of treeless grassland and shrubland habitat (Giesen 1998, pp. 3-4), the invasion of remaining native habitat within LEPC range by woody species such as eastern red cedar is a growing concern. An analysis of the rate of spread of eastern red cedar trees in Oklahoma by Oklahoma State University and the Oklahoma Cooperative Extension Service indicated that by 1995, eastern red cedar invasion would consume approximately 308 ha (762 ac) of rangeland habitats in Oklahoma each day, on average, amounting to over 113,312 ha (280,000 ac) annually (Bidwell *et al*. 2000, p. 4). More recently, a time series infrared satellite mapping analysis conducted by the Oklahoma NRCS in 2005 revealed that eastern red cedar trees alone are invading native rangelands in western Oklahoma at a rate of approximately 5 percent per year (Eckroat 2007). Given that southern Kansas and the northeastern Texas panhandle have similar rates of precipitation, fire exclusion, and grazing pressure compared to western Oklahoma, this rate of spread may be occurring throughout occupied LEPC range in these areas.

Tree invasion in native rangeland has the potential to render significant portions of remaining occupied habitat unsuitable within the near term. Woodward *et al.* (2001, pp. 270-271) documented a negative association between landscapes with increased woody cover and LEPC population indices. Similarly, Fuhlendorf *et al*. (2002, p. 625) examined the effect of landscape structure and change on population dynamics of LEPC in western Oklahoma and northern Texas. They found that landscapes with declining LEPC populations had significantly greater increases in tree cover types (riparian, windbreaks, and eastern red cedar encroachment) than landscapes with sustained LEPC populations.

Summary of Factor A

The curtailment of LEPC range has occurred throughout large portions of four of the five states occupied by LEPC. Estimates reveal that some 86 percent of the historically occupied range has been lost due to a variety of mechanisms including conversion of rangeland to cultivated cropland, energy development, and habitat fragmentation. In Kansas, the loss of suitable habitat has been offset by the restoration of native grasslands due to implementation of CRP. However, these short-term gains are expected to be negated as CRP contracts expire and the lands are converted to other uses. Rangewide destruction and modification of remaining LEPC habitat continues to occur. Within the next few years, the possible conversion of over a million acres of currently enrolled CRP grasslands to cropland and other less suitable land uses has the potential to destroy or modify some 14 percent of the remaining occupied habitat. Wind energy development with its associated infrastructure development is ongoing and the potential for additional wind energy facilities is substantial within nearly all occupied habitat in all states except New Mexico, where it may impact historical habitat important to linking the New Mexico population to populations to the north. Additionally, the continued loss and degradation of currently occupied habitat in several areas in the form of heavy grazing by livestock, woody plant invasion due to fire suppression, oil and gas development, and fragmentation are rendering portions of the range uninhabitable for the species.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

In the late 19th century, LEPC were subject to market hunting (Jackson and DeArment 1963). Harvest has been regulated since approximately the turn of the 20th century (Crawford 1980, pp. 3-4). Currently, the LEPC is classified as a game species in Kansas, New Mexico, Oklahoma, and Texas, although legal harvest is allowed only in Kansas. In March of 2009, Texas adopted a temporary, indefinite suspension of their current two-day season until LEPC populations recover to huntable levels. Previously in Texas, LEPC harvest was not allowed except on properties with an approved wildlife management plan specifically addressing the LEPC.

In Kansas, the bag limit is one bird daily for LEPCs located south of Interstate 70 and two birds for LEPCs located north of Interstate 70. During the 2006 season, Kansas hunters expended 1,900 hunter-days and harvested approximately 200 LEPC. Given the low number of LEPCs harvested per year in Kansas relative to the population size, the statewide harvest is probably insignificant at the population level.

Collectively, the total annual harvest in both Kansas and Texas was fewer than 1,000 birds annually. Both Hunt and Best (2004, p. 93) and Giesen (1998, p. 11) do not believe hunting has an additive mortality although in the past, hunting during periods of low population cycles may have accelerated declines (Taylor and Guthery 1980b, p. 2). However, because most remaining LEPC populations are now very small and isolated, and because they naturally exhibit a clumped distribution on the landscape, they are likely vulnerable to local extirpations through many mechanisms, including human harvest. Braun *et al*. (1994, p. 435) called for definitive experiments that evaluate the extent to which hunting is additive at different harvest rates and in different patch sizes. They suggested conservative harvest regimes for small or fragmented grouse populations because fragmentation likely decreases the resilience of populations to harvest. Sufficient information to determine the rate of localized harvest pressure is unavailable and, therefore, the Service cannot determine whether such harvest contributes to local population declines.

An additional activity that has the potential to negatively affect individual LEPC populations is the growing occurrence of public and guided bird watching tours of leks during the breeding season. The site-specific impact of recreational observations of LEPC at leks is currently unknown. However, disturbance effects are likely to be minimal at the population level if disturbance is avoided by observers remaining in vehicles or blinds until LEPC naturally disperse from the lek and observations are confined to a limited number of days and leks. Solitary leks comprised of fewer than ten males are most likely to be affected by repeated recreational disturbance. Research is needed to quantify this potential threat to local populations of LEPC.

In summary, it is possible that LEPCs harvested through sport hunting might be contributing to a decline of some populations, but we have no information that shows whether this is actually occurring and no basis on which to estimate whether it might be a problem in some areas. We are not aware of any other forms of utilization that are negatively impacting LEPC populations. Consequently, we conclude that overutilization is not a basis for concluding that listing the LEPC is warranted.

C. Disease or predation.

Giesen (1998, p. 10) provided no information on ectoparasites or infectious diseases in LEPC, although several endoparasites, including nematodes and cestodes, are known to infect the species. In Oklahoma, Emerson (1951, p. 195) documented the presence of the external parasites (biting lice-Order Mallophaga) *Goniodes cupido* sp. and *Lagopoecus* sp. in an undisclosed number of LEPC. Between 1997 and 1999, Robel *et al*. (2003, p. 342) conducted a study of helminth parasites in LEPC from southwestern Kansas. Of the carcasses examined, 95 percent had eye worm (*Oxyspirura petrowi*), 92 percent had stomach worm (*Tetrameres* sp.), and 59 percent had cecal worm (*Subulura* sp.) (Robel *et al*. 2003, p. 341). No adverse impacts to the LEPC population they studied were evident as a result of the observed parasite burden. Addison and Anderson (1969, p. 1223) also found eyeworm (*O. petrowi*) from a limited sample of LEPC in Oklahoma. The eyeworm also has been reported from LEPC in Texas (Pence and Sell (1979, p. 145). Pence and Sell (1979, p. 145) also observed the roundworm *Heterakis isolonche* and the tapeworm *Rhabdometra odiosa* from LEPC in Texas. Smith *et al*. (2003, p. 347) reported on the occurrence of blood and fecal parasites in LEPC in eastern New Mexico. Eight percent of the examined birds were infected with *Eimeria tympanuchi*, an intestinal parasite, and 13 percent were infected with *Plasmodium pedioecetii*, a hematozoan. Stabler (1978, p. 1126) first reported *Plasmodium pedioecetii* in the LEPC from samples collected from New Mexico and Texas. In the spring of 1997, a sample of 12 LEPC from Hemphill County, Texas, were tested for the presence of disease and parasites. No evidence of viral or bacterial diseases, hemoparasites, parasitic helminths, or ectoparasites was found (Hughes 1997, p. 2).

Peterson *et al*. (2002, p. 835) reported on an examination of 24 LEPC from Hemphill County, Texas for several disease agents. LEPC were seropositive for both the Massachusetts and Arkansas serotypes of avian infectious bronchitis, a type of coronavirus. All other tests were negative.

Reticuloendotheliosis is a viral disease documented from poultry, which has been found to cause serious mortality in captive Attwater's prairie-chickens (*Tympanuchus cupido attwateri*) and greater prairie-chickens. Researchers surveyed blood samples from 184 LEPC from three states during 1999 and 2000, for the presence of reticuloendotheliosis. All samples were negative, suggesting that reticuloendotheliosis may not be a serious problem for most wild populations of LEPC (Wiedenfeld *et al*. 2002, p. 143).

The impact of West Nile virus on LEPC is unknown. Ruffed grouse (*Bonasa umbellus*) have been documented to harbor West Nile virus infection rates similar to some corvids (crows, jays, and ravens). For 130 ruffed grouse tested in 2000, all distant from known West Nile virus epicenters, 21 percent tested positive. This was remarkably similar to American crows (*Corvus brachyrhynchos*) and blue jays (*Cyanocitta cristata*) (23 percent for each species), species with known susceptibility to West Nile virus (Bernard *et al*. 2001, p. 681). Recent analysis of the degree of threat to prairie grouse from parasites and infectious disease concluded that microparasitic infections that cause high mortality across a broad range of galliform (wildfowl species such as turkeys, grouse, and chickens) hosts have the potential to extirpate small, isolated prairie grouse populations (Peterson 2004, p. 35).

Non-parasitic diseases caused by mycotoxins, as well as pesticides and other toxic compounds,

also have the potential to influence population dynamics. However, the incidence of disease or parasite infestations in regulating populations of the LEPC is unknown. The LEPC Interstate Working Group (1997, p. 12) concluded that, while density-dependent transmission of disease was unlikely to have a significant effect on LEPC populations, a disease that was transmitted independently of density could have drastic effects. Further research is needed to establish whether parasites regulate prairie grouse populations. Peterson (2004, p. 35) urged natural resource decision makers to be aware that macro- and micro-parasites cannot be safely ignored as populations such as LEPC become smaller, more fragmented, and increasingly vulnerable to the effects of disease. Some degree of impact of parasites and disease is a naturally occurring phenomenon for most species, and one element of compensatory mortality that occurs among many species. There is no information that indicates parasites or disease are causing, or contributing to, the decline of any LEPC populations and at this time we have no basis for concluding that disease or parasite loads are threatening any LEPC populations.

Prairie falcon (*Falco mexicanus*), northern harrier (*Circus cyaneus*), Cooper's hawk (*Accipiter cooperii*), great-horned owl (*Bubo virginianus*), other unspecified raptors, and coyote (*Canis latrans*) have been identified as predators of LEPC adults and chicks (Davis *et al*. 1979, pp. 84-85; Merchant 1982, p. 49; Haukos and Broda 1989, pp. 182-183; Giesen 1994a, p. 96). Predators of nests and eggs also include Chihuahuan raven (*Corvus cryptoleucus*), striped skunk (*Mephitis mephitis*), ground squirrels (*Spermophilus* spp.), and bullsnakes (*Pituophis melanoleucus*), as well as coyotes and badgers (*Taxidea taxus*) (Davis *et al*. 1979, p. 51; Giesen 1998, p. 8). LEPC predation varies in both form and frequency throughout the year, with raptor predation increasing coincident with lek attendance (Wolfe *et al*. 2007, p. 100). Patten *et al*. (2005b, p. 240) stated that male LEPC are more vulnerable to predation when exposed during lek displays than they are at other times of the year and that male LEPC mortality was chiefly associated with predation. For females, predation during the nesting season would likely have the most significant impact on LEPC populations, particularly if that predation resulted in total loss of a particular brood.

Predation is a naturally occurring phenomenon and generally does not pose a risk to wildlife populations unless the populations are extremely small or have an abnormal level of vulnerability to predation. Predation on LEPC may be especially important relative to nest success. Nest success and brood survival of greater prairie-chickens accounted for most of the variation in population finite rate of increase (Wisdom and Mills 1997, p. 308). Bergerud (1988, pp. 646, 681, 685) concluded that population changes in many grouse species are driven by changes in breeding success. An analysis of Attwater's prairie chicken supported this conclusion (Peterson and Silvy 1994, p. 227). Recent demographic research on LEPC in southwestern Kansas confirmed that changes in nest success and chick survival, two factors closely associated with vegetation structure, have the largest impact on population growth rates and viability (Hagen *et al*. 2009, p. 1329).

The community of prairie mammals has undergone a significant restructuring due to destruction of habitat, removal of keystone species (a species that plays a pivotal role in maintaining the structure of an ecological community and whose impact on the community is greater than would be expected based on its relative abundance or biomass alone) and top predators, and the increase in generalists and introduced animals (Benedict *et al*. 1996, pp. 149-159). The reduction in large

canid populations (wolves (*Canis lupus*) and coyotes) following European settlement of the Great Plains (Caire *et al*. 1989, pp. 278, 282-283) may have been responsible for an expansion in both population size and range of medium-sized, generalist predators such as skunk, raccoon (*Procyon lotor*), and fox (*Vulpes fulva, Urocyon cinereoargenteus*) (Bowles 1981, p. 38; Jones *et al*. 1983, pp. 258-263, 301-306; Benedict *et al*. 1996, p. 157). These predators are known to reduce nest success in ducks, quail, and other ground nesting birds such as bobwhite quail (*Colinus virginianus*) and LEPC (Guthery and Beasom 1977, p. 404; Sargeant *et al*. 1984, pp. 36-37; Garrettson *et al*. 1996, p. 98; Henke and Bryant 1999, pp. 1066-1067).

Rates of predation on LEPC also are affected by habitat quality. As habitat fragmentation increases, the effects of terrestrial nest predators on grouse populations may increase (Braun *et al*. 1978, p. 316). Similarly, as habitat quality decreases through reduction in vegetative cover due to grazing or herbicide application, predation of LEPC nests, juveniles, and adults are all expected to increase. For this reason, researchers maintain that ensuring adequate shrub cover and removing raptor perches such as trees, power poles, and fence posts may lower predation more than any conventional predator removal methods (Wolfe *et al.* 2007, p. 101). However, there is not specific information that indicates predation is resulting in, or contributing to, a decline of any LEPC populations.

Although we have information on disease in LEPC and impacts of predators on LEPC at various life stages, there is no information that indicates either disease or predation are causing or contributing to population declines. Consequently, disease and predation do not contribute to a basis for a finding that listing the LEPC is warranted.

D. The inadequacy of existing regulatory mechanisms.
In 1973, the LEPC was listed as threatened in Colorado under the State's Nongame and Endangered or Threatened Species Conservation Act. While this designation prohibits unauthorized take, possession, and transport, no protections are provided for destruction or alteration of LEPC habitat. In the remaining states, the LEPC is classified as a game species, although the legal harvest is now closed in New Mexico, Oklahoma, and Texas. Accordingly, the State wildlife agencies do have the authority to regulate possession of the LEPC, set hunting seasons, and issue citations for poaching.

In July of 1997, the NMDGF received a formal request to commence an investigation into the status of the LEPC within New Mexico. This request began the process for potential listing of LEPC under New Mexico's Wildlife Conservation Act. In 1999, the recommendation to list the LEPC as a threatened species under the Wildlife Conservation Act was withdrawn until more information was collected from landowners, lessees, and land resource managers who may be affected by the listing or who may have information pertinent to the investigation. In late 2006, NMDGF determined that LEPC would not be state-listed in New Mexico. New Mexico's Wildlife Conservation Act, under which the LEPC could have been listed, offers little opportunity to prevent otherwise lawful activities, including the activities addressed under Factor A.

Regardless of each state's listing status, most occupied LEPC habitat throughout its current range occurs on private land (Taylor and Guthery 1980b, p. 6), where State wildlife agencies have little

authority to protect or direct management of the species' habitat. All five states in occupied range have incorporated the LEPC as a species of conservation concern and management priority in their respective State Wildlife Action Plans. While identification of the LEPC as a species of conservation concern does help heighten public awareness, this designation provides no protection from direct take or habitat destruction or alteration.

The National Forest Management Act is the principal law regarding the planning and management of national forests and grasslands by the USFS. A new planning rule (36 CFR Part 219) took effect on April 21, 2008. The previous planning regulation that was in place regarding preparation of the existing land and resource management plan for National Forests and National Grasslands included a requirement for the USFS to identify species as management indicator species, if their population changes were believed to be indicative of the effects of management activities (36 CFR 219.19). Under the new regulations, the concept of management indicator species was not included in the final rule. According to the new regulations, species that are identified as proposed and candidate species under the Endangered Species Act are now termed species-of-concern. The primary purpose of identifying species-of-concern is to put in place provisions that will contribute to keeping those species from being listed as threatened or endangered.

In Region 2 of the USFS, the Pike and San Isabel National Forest's Comanche and Cimarron National Grassland Land and Resource Management Plan was the first plan developed and released under the new 2008 planning rule. The pre-decisional review version of the Cimarron and Comanche National Grasslands Land Management Plan was made available to the public on October 17, 2008. The LEPC was included as a species-of-concern (USFS 2008, p. 35). The plan currently retains the Comanche LEPC Habitat Zoological Area, now designated as a Colorado Natural Area, which encompasses an area of 4,118 ha (10,177 ac) that is managed to benefit the LEPC. Current conditions on this area include existing oil and gas leases, two-track roads, utility corridors, and livestock grazing. Wildfires on the area have been suppressed over the last 30 years. The area provides a special viewing area for the LEPC, which has been closed. The plan specifies that the desired future condition of the area would be to retain habitat conditions suitable for the LEPC. Specifically, the objectives of the plan identify steps that would be taken over the next 15 years to achieve the desired conditions. One objective would be to retain a minimum of 6,665 ha (16,470 ac) of sand sagebrush prairie ecosystem for the LEPC. Within the Comanche LEPC Habitat Zoological Area, over the next 15 years a minimum of 202 ha (500 ac) would be treated to increase native plant diversity.

Design criteria identified in the current land and resource management plan for management of the sand sagebrush prairie include: 1) limited construction of new structures or facilities typically within 3.2 km (2 mi) of known LEPC leks or populations if those structures and facilities would negatively impact the LEPC; 2) protect leks, nesting habitat, and brood rearing habitat from surface disturbances (e.g., dog training, drilling, and various forms of construction) between March 15 to July 15; and 3) provide adequate residual cover during nesting periods. Within the Comanche LEPC Habitat Zoological Area, design criteria include limiting or using livestock grazing in a manner that does not negatively impact LEPC nesting habitat. The USFS also committed to monitoring any changes in distribution and abundance of the LEPC on the National Grasslands.

The USFS, under the old planning rule, also contracted with LEPC experts to prepare a succinct evaluation of species of potential viability concern, addressing eight factors pertinent to species viability. A Technical Conservation Assessment for the LEPC (Robb and Schroeder 2005, p. 8) was completed and confirms the need to retain sensitive species status designation for the LEPC. Species conservation assessments produced as part of the Species Conservation Project are designed to provide land managers, biologists, and the public with a thorough discussion of the biology, ecology, conservation, and management of the LEPC based on existing scientific knowledge. The assessment goals limit the scope of the work to summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific prescriptions for management of populations and habitats. Instead, it is intended to provide the ecological background upon which management should be based and focuses on the consequences of changes in the environment that result from management (i.e., management implications). This comprehensive document can be found on the internet at *http://www.fs.fed.us/r2/projects/scp/assessments/lesserprairiechicken.pdf*.

The other Federal land occupied by LEPC is administered by the BLM in New Mexico. In New Mexico, roughly 41 percent of the known historic and most of the currently occupied LEPC range occurs on BLM land. The BLM currently manages approximately 342,969 surface ha (847,491 ac) in eastern New Mexico. They also oversee another 120,529 ha (297,832 ac) of Federal minerals below private surface ownership. The core of currently occupied LEPC habitat in New Mexico is within the Roswell BLM Resource Area. However, the Carlsbad BLM Resource Area comprised much of the historic southern periphery of the species' range in New Mexico. The BLM's amended RMPA (BLM 2008, pp. 5-31) provides some limited protections for the LEPC in New Mexico by reducing the number of drilling locations, decreasing the size of well pads, reducing the number and length of roads, reducing the number of powerlines and pipelines, and implementing best management practices for development and reclamation. Implementation of these protective measures, particularly curtailment of new mineral leases, would be greatest in the Core Management and Primary Population Areas (BLM 2008, pp. 9-11). The Core Management and Primary Population Areas are located in the core of the LEPC occupied range in New Mexico. The effect of these best management practices on the status of the LEPC is unknown, particularly considering some 60,000 ha (149,000 ac) have already been leased in those areas (BLM 2008, p. 8). The effectiveness of the amended RMPA is hampered by a lack of explicit measures designed to improve the status of the LEPC, limited certainty that resources will be available to carry out the management plan, limited regulatory or procedural mechanisms in place to carry out the efforts, lack of monitoring efforts, and provision for exceptions to the best management practices under certain conditions, which could negate the benefit of the conservation measures.

The amended RMPA does stipulate that implementation of measures designed to protect the LEPC and sand dune lizard may not allow approval of all spacing unit locations or full development of a lease (BLM 2008, p. 8). In addition, the RMPA prohibits drilling and exploration in LEPC habitat between March 1 and June 15 of each year (BLM 2008, p. 8). No new mineral leases will be issued on approximately 32 percent of Federal mineral acreage within the RMPA planning area (BLM 2008, p. 8), although some exceptions are allowed on a case-by-

case basis (BLM 2008, pp. 9-11). Within the Core Management Area and Primary Population Area, new leases will be restricted in occupied and suitable habitat; however, if there is an overall increase in reclaimed to disturbed acres over a 5-year period, new leases in these areas will be allowed (BLM 2008, p. 11). Considering Hunt and Best (2004, p. 92) concluded that petroleum development at intensive levels likely is not compatible with populations of LEPC, additional development in the Core Management Area and Primary Population Area may hinder long-term conservation of the species in New Mexico. The RMPA allows lease applicants to voluntarily participate in a power line removal credit to encourage removal of idle power lines (BLM 2008, pp. 2-41). In the Sparse and Scattered Population Area and the Isolated Population Area to the south, where LEPCs are now far less common than in previous decades (Hunt and Best 2004), new leases will not be allowed within 2.4 km (1.5 mi) of a lek (BLM 2008, p. 11).

The ineffectiveness of certain imposed energy development stipulations near leks for the purpose of protecting grouse on Federal lands has been recently confirmed for sage grouse. Holloran (2005, p. 57) and Naugle *et al*. (2006a, p. 3) documented that sage grouse avoid energy development (coalbed methane) not only in breeding and nesting habitats, but also in wintering habitats. They assert that current best management practices in use by Federal land management agencies that place timing stipulations or limit surface occupancy near greater sage-grouse (*Centrocercus urophasianus*) leks result in a human footprint that far exceeds the tolerance limits of sage grouse. Ultimately, they recommended that effective conservation strategies for grouse must limit the cumulative impact of habitat disturbance, modification, and destruction in all habitats and at all times of the year (Holloran *et al*. 2005, p. 58; Naugle *et al*. 2006b, p. 12). Additional research on the effect of petroleum development on LEPC is needed. However available information on the LEPC (Hagen *et al*. 2004, pp. 74-75; Hunt and Best 2004, p. 92; Pitman *et al*. 2005, pp. 1267-1268) indicates that the effect is often detrimental.

Because only about four percent of the species' overall range occurs on Federal lands, the Service recognizes that the LEPC cannot be fully recovered on Federal lands alone. However, no laws or regulations currently protect LEPC habitat on private land, aside from State harvest restrictions. Therefore, the Service views decisions regarding the management and leasing of Federal lands and minerals within existing LEPC range as important to the future conservation and persistence of the species.

Since 2004, the construction of commercial wind energy projects near and within occupied LEPC habitat has raised concerns about the potential negative effects such projects may have on the species, if constructed at large scales in occupied range. As discussed under Factor A, a rapid expansion of transmission lines and associated wind energy development throughout large portions of occupied LEPC range is occurring. Because most wind development activities are privately funded and are occurring on private land, wind energy siting and development and operation falls outside the purview of the National Environmental Policy Act of 1969 (NEPA) and other Federal conservation statues and regulatory processes. As a result, little opportunity for timely and appropriate environmental review and consultation by Federal, State, and local conservation entities exists.

The current lack of regulatory oversight and public notice requirements for the purchase of wind rights and construction of wind generation and related transmission facilities is a concern.

Specifically, the Service is unaware of any State or Federal mechanisms that require potential wind energy producers to disclose the location, size, and anticipated construction date for pending projects or require analysis under the provisions of the NEPA. Lacking the ability to obtain pertinent siting information or analyze alternative siting locations, neither the Service nor State wildlife agencies have the ability to accurately influence the size and or timing of wind generation construction activities within occupied LEPC habitat.

In conclusion, most occupied LEPC habitat occurs on private land, where State wildlife agencies have little authority to protect LEPC or facilitate and monitor management of LEPC habitat beyond regulating recreational harvest. Because most LEPC habitat destruction and modification on private land occurs through otherwise lawful activities such as agricultural conversion, livestock grazing, energy development, and fire exclusion, few if any regulatory mechanisms are in place to substantially alter human land uses at a sufficient scale to protect LEPC populations and their habitat. While almost no regulatory protection is in place for the species, regulatory incentives, in the form of county, State, and national legislative actions, have been created to facilitate the expansion of structural fragmentation of occupied LEPC habitat, such as from oil, gas, and wind energy development. For the remaining four percent of occupied habitat currently under Federal management, habitat quality depends primarily on factors related to multiple use mandates, such as livestock grazing and oil, gas, and wind power development activities. Because prior leasing commitments and management decisions on the majority of occupied parcels of Federal land offer little flexibility for reversal, any new regulatory protection for uncommitted land units are unlikely to achieve substantial benefits for or recovery of the species in the short term.

We note also that the existing regulatory mechanisms at the Federal and State level have not been sufficient to preclude the decline of the species, and that under existing mechanisms the present and threatened destruction, modification, and curtailment of LEPC habitat and range (as described in Factor A above) is ongoing. Consequently, we conclude that the inadequacy of existing regulatory mechanisms contributes to a basis for concluding that listing the LEPC is warranted.

E. Other natural or manmade factors affecting its continued existence.

Drought

Drought is considered a universal ecological driver across the Great Plains (Knopf 1996, p. 147). Infrequent, severe drought may cause local extinctions of annual forbs and grasses that have invaded stands of perennial species and recolonization of these areas may be slow (Tilman and El Haddi 1992, p. 263). In this way, drought may impact LEPC through its effect on seasonal growth of vegetation necessary to provide nesting and roosting cover, food, and opportunity for escape from predators (Merchant 1982, p. 51; Peterson and Silvy 1994, p. 227; Morrow *et al*. 1996, pp. 596-597). The sensitivity of LEPC to drought was discussed by Crawford (1980, pp. 4, 5) and Hamerstrom and Hamerstrom (1961, p. 289). Precipitation appears to affect LEPC adult population trends with a potential lag effect (Giesen 2000, p. 145). That is, rain in one year promotes more vegetative cover for eggs and chicks in the following year, which enhances their survival. The effects of drought are likely exacerbated by land use practices, but no studies have

clearly demonstrated such cumulative impacts on populations (Hagen and Giesen 2005, p. 1).

LEPC home ranges have been documented to be larger in drought years (Copelin 1963, p. 37; Merchant 1982, p. 39), and recruitment may be depressed following drought years (Merchant 1982, pp. 43-48; Morrow 1986, p. 597; Giesen 1998, p. 11). Nest failure and poor chick survival in general (Merchant 1982, p. 56) may drive population trends more than annual changes in adult survival (Hagen 2003, pp. 176-177). Along with other prairie grouse, LEPC have high reproductive potential in years of adequate precipitation conditions. Although drought conditions are unlikely to be the sole causative factor in long-term LEPC population declines, the effects of drought on population growth rate may exacerbate the extirpation risk to small, fragmented populations.

Projections based on an analysis using 19 different climate models revealed that southwestern North America, including the entire historical range of the LEPC, will consistently become drier throughout the 21st century (Seager *et al*. 2007, p. 1181). Severe future droughts are anticipated, particularly during persistent La Niña events, but they are anticipated to be more severe than most droughts on record (Seager *et al*. 2007, pp. 1182-1183). LEPC populations are expected to decline in response to drought conditions. Biologists in several states previously confirmed a reduction in LEPC population indices following drought conditions in 2006 and severe winter conditions in 2006 and early 2007. For example, in 2007, LEPC lek indices from surveys in Hamilton County, Kansas declined by nearly 70 percent from 2006 levels, and were the lowest on record (Rodgers 2007b, p. 3). In combination with other mounting threats, the Service views the population reductions as a result of drought conditions in 2006, as well as the current low precipitation trend (Oklahoma Climatological Survey 2009), as an additional threat to vulnerable portions of the remaining population throughout all states.

Nest Parasitism and Competition by Exotic Species

Pheasants (*Phasianus colchicus*) are nonnative species that overlap the range of the LEPC in Kansas and portions of Colorado, Oklahoma, and Texas (Johnsgard 1979, p. 121). Hen pheasants have been documented to lay eggs in the nests of several bird species, including LEPC and greater prairie-chicken (Hagen *et al*. 2002, pp. 522-524; Vance and Westemeier 1979, p. 223; Kimmel 1987, p. 257; Westemeier *et al*. 1989, pp. 640-641). Consequences of nest parasitism vary, and may include abandonment of the host nest, reduction in number of host eggs, lower hatching success, and parasitic broods (Kimmel 1987, p. 255). Predation rates also may increase with incidence of nest parasitism (Vance and Westemeier 1979, p. 224). Further consequences are hypothesized to include the imprinting of the pheasant young from the parasitized nest to the host species, and later attempts by male pheasants to court females of the host species (Kimmel 1987, pp. 256-257). Male pheasants have been observed disrupting the breeding behavior of greater prairie-chickens on leks (Sharp 1957, pp. 242-243; Follen 1966, pp. 16-17; Vance and Westemeier 1979, p. 222). In addition, pheasant displays toward female prairie-chickens almost always cause the female to leave the lek (Vance and Westemeier 1979, p. 222). Thus, an attempt by a male pheasant to display on a prairie-chicken lek could disrupt the normal courtship activities of prairie-chickens.

Only one published account of LEPC nest parasitism by pheasants exists (Hagen *et al*. 2002, pp.

522-524), although biologists from KPWD, ODWC, Sutton Center, TPWD, and the Oklahoma Cooperative Fish and Wildlife Research Unit have given more than 10 unpublished accounts of such occurrences. Westemeier *et al*. (1998, p. 858) documented statistically that for a small, isolated population of greater prairie-chickens in Illinois, nest parasitism by pheasants significantly reduced the hatchability of nests. Based on their findings, they submit that in areas with high pheasant populations, the survival of isolated, remnant flocks of prairie-chicken may be enhanced by management intervention to reduce nest parasitism by pheasants (Westemeier *et al*. 1988, p. 861). While Hagen *et al*. (2002, p. 523) documented a rate of only 4 percent parasitism (3 of 75 nests) of LEPC nests in Kansas, the sample size was small and may not reflect actual impacts across larger time, geographic, and precipitation scales. Competition with and parasitism by pheasants may be a potential factor that could negatively affect vulnerable LEPC populations at the local level, particularly if remaining native rangelands become increasingly fragmented (Hagen *et al*. 2002, p. 524). More research is needed to understand and quantify impacts of pheasants on LEPC populations range wide.

Insecticides

To date, no studies have been conducted examining potential effects of agricultural insecticide use on LEPC populations. However, significant impacts from pesticides to other prairie grouse have been documented. Of approximately 200 sage grouse known to be feeding in a block of alfalfa sprayed with dimethoate, 63 were soon found dead, and many others exhibited intoxication and other negative symptoms (Blus *et al*. 1989, p. 1139). Because LEPC are known to selectively feed in alfalfa fields throughout their range, the Service believes there may be cause for concern that similar impacts may be occurring.

Herbicides

Mixed sand sagebrush and shinnery oak rangelands are well documented as preferred LEPC habitat, and long term stability of shrubland landscapes has been shown to be particularly important to the species (Woodward *et al*. 2001, p. 271). Consequently, herbicide application to native rangelands for the purposes of permanently decreasing or eliminating the shrub component to increase forage production for livestock reduces habitat quality for LEPC throughout the species' range. Herbicide application (primarily 2,4-D and tebuthiuron) to reduce or eliminate shrubs from native rangelands is a common ranching practice throughout LEPC range. Through foliar and pellet application, respectively, these herbicides are designed to kill or suppress by repeatedly defoliating dicotyledon plants such as forbs, shrubs, and trees, while causing no significant damage to monocotyledon plants such as grasses.

Several studies have shown that shrub removal, primarily by herbicide application, is one mechanism that may be contributing to observed declines of LEPC (Fuhlendorf *et al*. 2002, pp. 624-626; Bell 2005, pp. 23-25; Haukos and Smith 1989, p. 625). Observations by Johnson *et al*. (2004, pp. 338-342) suggest that herbicide treatment to control shinnery oak adversely impacts nesting LEPC. Bell (2005, pp. 20-21) documented strong thermal selection for, and dependency of LEPC broods on, shinnery oak dominance in shrubland habitats. Both Bell (2005, pp. 20-23) and Patten *et al*. (2005a, pp. 1274-1275) revealed that survivorship was statistically higher for LEPC that used sites with greater than 20 percent cover of shrubs than for those choosing 10 to

20 percent cover; in turn, survivorship was statistically higher for LEPC choosing 10 to 20 percent cover than for those choosing less than 10 percent cover. In particular, shrub cover (especially of shinnery oak), canopy height, and mid-height density were markedly and statistically higher at LEPC nest sites than at random sites.

These findings are important for two reasons. First, the distribution of shinnery oak overlaps much of the historic LEPC range in New Mexico, Oklahoma, and Texas (Peterson and Boyd 1998, p. 2). Bell (2005, pp. 24-26) found that LEPC select for and survive better in habitats with at least 20 percent shinnery oak cover. However, once shinnery oak is eradicated, it is unlikely to recolonize treated areas. Shinnery oak is a rhizomatous shrub that reproduces very slowly and does not invade previously unoccupied areas (Dhillion *et al*. 1994, p. 52). Shinnery oak rhizomes do not appear to be viable in sites where the plant was previously eradicated, even decades after treatment. While shinnery oak has been germinated successfully in a laboratory setting (Pettit 1986, pp. 1, 3), little documentation exists that shinnery oak acorns successfully germinate in the wild (Wiedeman 1960, p. 22; Dhillion *et al*. 1994, p. 52). In addition, shinnery oak produces an acorn crop in only about three of every 10 years (Pettit 1986, p. 1). A more thorough synthesis of shinnery oak life history and management can be found in Peterson and Boyd (1998, pp. 1-15).

Lacking reproduction by acorns, timely recolonization of treated areas, or any established propagation or restoration method, the application of tebuthiuron at approved rates in most states effectively eliminates high quality LEPC habitat. Because large tracts of shrubland communities are decreasing, and native shrubs drive reproductive output for ground nesting birds in shinnery oak rangelands (Guthery *et al*. 2001, p. 116), Bell (2005, p. 25) asserted that it is likely that LEPC will become extinct if permanent losses of shrubland plant communities continue.

Second, in most LEPC states where shinnery oak occurs, the Ecological Site Descriptions used by NRCS, which establish the pre-settlement plant community for the agency, generally indicate that shinnery oak should not exceed 20 percent of the total ungrazed plant composition, by weight, on sites where it naturally occurs. As a result, landowners may apply to NRCS to receive federally-funded cost share assistance to apply herbicides to reduce shinnery levels to 20 percent of the total plant composition on their land. In practice, the Service has been advised anecdotally that many landowners receiving these funds instruct herbicide applicators to apply herbicides at full eradication rates, the cost of which they offset with private funds. Inherent to this practice is the fact that few landowners elect to treat shinnery oak without Federal assistance due to the significant expense of tebuthiuron application. Eradication of shinnery oak below the 20 percent level has been shown to be detrimental to LEPC (Bell 2005, pp. 20-21).

Prior to the late 1990's, approximately 40,469 ha (100,000 ac) of shinnery oak in New Mexico and 404,685 ha (1,000,000 ac) of shinnery oak in Texas were treated for agriculture and range improvement. In September 2007, the New Mexico NRCS issued Biology Technical Note 53, which provided guidance on herbicide management of shinnery oak in LEPC and sand dune lizard occupied range. That guidance was not supported by prairie-chicken specialists, and was not supported by the Service. In 2008, the NRCS revised Biology Technical Note 53 (NRCS 2008), to better address shinnery oak habitat for the LEPC. In 2008, the NRCS informed the Service that it plans to implement its recent guidance (NRCS 2008) and resume spraying

shinnery oak in 2008 in LEPC habitat. In its recently released RMPA (BLM 2008, pp. 16-17), the BLM will allow spraying of shinnery oak in LEPC habitat where it does not overlap with the sand dune lizard.

Although the Service cannot specifically quantify how many acres of LEPC habitat are treated annually with tebuthiuron or other herbicides, applications which reduce shinnery oak cover to less than 20 percent are detrimental to LEPC. The extent to which Federal dollars are used in each state for this purpose is unknown, but in combination with privately-funded eradication efforts, it is likely to be a significant threat to LEPC.

Hybridization

The sympatric (overlapping) occupation of habitat and leks by greater prairie-chicken and LEPC in central Kansas may pose a limited, but potential threat to the species in that region. Hybridization could lead to introgression (infiltration of the genes of one species into the gene pool of another through repeated backcrossing) and reduced reproductive potential; however hybridization has not been confirmed in these two species (Bain and Farley 2002, p. 684 and 686). Historical records document that the species' ranges overlapped, but that habitat partitioning was clearly evident based on the abundance of sand-adapted vegetation. The relative frequency of natural hybridization prior to European settlement is unknown. Currently, the incidence of hybridization between greater prairie-chicken and LEPC appears very low, typically less than one percent. The occurrence of hybridization also is restricted to a small portion, about 250,000 ha (617,000 ac), of the overall current range (Bain and Farley 2002, p. 684). Because current populations north of the Arkansas River in Kansas are generally characterized as low density and very dependent upon the residual habitat structure of fragmented tracts of CRP lands, those populations may be ephemeral depending on implementation of CRP projects and stochastic environmental factors. Low population density also may increase the susceptibility of LEPC to hybridization and exacerbate the potentially negative effects of hybridization. To date, the fertility of hybrid individuals throughout subsequent generations has not been rigorously tested. The immediate and long-term influence of hybridization on the species is unknown and warrants investigation.

Collision Mortality

Wire fencing is ubiquitous throughout the Great Plains as the primary means of confining livestock to ranches and pastures, or excluding them from areas not intended for grazing such as CRP lands, agricultural fields, and public roads. As a result, thousands of miles of fencing, primarily barbed wire, have been constructed throughout LEPC range. Like most grassland wildlife throughout the Great Plains, LEPC evolved in open habitats free of vertical features or flight barriers. Fences, power lines, or other wire structures are an unnatural threat to prairie grouse that, until recently, were seldom perceived as significant at the population level (Wolfe *et al*. 2007, p. 101).

Prompted by reports of high collision rates in species of European grouse (Petty 1995, p. 3; Baines and Summers 1997, p. 941; Bevanger and Broseth 2000, p. 124; 2004, p. 72) and seemingly unnatural rates of mortality in some local populations of LEPC, the Sutton Center

began to investigate line collision and collision mortality in LEPC. From 1999 to 2004, researchers recovered 322 carcasses of radio marked LEPC in New Mexico, Oklahoma, and portions of the Texas panhandle. For LEPC in which the cause of death could be determined, 42 percent of mortality in Oklahoma was attributable to collisions with fences, power lines, or automobiles. In New Mexico, only 14 percent of mortality could be traced to collision. The difference in rate of observed collision between states is attributable to differences in the amount of fencing on the landscape resulting from differential land settlement patterns in the two states (Patten *et al*. 2005a, p. 245).

With between 14 and 42 percent of adult LEPC mortality currently attributable to collision with human-induced structures, Wolfe *et al*. (2007, p. 101) assert that fence collisions will negatively influence long term population viability for LEPC. As an example, Moss (2001, p. 256) modeled the estimated future population of capercaille grouse (*Tetrao urogallus*) in Scotland and found that by removing fence collision risks, the entire Scotland breeding population would consist of 1,300 instead of 40 females by 2014. Similarly, recent experiments involving fence marking to increase visibility resulted in a 71 percent overall reduction in grouse collisions in Scotland (Baines and Andrew 2003, p. 174).

To quantify the magnitude of threat due to construction of new fencing in LEPC habitat, the Service obtained information from the Oklahoma NRCS regarding the construction of new fencing through Federal cost-share assistance in Fiscal Year 2006 in occupied LEPC counties (Zetterberg 2007). In total, approximately 177.3 km (110 mi) of new fencing was constructed in these counties in a single year. While the Service has no method to determine what amount of new fencing was constructed specifically in occupied LEPC habitat in Oklahoma or the other four states, the estimates provided by NRCS illustrate that a significant amount of new fencing is actively being constructed both privately and through financial incentives offered by Federal conservation-based programs and policies. Although collisions with fences is considered a threat to the survival of LEPC, additional information is needed to fully quantify the magnitude of this ongoing activity and its impact on LEPC rangewide.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has concluded that warming of the climate is unequivocal and continued green house gas emissions at or above current rates would cause further warming (Solomon *et al*. 2007, pp. 51, 60, 86). The IPCC also projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation (Solomon *et al*. 2007, p. 89). Although very little specific information related to the effects of climate change on LEPC status is known, the LEPC appears to be particularly vulnerable to the anticipated impacts. Increasing temperatures, declining precipitation, and extended, severe drought events would be expected to adversely alter habitat conditions, reproductive success and survival of the LEPC. While populations of LEPC in the southwestern part of their range are likely to be most acutely affected, populations throughout their range into Colorado and Kansas are likely to be impacted as well.

Warmer air temperatures may influence LEPC habitat quality through factors such as increased evapo-transpiration (combined processes of evaporation, sublimation, and transpiration of water

from the earth's surface into the atmosphere), increased evaporation, and decreased soil moisture. Warmer air and surface soil temperatures and decreased soil moisture near nest sites have been correlated with lower survival and recruitment in some ground nesting birds such as the LEPC (Bell 2005, pp. 16, 21) and bobwhite quail (Guthery *et al*. 2001, pp. 113-115). Patten *et al*. (2005a, p. 1275) observed that, on average, LEPC avoided sites that were hotter, drier, and more exposed to the wind. Other species of grouse have already exhibited significant and measurable negative impacts attributed to climate change. For example, capercaillie grouse in Scotland have been shown to nest earlier than in historic periods in response to warmer springs yet reared fewer chicks (Moss *et al*. 2001, p. 58). The resultant lowered breeding success as a result of the described climactic change was determined to be the major cause of the decline of the Scottish capercaillie (Moss *et al*. 2001, p. 58).

Extreme Weather Events

Very little published information is available on the effects of weather events, particularly hail storms, on LEPC. However, hail storms are known to cause mortality of prairie grouse, particularly during the spring nesting season. Fleharty (1995, p. 241) provides an excerpt from the May 1879 Stockton News which describes a large hail storm near Kirwin, Kansas as responsible for killing prairie chickens (likely greater prairie-chicken) and other birds by the hundreds. In May of 2008, a hail storm was known to have killed six LEPC in New Mexico. Although this phenomenon is undoubtedly rare, we are particularly interested in documenting the occurrence and magnitude of such events on the LEPC.

Small Population Size and Lek Mating System

A number of harmful effects, such as reduced reproductive success and loss of genetic variation and diversity, begin to express themselves as population sizes decline. These effects may be exacerbated by the lek mating system characteristic of many grouse species. The following discussion, taken from Johnsgard (2002, p. 129), analyzes the influence of the lek mating system on prairie grouse. The lek mating system works only when populations are dense enough to provide the visual and acoustic stimuli necessary to attract pre-breeding females to the lek. Once present, the lek must be large enough to assure that the matings will be performed by the most physically and genetically fit males. Lek breeding already tends to promote inbreeding owing to the limitations caused by relatively few males siring offspring. The tendency of female LEPC and other prairie grouse to typically nest near a lek other than the one on which they mated is an innate mechanism which can help reduce the effects of inbreeding. The remaining small and fragmented LEPC populations which exist over portions of the currently occupied range indicate that such harmful effects may already be, or soon will be occurring.

As populations contract and distances between populations increase, opportunities for gene flow are reduced. Specifically, Pruett *et al*. (2009, p. 258) discussed the influence of population connectivity, or lack thereof, on the LEPC. They concluded that historically LEPC populations were connected, as evidenced by the lack of geographic variation in morphology and the available genetic information which suggests that the populations were contiguous and gene flow occurred among the extant populations. However, Johnson (2008, p. 171) reported that his results indicate that gene flow is currently restricted between LEPC populations in New Mexico

and Oklahoma. These findings are not unexpected given information on LEPC movements. Pruett *et al*. (2009, p. 258) report findings by the Sutton Center that LEPC in Oklahoma were observed to move as much as 20 to 30 km (12 to 19 mi) but the extant LEPC populations in New Mexico and Oklahoma are separated by more than 200 km (124 mi). Given the limited movements of individual LEPC and the distance between these two populations, Pruett *et al* (2009, p. 258) considered interaction between these populations to be highly unlikely. Johnson (2008, p. 171) speculated that the observed estimate of gene flow between the New Mexico and Oklahoma populations could be due to effects of recent genetic drift as habitat fragmentation and isolation developed between the New Mexico and Oklahoma populations. Further examination of the viability of existing LEPC populations will be needed to thoroughly describe the effects of small population size and isolation on persistence of the LEPC.

Summary of Factor E

Several other natural or manmade factors are affecting the continued existence of the LEPC. Weather related events such as drought and hail storms influence habitat quality or result in direct mortality of LEPC. Drought conditions reduce the capability of the habitat to provide suitable foraging, nesting, and brood rearing conditions, negatively affecting survival of LEPC. Parasitism of LEPC nests by pheasants and hybridization with greater prairie chickens has been documented but the incidence remains low. The influence of these events on LEPC survival is expected to remain low unless populations continue to decline. Low population density can increase the susceptibility of LEPC to possible genetic effects and increase the negative effects of hybridization, nest parasitism, and competition. Although the effects of climate change on survival of the LEPC are largely unknown, the LEPC appears to be particularly vulnerable to the anticipated impacts. Increasing temperatures, declining precipitation, and extended, severe drought events would be expected to adversely alter habitat conditions, reproductive success, and survival of the LEPC. Fences are prevalent throughout much of the range of the LEPC. Until recently, fences were not known to be a threat to LEPC. However, research in several small portions of LEPC range demonstrated that between 14 and 42 percent of adult LEPC mortality may be attributable to collision with fences and other human-induced structures and likely will negatively influence long term population viability of LEPC. The application of insecticides and herbicides occurs throughout the species' range. However, there are no known instances of mortality or deleterious effects from the application of insecticides on LEPC. Application of herbicides, primarily to control shrubs and other forms of herbaceous vegetation on rangelands, also occurs throughout the species' range. Herbicide use which significantly reduces the vegetative diversity of rangeland systems or the shinnery oak and other shrubby vegetative component likely will reduce the value of these areas as LEPC habitat. The effects of certain natural and manmade factors are considered a threat to the LEPC and contribute to the basis for concluding that listing of the LEPC is warranted.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

All of the states conduct outreach efforts intended to educate landowners and others about the conservation status of the LEPC. Annual LEPC festivals are held in several states (Milnesand, New Mexico; Woodward, Oklahoma; and Canadian, Texas) to inform and raise awareness of the public. Other important outreach efforts include an extension publication on the ecology and

management of the LEPC by the Oklahoma State University Cooperative Extension Service in 2009 and a publication on the plight of LEPC by the TPWD and the Dorothy Marcille Wood Foundation in 2009. The TPWD also published an article on LEPC and wind development in Texas in their agency magazine in late 2009.

The CDOW hosted a workshop on the conservation of LEPC in late 2009. This workshop provided information to local landowners and other interested parties on conservation of the LEPC. Specific management actions of benefit to the LEPC were discussed.

On July 6, 2009, the Kansas Ornithological Society, along with six National Audubon Society Chapters in Kansas, filed a petition with the KDWP requesting the agency consider an emergency listing of LEPC as a Threatened Species. The KDWP is currently conducting a scientific review of this request and held several public informational meetings regarding this request in late April and Early May of 2010. A final decision will be made sometime following conclusion of the public meetings.

Cooperative efforts in Oklahoma and Kansas have each led to development of a web-based wind resource planning tools that can be used by the wind and transmission industry to guide development away from sensitive habitats used by the LEPC. The states and other partners continue to discuss the feasibility of developing a similar tool for use over the entire historical range of the LEPC. In Oklahoma, the ODWC and the Service continue to provide technical assistance and guidance to Oklahoma utilities and wind industry representatives, including use of the planning tool. These efforts are focused on reducing impacts to the LEPC. Partly as a result of these discussions, Oklahoma Gas and Electric provided a 3.75 million dollar contribution to the ODWC in 2009 which was used to offset impacts to the LEPC from one of their wind power projects near Woodward, Oklahoma. These funds were largely used to acquire lands for conservation of the LEPC and other wildlife. Then in February 2010, Oklahoma Gas and Electric agreed to provide a similar contribution, up to 4.9 million dollars, to the ODWC for another wind power project located near Woodward, Oklahoma.

In 2008 and 2009, a series of prescribed burning schools for CRP landowners were held in Kansas. Oklahoma State University also hosts fire field days to help inform landowners of the benefits of prescribed fire for controlling invasion of woody vegetation in prairies and improving habitat conditions for wildlife. Prescribed burning is one tool landowners can use to improve the value of CRP fields and native prairie for wildlife, including LEPC.

Since 2004, the Sutton Center has worked to reduce or eliminate the significant LEPC mortality observed from fence collisions on their study areas in Oklahoma and Texas. The Sutton Center, using Private Stewardship Grant and other funding sources, either physically removed unnecessary fencing or applied visual fence markers of their own design (Wolfe *et al*. 2009, p. 141-142) on the top wires of approximately 273.5 km (170 mi) of barbed wire fence in Oklahoma and Texas. These actions have been concentrated within 1.6 km (1 mi) of active LEPC leks. Collectively, these conservation activities have the potential to significantly reduce the threat of collision mortality on 44,110 ha (109,000 ac) of prime occupied LEPC habitat. Anecdotally, since the initiation of their marking efforts, the Sutton Center has observed no collision mortality along marked spans of fencing that, prior to marking, were observed to be

especially fatal to LEPC (Wolfe 2008). The Service's Partners for Fish and Wildlife Program also initiated a similar fence marking effort in New Mexico during 2008. Fence marking activities by voluteers during LEPC festivals and similar events also has made an important but unquantified contribution to this conservation effort. While the Sutton Center's fence marking efforts have the potential for significant benefit to the LEPC if implemented on a sufficient scale, the Service has determined that the current rate of new fence construction through NRCS cost-share funding in the same counties exceeds the amount that has been removed by the Sutton Center (Norton 2007). As a result, local benefits of fence removal and marking are not expected to have a population-level impact, although without the fence removal and marking efforts, the total amount of mortality due to fence collisions likely would be higher.

The TPWD, along with other partners, held five meetings during May 2009 in the Texas panhandle region, as part of an effort to aid the LEPC. These meetings are intended to inform landowners about financial incentives and other resources available to improve habitat for the LEPC, including the State Acres for Wildlife Enhancement (SAFE) program. The SAFE program, administered by the USDA-Farm Service Agency, is designed to create 2,093 ha (20,000 ac) of native mixed grassland habitat for the LEPC in Texas. Previously, TPWD hosted a series of landowner meetings and listening sessions in six of the 13 counties confirmed to be occupied by the LEPC in Texas (Hemphill, Wheeler, Gray, Bailey, Cochran, and Gaines). Private landowners and the general public were invited to discuss LEPC conservation and management, receive information, and provide input on programs and incentives that are available for managing LEPC on privately owned habitats. In response to these meetings, TPWD worked with the Service and landowners to finalize the first statewide umbrella Candidate Conservation Agreement with Assurances (CCAA) for LEPC in Texas in 2006. To date, however, TPWD has received no enrollments under this CCAA.

TPWD also continues to fund LEPC research projects. In conjunction with several Texas universities, TPWD is evaluating the use of aerial line transects and forward-looking infrared technology to survey for LEPC; TPWD also is providing initial funding and coordination support for development of a spatially explicit population viability analysis for LEPC in Texas. Other ongoing research includes evaluation of LEPC population response to shinnery oak treatments, and evaluation of relationships among LEPC, raptors, and oil-gas infrastructure. Additionally, in 2007, The Nature Conservancy of Texas acquired approximately 2,428 ha (6,000 ac) of private ranchland in Yoakum and Terry counties to restore and protect habitat for the LEPC. The Service views this as a geographically important acquisition that helps secure LEPC populations within potential recovery and connectivity corridors.

As discussed under Factor D, (inadequacy of existing regulatory mechanisms), in November of 2003 the USFS Region 2 (Rocky Mountain Region), revised the Regional Forester's sensitive species list. The Region contracted with experts to prepare succinct evaluations of species of potential viability concern, addressing eight factors pertinent to species viability. These evaluations were used by Regional biologists as a basis for determining whether each of nearly 1,000 pre-screened species met the criteria for Regional sensitive species status. A Technical Conservation Assessment for the LEPC (Robb and Schroeder 2005, p. 8) was completed and confirms the need to retain sensitive species status designation for the LEPC. This document can be found on the internet at *http://www.fs.fed.us/r2/projects/scp/assessments*.

In January 2003, a working group composed of local, State, and Federal officials, along with private and commercial stakeholders, was formed to address conservation and management activities for the LEPC and sand dune lizard in New Mexico. This working group, formally named the New Mexico Lesser Prairie-Chicken/Sand Dune Lizard Working Group, worked diligently for 2.5 years resulting in the publication of the Collaborative Conservation Strategies for the Lesser Prairie-Chicken and Sand Dune Lizard in New Mexico (Strategy) in August 2005. This Strategy provided guidance in the development of BLM's Special Status Species RMPA, approved in April 2008, which also addresses the concerns and future management of LEPC and sand dune lizard habitats on BLM lands, and established the LEPC Habitat Preservation Area of Critical Environmental Concern. Both plans prescribe active cooperation among all stakeholders to reduce or eliminate threats to these species in New Mexico. As an outcome, the land use prescriptions contained in the RMPA now serve as baseline mitigation (for both species) to those operating on Federal lands or non-Federal lands with Federal minerals. Following approval of the RMPA, a Candidate Conservation Agreement (CCA) was drafted between the Service, BLM, Center of Excellence for Hazardous Materials Management, and participating cooperators that addresses the conservation needs of the LEPC and sand dune lizard on BLM lands in New Mexico. Through this CCA, Center of Excellence for Hazardous Materials Management will work with participating cooperators who voluntarily commit to implementing or funding specific conservation actions that will reduce or eliminate threats to these species. The CCA builds upon the BLM's RMPA for southeast New Mexico. The RMPA established the foundational requirements that will be applied to all future Federal activities, regardless of whether a permittee or lessee participates in this CCA. The strength of the CCA comes from the implementation of additional conservation measures that are additive, or above and beyond those foundational requirements established in the RMPA. In addition to the CCA, a CCAA has been developed in association with the CCA to facilitate conservation actions for the LEPC and sand dune lizard on private and State lands in southeastern New Mexico. The CCA and CCAA were completed and signed in December 2008. To date, twelve landowners have enrolled over 52,600 ha (130,000 ac) in this CCAA.

Other important conservation actions in New Mexico occurred in 2007; principal among them was the acquisition of 2,137 ha (5,285 ac) of private ranchland in Roosevelt County by the State Game Commission using New Mexico State Land Conservation Appropriation funding. This property, the Sandhills Prairie Conservation Area (formerly the Lewis ranch), is located east of Milnesand, New Mexico and adjoins two existing Commission-owned Prairie-chicken Areas. The BLM, on March 3, 2010, acquired 3,010 ha (7,440 ac) of land east of Roswell, New Mexico to protect key habitat for the LEPC. Additionally, in 2008 the ODWC acquired two properties known to be used by LEPC: the Cimarron Bluff Wildlife Management Area, which encompasses 1,388 ha (3,430 ac) in northeastern Harper County, Oklahoma and the Cimarron Hills Wildlife Management Area in northwestern Woods County, Oklahoma totaling 1,526 ha (3,770 ac). These acquisitions are expected to provide local conservation benefit for LEPC in portions of New Mexico and Oklahoma.

Texas Senate Bill 2534 enacted by the 81st Texas Legislature established the Interagency Task Force on Economic Growth and Endangered Species. The purpose of the task force is to provide policy and technical assistance regarding compliance with endangered species laws and

regulations to local and regional governmental entities and their communities engaged in economic development activities so that compliance with endangered species laws and regulations is as effective and cost efficient as possible. Within this task force, a Lesser Prairie-Chicken Advisory Committee has been established and functions to provide input and information to the task force to help prevent listing and minimize harm to economic sectors if listing does occur, and to assist in outreach and education efforts on potential listing decision and methods to minimize the impact of listing. More information on this effort can be found on the internet at *http://www.texasahead.org/economic_developer/endangered_species*.

Finally, much attention has been directed to the decline of prairie grouse nationwide, as evidenced through special sessions, symposia, and solicited publications throughout professional conservation arenas. In particular, the spring 2004 edition of The Wildlife Society Bulletin contains a host of publications relevant to recent LEPC management, including formal guidelines for management of the species and its habitats (Hagen *et al*. 2004, pp. 69-82). The North American Grouse Partnership, in cooperation with the National Fish and Wildlife Foundation and multiple State wildlife agencies and private foundations, has embarked on the preparation of the prairie grouse portions of an overarching North American Grouse Management Strategy. The strategy provides recovery actions and defines the levels of funding necessary to achieve management goals for all species of grouse in North America. The final version of the prairie grouse portions of this strategy, encompassing 26 million ha (65 million ac) of grassland habitat in the United States and Canada, was officially released and unanimously endorsed by the Association of Fish and Wildlife Agencies in late March of 2008. The LEPC portion of the North American Grouse Partnership Strategy was developed under the leadership of the LEPC Interstate Working Group in cooperation with the Playa Lakes Joint Venture, and is independently identified as the Lesser Prairie-chicken Conservation Initiative. This initiative was completed in May of 2008 (Davis *et al*. 2008).

The Service views the increased emphasis and exposure for prairie grouse as positive for the conservation and recovery of the LEPC. However, many of these important conservation efforts will fail to materialize if adequate funding and institutional participation is lacking.

SUMMARY OF THREATS (including reasons for addition or removal from candidacy, if appropriate)

The most serious threats to the LEPC are loss of habitat from conversion of native rangelands to introduced forages and cultivation, recent and anticipated conversion of CRP lands to cropland, cumulative habitat degradation caused by inappropriate livestock grazing practices, wind energy development, oil and gas development, woody plant invasion of open prairies due to fire suppression, inappropriate herbicide applications, and habitat fragmentation caused by structural and transportation developments. Many of these threats may exacerbate the normal effects of periodic drought on LEPC populations. In many cases, the remaining suitable habitat has become fragmented by the spatial occurrence of these individual threats. Habitat fragmentation can be a threat to the species through several mechanisms: remaining habitat patches may become smaller than necessary to meet the requirements of individuals and populations, necessary habitat heterogeneity may be lost to areas of homogeneous habitat structure, areas between habitat patches may harbor high levels of predators or brood parasites, and the

probability of recolonization decreases as the distance between suitable habitat patches expands. Existing regulatory mechanisms have not been adequate to halt the decline of LEPC populations and habitat.

Based on the information described above, we find that this species is warranted for listing throughout all of its range. Therefore, it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

For species that are being removed from candidate status:

____Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

RECOMMENDED CONSERVATION MEASURES:

1. Reduce or eliminate upland construction of fence lines and utility lines within occupied habitat and for 8 km (5 mi) surrounding all occupied habitat, especially near leks. If fence lines cannot be removed, it is recommended that the top and third wires of lines near active LEPC leks be conspicuously marked to minimize collision mortality.
2. Limit or eliminate the federally-funded application of tebuthiuron herbicide in remaining shinnery oak habitats and 2, 4-D herbicide in sand sagebrush habitats.
3. Encourage rangewide adherence to the Service's Voluntary Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines, released in July 2003, (*http://www.fws.gov/habitatconservation/wind.pdf*)
4. Work cooperatively with energy-related industry to avoid, minimize, and compensate for impacts to LEPC populations and habitats.
5. Work with partners to target re-enrollments and new contracts under CRP and related agricultural conservation programs to benefit LEPC.
6. Minimize further fragmentation of remaining Federal lands within current and historic LEPC range by abandoning the use of ineffective timing, noise, and distance stipulations near active or historic leks. Instead, future energy leasing, exploration, and development, or other fragmenting human land uses within essential LEPC habitats should be limited.
7. Establish secure and well-funded financial incentive mechanisms for private landowners to provide light to moderately grazed native rangeland habitats that are suitable for LEPC use, and are not subject to herbicidal shrub control practices.
8. Encourage increased use of prescribed fire and patch burn grazing concepts to facilitate habitat heterogeneity in LEPC range and decrease encroachment of woody vegetation. Patch burn grazing is a system that utilizes prescribed fire to encourage intensive grazing on a portion of a pasture each year while resting the remainder of the pasture.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1

	Non-imminent	**Species** Subspecies/population Monotypic genus Species Subspecies/population	**2*** 3 4 5 6
Moderate to Low	Imminent Non-imminent	Monotypic genus Species Subspecies/population Monotypic genus Species Subspecies/population	7 8 9 10 11 12

Rationale for listing priority number:

Magnitude: We have determined that the overall magnitude of threats to the LEPC throughout its range is high. The magnitude of threats to LEPC depends primarily on the quality, integrity, and scale of remaining habitat. At present, long term habitat destruction and modification due to ongoing and increasing agricultural activities, increasing energy development, tree invasion due to fire suppression, collision mortality from fences and power lines, and fragmentation are continuing and significant throughout the entire range. Foreseeable threats to habitat degradation caused by human land use also exist. Reports indicate that funding for and construction of primary transmission lines to facilitate extensive wind generation construction throughout LEPC occupied portions of Kansas, Oklahoma, and Texas is likely to begin in the near future, concomitant with wind energy development in all LEPC states. In addition, projected, near-term changes in CRP enrollments, largely due to expiring contracts, could result in widespread conversion of important LEPC habitat to crop or livestock production. This is especially problematic in Kansas where native CRP plantings have resulted in increased LEPC populations and range over the last decade. As a result of the consolidation and interaction of these threats, the Service concludes that the cumulative magnitude of threats to the LEPC and its habitat is high.

Imminence: The majority of threats to remaining LEPC populations are ongoing and foreseeable within the near term, thus they are considered imminent. Remaining populations are becoming increasingly isolated and vulnerable to stochastic environmental impacts (e.g., drought) as well as the effects of human habitat fragmentation. This is particularly true for isolated LEPC populations such as those in the Permian Basin/western panhandle of Texas, populations residing on USFS lands in southeastern Colorado, and areas south of Highway 380 in southeastern New Mexico.

COORDINATION WITH STATES
Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: Colorado, Kansas, New Mexico, Oklahoma, and Texas

Indicate which State(s) did not provide any information or comments: None

LITERATURE CITED

Addison, E.M. and R.C. Anderson. 1969. *Oxyspirura lumsdeni* n. sp. (Nematoda: Thelaziidae) from Tetraonidae in North America. Can. J. Zool. 47(6):1223-1227.

Aldrich, J.W. 1963. Geographic orientation of American Tetraonidae. J. Wildl. Manage. 27(4):529-545.

American Wind Energy Association. 2010a. U.S. wind energy projects-resources. Available on-line at http://www.awea.org/projects/Default.aspx. Accessed April 16, 2010.

American Wind Energy Association. 2010b. U.S. wind energy projects-resources. Available on-line at http://www.awea.org/projects/Projects.aspx "by state". Accessed April 16, 2010.

American Wind Energy Association (AWEA). 2007a. Wind Energy Weekly, Vol. 25, #1225, 26 January 2007.

American Wind Energy Association. 2007b. Wind Energy Weekly, Vol. 26, #1249, 20 July 2007.

American Ornithologist's Union. 1998. Checklist of North American birds. Seventh edition. Allen Press, Inc., Lawrence, KS. 829 pp.

Anderson, R.K. 1969. Prairie chicken responses to changing booming-ground cover type and height. J. Wild. Manage. 33(3):636-643.

Anonymous. 1997. World's oldest plant? Science. 277: 483.

Augustine, D. 2005. Unpublished LEPC status report for the Cimarron and Comanche National Grasslands; presented to the Lesser Prairie-chicken Interstate Working Group. 4 pp.

Augustine, D. 2006. Unpublished LEPC status report for the Cimarron and Comanche National Grasslands; presented to the Lesser Prairie-chicken Interstate Working Group. 10 pp.

Babcock, B.A. and C.E. Hart. 2008. Options for the Conservation Reserve Program. Iowa Ag Review 14(2): 6-7. Publ. by Iowa State Univ., Center for Agricultural and Rural Development.

Bailey, A.M., and R.J. Niedrach. 1965. Birds of Colorado. Vol. 1. Denver Mus. Nat. Hist. Denver, Colorado. 454 pp.

Bain, M.R. and G.H. Farley. 2002. Display by apparent hybrid prairie-chickens in a zone of geographic overlap. Condor 104:683-687.

Baines, D. and R.W. Summers. 1997. Assessment of bird collisions with deer fences in Scottish

forests. J. Appl. Ecol., 34: 941–948.

Baines, D. and M. Andrew. 2003. Marking of deer fences to reduce frequency of collisions by woodland grouse. Biol. Cons. 110:169-176.

Baker, M.F. 1953. Prairie chickens of Kansas. Univ. Kansas Mus. Nat. Hist. and Biol. Surv. Kansas. Misc. Publ. 5., Lawrence.

Beauprez, G.M. 2009. Survey for active lesser prairie chicken leks: Spring 2009. New Mexico Dept. of Game and Fish Fed. Aid in Wildlife Restor. Proj. W-138-R-7. Sante Fe. 25 pp.

Beauprez, G.M. 2008. Survey for active lesser prairie chicken leks: Spring 2008. New Mexico Dept. of Game and Fish Fed. Aid in Wildlife Restor. Proj. W-138-R-6. Sante Fe. 25 pp.

Belinda, S. 2003. Lesser prairie-chicken survey report and recommendations. Bureau of Land Mngmt., Carlsbad Field Office, Carlsbad, New Mexico, unpublished document. 4 pp.

Bell, L.A. 2005. Habitat use and growth and development of juvenile lesser prairie-chickens in southeast New Mexico. M.S. Thesis, Oklahoma State University, Stillwater, Oklahoma. 55 pp.

Benedict, R.A., P.W. Freeman, and H H. Genoways. 1996. Prairie legacies - mammals. Pages 149-166 *in* F. B. Samson and F. L. Knopf, eds. Prairie Conservation: preserving North America's most endangered ecosystem. Island Press, Washington, D. C.

Bent, A.C. 1932. *Life Histories of North American Gallinaceous Birds*. U. S. Natl. Mus. Bull. 162. 490 pp.

Bergerud, A.T. 1988. Population ecology of North American grouse. Pages 578-685 *in* A. T. Bergerud and M. W. Gratson, eds. Adaptive strategies and population ecology of northern grouse, vol. II. Univ. Minnestota Press, Minneapolis. 809 pp.

Bernard, K.A., J.G. Maffei, S.A. Jones, E.B. Kauffman, G.D. Ebel, A.P. Dupuis II, K.A. Ngo, D. C. Nicholas, D.M. Young, P. Shi, V.L. Kulasekera, M. Eidson, D.J. White, W.B. Stone, NY State West Nile Virus Surveillance Team, and L.D. Kramer. 2001. West Nile infection in birds and mosquitoes, New York State, 2000. Emerg. Infect. Dis. 7:679-685.

Best, T.L., K. Geluso, J.L. Hunt, and L.A. McWilliams. 2003. The lesser prairie chicken (*Tympanuchus pallidicinctus*) in southeastern New Mexico: a population survey. Texas Journal of Science 55(3):225-234.

Bevanger, K. and H. Broseth. 2004. Impact of power lines on bird mortality in a subalpine area. Anim. Biodiv. and Cons. 27(2):67-77.

Bevanger, K. and H. Broseth. 2000. Reindeer *Rangifer tarandus* fences as a mortality factor for ptarmigan *Lagopus* spp. Wildl. Biol. 6:121-127.

Bidwell, T.G. and A. Peoples. 1991. Habitat management for Oklahoma's prairie chickens. Coop. Ext. Serv., Div. of Agr., Oklahoma State University. Bulletin No. 9004.

Bidwell, T.G., D.M. Engle, M. E. Moseley, R.E. Masters. 2000. Invasion of Oklahoma rangelands and forests by eastern redcedar and ashe juniper. Oklahoma Cooperative Extension Service E-947. Oklahoma State University, Stillwater. 12 pp.

Bidwell, T., S. Fuhlendorf, B. Gillen, S. Harmon, R. Horton, R. Rodgers, S. Sherrod, D. Wiedenfeld, and D. Wolfe. 2002. Ecology and management of the lesser prairie-chicken. Oklahoma Cooperative Extension Service E-970. Oklahoma State University, Stillwater.

Blus, L.J., C.S. Staley, C.J. Henny, G.W. Pendleton, E.H. Craig, and D.K. Halford. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. J. Wildl. Manage. 53(4):1139-1146.

Bowles, J.B. 1981. Iowa's mammal fauna: an era of decline. Proc. Iowa Acad. Science 88(1):38-42.

Boyd, D. T. 2009. Oklahoma 2008 drilling highlights. Shale Shaker, March/April 2009. pp. 1-10. Oklahoma City Geological Society.

Boyd, D. T. 2007. Oklahoma 2006 drilling activity. Shale Shaker, May/June 2007. pp. 1-10. Oklahoma City Geological Society.

Bragg, T.B. and A.A. Steuter. 1996. Prairie ecology - the mixed prairie. Pages 53-65 in F. B. Samson and F. L. Knopf, eds., Prairie conservation: preserving North America's most endangered ecosystem. Island Press, Washington, D.C. 339 pp.

Braun, C.E., K.W. Harmon, J.A. Jackson, and C.D. Littlefield. 1978. Management of National Wildlife Refuges in the United States: its impact on birds. Wilson Bull. 90:309-321.

Braun, C.E., K. Martin, T.E. Remington, and J.R. Young. 1994. North American grouse: issues and strategies for the 21st century. Trans. 59th No. Am. Wildl. And Natur. Res. Conf.:428-437.

Bureau of Land Management. 1997. Roswell Approved Resource Management Plan and Record of Decision, Roswell Resource Area, Roswell District, New Mexico. October 1997.

Bureau of Land Management. 2008. Special status species record of decision and approved resource management plan amendment. Pecos Dist. Office, Roswell, NM. 110 pp.

Caire, W., J.D. Tyler, B.P. Glass, and M.A. Mares. 1989. Mammals of Oklahoma. Univ. of Oklahoma Press, Norman. 567 pp.

Campbell, H. 1972. A population study of lesser prairie-chicken in New Mexico. J. Wildl. Manage. 36(3):689-699.

Cannon, R.W. and F.L. Knopf. 1979. Lesser prairie chicken responses to range fires at the booming ground. Wildl. Soc. Bull. 7(1):44-46.

Cannon, R.W. and F.L. Knopf. 1980. Distribution and status of the lesser prairie-chicken in Oklahoma. Pages 71-74 *in* Vohs, P. A. and Knopf, F. L. (eds) Proceedings: Prairie Grouse Symposium. Oklahoma State University, Stillwater.

Cannon, R.W. and F.L. Knopf. 1981. Lek numbers as a trend index to prairie grouse populations. J. Wildl. Manage. 45(3):776-778.

Chappell, A. T. 2010. Lesser prairie-chicken surveys 2007. Unpublished LEPC survey report for the Cimarron National Grasslands. Submitted by Andrew Chappell, U.S. Forest Service, to Ken Collins, USFWS by e-mail on April 14, 2010. 2 pp.

Chappell, A. T. 2009a. Lesser prairie-chicken surveys 2008. Unpublished LEPC survey report for the Cimarron National Grasslands. Submitted by Andrew Chappell, U.S. Forest Service, to Ken Collins, USFWS by e-mail on April 16, 2009. 2 pp.

Chappell, A. T. 2009b. Lesser prairie-chicken surveys 2009. Unpublished LEPC survey report for the Cimarron National Grasslands. Submitted by Andrew Chappell, U.S. Forest Service, to Ken Collins, USFWS by e-mail on April 24, 2009. 2 pp.

Cita, J., B. Glass and J. Sanderson. 2008. A benefit cost study of the 2015 wind challenge: an assessment of wind energy economics in Kansas for 2006-2015. 424 pp.

Coats, J. 1955. Raising Lesser Prairie Chickens in captivity. Kansas Fish and Game 13:16-20.

Collins, S. L. 1992. Fire frequency and community heterogeneity in tallgrass prairie vegetation. Ecol. 73(6):2001–2006.

Colorado Division of Wildlife. 2007. Letter to US Fish and Wildlife Service regarding the 2007 lesser prairie-chicken candidate notice of review, dated 3/29/2007.

Cook, R.E. 1985. Growth and development in clonal plant populations. Pp. 259-296. In: J. B. C. Jackson, L. W. Buss, and R. E. Cook, eds, Population biology and evolution of clonal organisms. Yale University Press, New Haven. 530 pp.

Copelin, F.F. 1963. The lesser prairie-chicken in Oklahoma. Oklahoma Wildlife Conservation Department Technical Bulletin No. 6. Oklahoma City. 58 pp.

Coppedge, B.R., D.M. Engle, R.E. Masters, and M.S. Gregory. 2001. Avian response to landscape change in fragmented southern Great Plains grasslands. Ecol. Appl. 11:47-59.

Crawford, J.A. 1980. Status, problems, and research needs of the lesser prairie-chicken. Pages 1-7 *in* Vohs, P. A. and Knopf, F. L. (eds) Proceedings: Prairie Grouse Symposium. Oklahoma State University, Stillwater.

Crawford, J.A. and E.G. Bolen. 1976. Effects of land use on lesser prairie-chickens in Texas. J. Wildl. Manage. 40:96-104.

Davies, B. 1992. Lesser prairie-chicken recovery plan. Colorado Division of Wildlife, Colorado Springs. 23 pp.

Davis, C.A., T.Z. Riley, R.A. Smith, H.R. Suminski, and M.J. Wisdom. 1980. Spring-summer foods of lesser prairie-chickens in New Mexico. Pages 75-80 *in* Vohs, P. A. and Knopf, F. L. (eds) Proceedings: Prairie Grouse Symposium. Oklahoma State University, Stillwater.

Davis, C.A., T.Z. Riley, R.A. Smith, H.R. Suminski, and M.J. Wisdom. 1979. Final report, habitat evaluation of lesser prairie-chickens in eastern Chaves County, New Mexico. Dept. Fish and Wildl. Sci., New Mexico Agric. Exp. Sta., Las Cruces. 141 pp.

Davis, D.M. 2006. Survey for active lesser prairie-chicken leks: Spring 2006. New Mexico Department of Game and Fish annual report, project W-138-R-4, 11 pp.

Davis, D.M. 2005. Status of the lesser prairie-chicken in New Mexico: recommendation to not list the species as threatened under the New Mexico Wildlife Conservation Act. Submitted December 15, 2005. New Mexico Department of Game and Fish Final Investigation Report. 118 pp.

Davis, D.M., R.E. Horton, E.A. Odell, R.D. Rodgers, and H.A. Whitlaw. 2008. Lesser prairie-chicken conservation initiative. Lesser Prairie Chicken Interstate Working Group. Unpublished Rept. Colorado Division of Wildlife, Ft. Collins, CO. 114 pp.

Davison, V.E. 1940. An 8-year census of lesser prairie-chickens. J. Wildl. Manage. 4(1):55-62.

Dhillion, S.S., M.A. McGinley, C.F. Friese, and J.C. Zak. 1994. Construction of sand shinnery oak communities of the Llano Estacado: animal disturbances, plant community structure and restoration. Rest. Ecol. 2:51-60.

Duck, L.G. and J.B. Fletcher. 1944. A survey of the game and furbearing animals of Oklahoma. Oklahoma Game and Fish Dept., Oklahoma City. State Bull. 3.

Eckroat, J. Telephone interview with Jack Eckroat, Eastern Red Cedar Taskforce, Oklahoma NRCS, Stillwater, OK.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. *The Birder's Handbook: A Field Guide to the Natural History of North American Birds*. Simon and Schuster, New York. 785 pp.

Emerson, K.C. 1951. A list of Mallophaga from gallinaceous birds of North America. J. Wildl. Manage. 15(2):193–195.

Fleharty, E.D. 1995. Wild animals and settlers on the Great Plains. Univ. of Oklahoma Press, Norman. 316 pp.

Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. Cons. Biol. 8(3):629–644.

Flock, B.E. 2002. Landscape features associated with greater prairie-chicken lek locations in Kansas. M. S. Thesis, Emporia State University, Emporia, Kansas.

Follen, D.G., Sr. 1966. Prairie chicken vs. pheasant. Passenger Pigeon 28:16-17.

Forest Oil Corporation. 2008. Presentation on March 6, 2008, at Granite Wash Conference, Oklahoma Geological Survey. PowerPoint presentation available at http://www.ogs.ou.edu/GraniteWash/Forest_%20Granite%20Wash.ppt. Accessed April, 2008.

Fuhlendorf, S.D. and F.E. Smeins. 1999. Scaling effects of grazing in a semi-arid grassland. J. Veg. Sci. 10:731–738.

Fuhlendorf, S.D., A.J.W. Woodward, D.M. Leslie Jr., and J.S. Shackford. 2002. Multi-scale effects of habitat loss and fragmentation on lesser prairie-chicken populations of the US Southern Great Plains. Lands. Ecol. 17:617-628.

Garrettson, P.R., F.C. Rohwer, J.M. Zimmer, B.J. Mense, and N. Dion. 1996. Effects of mammalian predator removal on waterfowl and non-game birds in North Dakota. Trans. 61st No. Am. Wildl. And Natur. Res. Conf.:94-101.

Giesen, K.M. 1994a. Movements and nesting habitat of lesser prairie-chicken hens in Colorado. Southwestern Nat. 39(1):96-98.

Giesen, K.M. 1994b. Breeding range and population status of lesser prairie-chickens in Colorado. Prairie Nat. 26(3):175-182.

Giesen, K.M. 1998. The lesser prairie-chicken. In Birds of North America, No. 364, A. Poole and G. Gill, eds. Philadelphia: the Academy of Natural Sciences; Washington, D. C. The American Ornithologist's Union.

Giesen, K.M. 2000. Population status and management of lesser prairie-chicken in Colorado. Prairie Nat. 32(3):137-148.

Guthery, F.S. and S.L. Beasom. 1977. Responses of game and nongame wildlife to predator control in south Texas. J. Range Manage. 30:404-409.

Guthery, F.S., C.L. Land, and B.W. Hall. 2001. Heat loads on reproducing bobwhites in the semiarid subtropics. J. of Wildl. Manage. 65:111-117.

Hagen, C.A. 2003. A demographic analysis of lesser prairie-chicken populations in southwestern Kansas: survival, population viability, and habitat use. Dissertation, Kansas State University, Manhattan, USA.

Hagen, C.A. and K.M. Giesen. 2005. Lesser prairie-chicken (*Tympanuchus pallidicinctus*). The birds of North America online (A. Poole, Ed.). Ithaca: Cornell Lab. of Ornithology. (http://csaproxy.museglobal.com/MuseSessionID=cb6a9bb5d7c2538e76f10ec20f139ed/MuseHost=bna.birds.cornell.edu/MuseFirst=1/MusePath/BNA/account/Lesser_Prairie-Chicken/).

Hagen, C.A., B.E. Jamison, R.J. Robel, and R.D. Applegate. 2002. Rang-necked pheasant parasitism of lesser prairie-chicken nests in Kansas. Wilson Bull., 114(4):522-524.

Hagen, C.A., B.E. Jamison, K.M Giesen, and T.Z. Riley. 2004. Guidelines for managing lesser prairie-chicken populations and their habitats. Wildl. Soc. Bull. 32(1):69-82.

Hagen, C.A., J.C. Pitman, B.K. Sandercock, R.J. Robel, and R.D. Applegate. 2005. Age-specific survival and probable causes of mortality in female lesser prairie-chickens. J. Wildl. Manage. 71(2):518-525.

Hagen, C.A., J.C. Pitman, B.K. Sandercock, R.J. Robel, and R.D. Applegate. 2005. Age-specific variation in apparent survival rates of male lesser prairie-chickens. Condor 107(1):78-86.

Hagen, C.A., B.K. Sandercock, J.C. Pitman, and R.J. Robel. 2009. Spatial variation in lesser prairie-chicken demography: a sensitivity analysis of population dynamics and management alternatives. J. Wildl. Manage. 73(8):1325-1332.

Hamerstrom, F.N. and F. Hamerstrom. 1961. Status and problems of North American Grouse. Wilson Bull. 73:284-294.

Haukos, D.A. 1988. Reproductive ecology of lesser prairie-chickens. M. S. Thesis, Texas Tech. Univ., Lubbock.

Haukos, D.A. and G.S. Broda. 1989. Northern harrier (*Circus cyaneus*) predation of lesser prairie-chicken *(Tympanuchus pallidicinctus*). J. Raptor Res. 23(4):182-183.

Haukos, D.A. and L.M. Smith. 1989. Lesser prairie-chicken nest site selection and vegetation characteristics in tebuthiuron-treated and untreated sand shinnery oak in Texas. Great Basin Nat. 49(4):624-626.

Henika, F.S. 1940. Present status and future management of the prairie chicken in Region 5.

Special Report: Texas Game Fish and Oyster Commission, Division of Wildlife Restoration.

Henke, S.E. and F.C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. J. Wildl. Manage. 63(4):1066-1081.

Hoffman, D.M. 1963. The lesser prairie-chicken in Colorado. J. Wildl. Manage. 27(4):726-732.

Holloran, M.J. 2005. Greater sage-grouse (*Centrocercus urophasianus*) population response to natural gas field development in western Wyoming. Ph.D. Dissertation, University of Wyoming, Laramie., 77 pp.

Horton, R.E. 2000. Distribution and abundance of lesser prairie-chicken in Oklahoma. Prairie Nat. 32(3):189-195.

Hughes, J. 1997. Personal letter dated, August 26, 1997. Texas Parks and Wildlife Department. 6pp.

Hughes 2008 personal communications with Stephanie Manes

Hunt, J.L. and T.L. Best. 2004. Investigation into the decline of populations of the lesser prairie-chicken (*Tympanuchus pallidicinctus*) on lands administered by the Bureau of Land Management, Carlsbad Field Office, New Mexico. Final Report, Cooperative Agreement GDA010007, 297 pp.

Jackson, A.S. and R.DeArment. 1963. The lesser prairie-chicken in the Texas panhandle. J. Wildl. Manage. 27(4):733-737.

Johnsgard, P.A. 1973. *Grouse and Quails of North America*. Univ. Nebraska Press, Lincoln. 553 pp.

Johnsgard, P.A. 1979. *Birds of the Great Plains-Breeding Species and Their Distribution*. Univ. Nebraska Press, Lincoln. 539 pp.

Johnsgard, P.A. 1983. *The Grouse of the World*. Univ. of Nebraska Press, Lincoln. 413 pp.

Johnsgard, P.A. 2002. *Grassland Grouse and Their Conservation*. Smithsonian Inst. Press, Washington. 157 pp.

Johnson, J. A. 2008. Recent range expansion and divergence among North American prairie grouse. J. Heredity 99(2):165-173.

Johnson, K., B.H. Smith, G. Sadoti, T.B. Neville, and P. Neville. 2004. Habitat use and nest site selection by nesting lesser prairie-chickens in southeastern New Mexico. Southwestern Nat. 49(3):334-343.

Jones, R.E. 1963. Identification and analysis of lesser and greater prairie-chicken habitat. J. Wildl. Manage. 27(4):757-778

Jones, R.E. 1964. The specific distinctness of the greater and lesser prairie chickens. Auk 81:65-73.

Jones, J.K., Jr., D.M. Armstrong, R.S. Hoffmann, C. Jones. 1983. *Mammals of the Northern Great Plains.* Lincoln, University of Nebraska Press.

Kimmel, R.O. 1987. Potential impacts of ring-necked pheasants on other game birds. Pages 253-265 in D. H. Hallett, W. R. Edwards, and G. V. Burger, eds. Pheasants: symptoms of wildlife problems on agricultural lands. Northcentral Section of The Wildlife Society.

Knopf, F.L. 1996. Prairie legacies - birds. Pages 135-148 in F. B. Samson and F. L. Knopf, eds. *Prairie Conservation: preserving North America's most endangered ecosystem*. Island Press, Washington, D. C.

Knopf, F.L. and F.B. Samson. 1997. Conservation of grassland vertebrates. Pages 273-289 in F. L. Knopf and F. B. Samson, eds. Ecology and conservation of Great Plains vertebrates. Ecological Studies Series 125. Springer-Verlag New York, New York. 320 pp.

Kuchler, A.W. 1985. Potential national vegetation. National Atlas of the United States of America, map. Reston. U. S. Department of the Interior, Geological Survey.

Laycock, W.A. 1987. History of grassland plowing and grass planting on the Great Plains. Pages 3-8 in J. E. Mitchell, ed. Impacts of the Conservation Reserve Program in the Great Plains, Symposium Proceedings. USDA Forest Service Gen. Tech. Rep. RM-158.

Leddy, K.L., K.F. Higgins, D.E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bull. 111(1): 100-104.

Lee, L. 1950. Kill analysis of the lesser prairie-chicken in New Mexico, 1949. J. Wildl. Manage. 14:475-477.

Lesser prairie-chicken Interstate Working Group. 1997. Draft conservation plan for lesser prairie-chicken (*Tympanuchus pallidicinctus*). 30 pp.

Ligon, J.S. 1927. Lesser prairie hen (*Tympanuchus pallidicinctus*). Pages 123-125 in Wildlife of New Mexico: its conservation and management. New Mexico Department of Game and Fish, Santa Fe. 212 pp.

Lionberger, J.E. 2008. Small game research and surveys: lesser prairie-chicken monitoring and harvest recommendations. Performance report to Federal aid in wildlife restoration, Texas Parks and Wildlife Department, Lubbock, Texas. 17 pp.

Lionberger, J.E. 2009. Small game research and surveys: lesser prairie-chicken monitoring and harvest recommendations. Performance report to Federal aid in wildlife restoration, Texas Parks and Wildlife Department, Lubbock, Texas. 17 pp.

Litton, G.W. 1978. The lesser prairie-chicken and its management in Texas. Texas Parks and Wildlife Department Booklet 7000-25. Austin, Texas. 22 pp.

Manville A.M., II. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. Division of Migratory Bird Management, US Fish and Wildlife Service, Arlington, VA, peer-reviewed briefing paper. 17 pp.

Mayes, S.G., M.A. McGinley, and C.R. Werth. 1998. Clonal population structure and genetic variation in sand-shinnery oak, *Quercus havardii* (Fagaceae). Amer. J. Bot. 85(11):1609-1617.

McRoberts, J.T. 2009. Aerial surveys for lesser prairie-chicken leks: detectability and disturbance response. M.S. thesis, Texas Tech University, Lubbock, Texas. 138 pp.

Merchant, S.S. 1982. Habitat use, reproductive success, and survival of female lesser prairie-chickens in two years of contrasting weather. M.S. thesis, New Mexico State Univ., Las Cruces.

Morrow, M.E. 1986. Ecology of Attwater's prairie chicken in relation to land management practices on the Attwater Prairie Chicken National Wildlife Refuge. Ph.D. Diss., Texas A&M Univ., College Station 100 pp.

Morrow, M.E., R.A. Adamcik, J.D. Friday, and L.B. McKinney. 1996. Factors affecting Attwater's prairie-chicken decline on the Attwater Prairie Chicken National Wildlife Refuge. Wildl. Soc. Bull. 24(4):593-601.

Moss, R. 2001. Second extinction of capercaillie (*Tetrao urogallus*) in Scotland? Biol. Cons. 101:255-257.

Moss, R., J. Oswald and D. Baines. 2001. Climate change and breeding success: decline of the capercaillie in Scotland. J. Animal Ecol 70 (1):47-61.

Natural Resources Conservation Service. 2008. Criteria for chemical brush management in lesser prairie-chicken and sand dune lizard habitat. Biology Technical Note 53. 3 pp.

Naugle, D.E., B.L. Walker, and K.E. Doherty. 2006(a). Sage-grouse population response to coal-bed natural gas development in the Powder River Basin: interim progress report on region-wide lek-count analyses. Unpublished Report, University of Montana, Missoula.

Naugle, D.E., K.E. Doherty, and B.L. Walker. 2006(b). Sage-grouse winter habitat selection

and energy development in the Powder River Basin: completion report. Unpublished Report, University of Montana, Missoula.

New Mexico Lesser Prairie Chicken / Sand Dune Lizard Working Group. 1995. Collaborative conservation strategies for the lesser prairie-chicken and sand dune lizard in New Mexico – findings and recommendations of the New Mexico lesser prairie-chicken/sand dune lizard Working Group. 179 pp.

Norton, K. D. 2007. March 29, 2007, letter from Kevin Norton, Acting State Conservationist, Natural Resources Conservation Service, Stillwater, OK. 2 pp. with enclosures.

Oberholser, H.C. 1974. *The Birdlife of Texas.* Vol. 1. Univ. Texas Press, Austin. 503 pp.

Oklahoma Climatological Survey. 2009. Annual precipitation history with 5-year weighted trends. Available at http://climate.mesonet.org/product.html?/images/climate_trends_traces/trace.OK-CD00.prcp.Annual.png. Accessed February 24, 2009.

Oklahoma Department of Wildlife Conservation. 2007. Performance Report, project number W-82-R-46, Project number 001. July 1, 2006 - June 30, 2007. Monitoring greater and lesser prairie-chickens. 7 pp.

O'Meilia, C. M. 2005. Interview with Chris O'Meilia, Fish and Wildlife Biologist, Oklahoma Ecological Services Field Office. (January 2005).

Patten, M.A, D.H. Wolfe, E. Shochat , and S.K. Sherrod. 2005(a). Effects of microhabitat and microclimate selection on adult survivorship of the lesser prairie-chicken. J. Wildl. Manage. 69:1270–1278.

Patten, M.A., D.H. Wolfe, E. Shochat, and S.K. Sherrod. 2005(b). Habitat fragmentation, rapid evolution, and population persistance. Evol. Ecol. Res. 7:235-249.

Pennel, E. 2009. SPP priority transmission expansion projects endorsed, pending further study. Press Release dated October 27, 2009. Available online at http://www.spp.org/publications/SPP_Priority_Projects_Endorsed_10_27_09.pdf Accessed April 14, 2006.

Pence, D.B. and D.L. Sell. 1979. Helminths of the lesser prairie chicken, Tympanuchus pallidicintux (Ridgway) (Tetraonidae), from the Texas panhandle. Proc. Helminth. Soc. of Washington 46(1):146-149.

Peterson, M.J. 2004. Parasites and infectious diseases of prairie grouse: should managers be concerned? Wildl. Soc. Bull. 32(1):35-55.

Peterson, M.J., P.J. Ferro, M.N. Peterson, R.M. Sullivan, B.E. Toole, and N.J. Silvy. 2002. Infectious disease survey of Lesser prairie chickens in North Texas. J. Wildl. Dis.

38(4):834-839.

Peterson, M.J. and N.J. Silvy. 1994. Spring precipitation and fluctuations in Attwater's prairie-chicken numbers: hypotheses revisited. J. Wildl. Manage. 58(2):222-229.

Peterson, R.S., and C.S. Boyd. 1998. Ecology and management of sand shinnery communities: a literature review. USDA Forest Service General Technical Report. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, USA. 44 pp.

Pettit, R.D. 1986. Sand shinnery oak: control and management. Management Note 8. Texas Tech Univ., Lubbock. Range and Wildlife Manage. 5 pp.

Petty, S.J. 1995. Assessment of fence collisions by grouse species in Scotland. For. Comm. Res. Info. Note 264.

Pitman, J.C., C.A. Hagen, B.E. Jamison, R.J. Robel, T.M. Loughlin, and R.D. Applegate. 2006. Survival of juvenile lesser prairie-chickens in Kansas. Wildl. Soc. Bull. 34(3):675-681.

Pitman, J.C., C.A. Hagen, R.J. Robel, T.M. Loughlin, and R.D. Applegate. 2005. Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance. J. Wildl. Manage. 69(3):1259-1269.

Playa Lakes Joint Venture. January 29, 2007. Draft species distribution map for the lesser prairie-chicken.

Pruett, C.L. M.A. Patten, and D.H. Wolfe. 2009. It's not easy being green: wind energy and a declining grassland bird. BioScience 59(3):257-262.

Ridgway, R. 1873. A new variety of prairie chicken. Bull. Essex Inst. 5:199.

Ridgway, R. 1885. Some emended names of North American birds. Proceedings of the United States National Museum, 8:354-356.

Riffell, S.K. and L.W. Burger. 2006. Estimating wildlife response to the Conservation Reserve Program: bobwhite and grassland birds. Final report for: solicitation number FSA-R-28-04DC, Farm Service Agency, Acquisition Management Branch, Special Projects Section. 49 pp.

Riley, T.Z., C.A. Davis, and R. A. Smith. 1993. Autumn and winter foods of the lesser prairie-chicken (*Tympanuchus pallidicinctus*) (Galliformes: Tetraonidae). Great Basin Nat. 53(2):186-189.

Riley, T.Z., C.A. Davis, M. Ortiz, and M. J. Wisdom. 1992. Vegetative characteristics of successful and unsuccessful nests of lesser prairie-chickens. J. Wildl. Manage. 56(2):383-387.

Ripper, D., and T. VerCauteren. 2007. Assessment of CRP fields with current Lesser Prairie-Chicken range. Tech. Report # PPR-LEPC-ED07-01, Rocky Mountain Bird Observatory, Brighton, CO, 42 pp.

Robb, L.A. and M.A. Schroeder. 2005. Lesser prairie-chicken (*Tympanuchus pallidicinctus*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. Available on-line at: http://www.fs.fed.us/r2/projects/scp/assessments/lesserprairiechicken.pdf.

Robel, R.J. 2002. Expected impacts on greater prairie-chickens of establishing a wind turbine facility near Rosalia, Kansas. Report to Zilkha Renewable Energy. 31 pp.

Robel, R.J., J.A. Harrington, Jr., C.A. Hagen, J.C. Pitman, and R.R. Reker. 2004. Effect of energy development and human activity on the use of sand sagebrush habitat by lesser prairie chickens in southwestern Kansas. Trans. 69th No. Am. Wildl. And Natur. Res. Conf.:251-266.

Robel, R.J., T.L. Walker, Jr., C.A. Hagen, R.K. Ridley, K.E. Kemp, and R.D. Applegate. 2003. Helminth parasites of lesser prairie-chicken *Tympanuchus pallidicinctus* in southwestern Kansas: incidence, burdens and effects. Wildl. Biol. 9(4):341-349.

Rodgers, R. 2006. Prairie Chicken Lek Survey – 2006. May 2006 Performance Report, Kansas Dept. Wildl. and Parks, 5 pp.

Rodgers, R. 2007a. Letter written to US Fish and Wildlife Service, Oklahoma Ecological Services, March 15, 2007. Resources directed at benefiting lesser prairie chickens in Kansas (January 2006 – February 2007). Kansas Department of Wildlife and Parks. 4 pp.

Rodgers, R. 2007b. Prairie Chicken Lek Survey – 2007. May 2007 Performance Report, Kansas Dept. Wildl. and Parks, 5 pp.

Rodgers, R. 2008. Prairie Chicken Lek Survey – 2008. May 2008 Performance Report, Kansas Dept. Wildl. and Parks, 5 pp.

Rodgers, R. 2009. Prairie Chicken Lek Survey – 2009. June 2009 Performance Report, Kansas Dept. Wildl. and Parks, 6 pp.

Rodgers, R. D. and R. W. Hoffman. 2005. Prairie Grouse Population Response to Conservation Reserve Grasslands: An Overview. Pgs. 120-128 *in* A. W. Allen and M. W. Vandever, eds. The Conservation Reserve Program–Planting for the Future: Procedings of the National Conference, Fort Collins, Colorado, June 6-9, 2004. U. S. Geological Survey, Biological Resources Division, Scientific Investigation Report 2005-5145. 248 pp.

Samson, F.B. 1980. Island biogeography and the conservation of prairie birds. Proc. N. Am. Prairie Conf. 7:293-305.

Sands, J.L. 1968. Status of the lesser prairie-chicken. Audubon Field Notes 22:454-456.

Sargeant, A.B., S.H. Allen, and R.T. Eberhardt. 1984. Red fox predation on breeding ducks in midcontinent North America. Wildl. Monogr. 89:1-41.

Schoeling, D. 2010. E-mail communication dated February 8, 2010, providing 2009 lek attendance and density estimates for Oklahoma. Oklahoma Dept. of Wildlife Conservation, unpublished data. 5pp.

Schwilling, M.D. 1955. A study of the lesser prairie-chicken in Kansas. Job completion report, Kansas Forestry, Fish and Game Comm., Pratt. 51 pp.

Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harnik, A. Leetmaa, N. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminet transistion to a more arid climate in southwestern North America. Science 316(5828):1181-1184.

Seyffert, K.D. 2001. Birds of the Texas Panhandle: their status, distribution, and history. Texas A&M University Press, College Station, Texas, 501 pp.

Sharp, W.M. 1957. Social and range dominance in gallinaceous birds - pheasants and prairie grouse. J. Wildl. Manage. 21:242-244.

Shively, S. 2009a. Unpublished LEPC counts for the Comanche National Grasslands provided by e-mail to K. Collins, USFWS, Tulsa, OK on April 16, 2009. 4 pp.

Shively, S. 2009b. Unpublished LEPC survey report for the Comanche National Grasslands dated November 21, 2009 and provided by e-mail to K. Collins, USFWS, Tulsa, OK on April 12, 2010. 3 pp.

Smith, B.H., D.W. Duszynski, and K. Johnson. 2003. Survey for coccidia and haemosporidia in the lesser prairie-chicken (*Tympanuchus pallidicintus*) from New Mexico with description of a new *Eimeria* species. J. Wildl. Dis. 39(2):347-353.

Smith, L. and R. Smith. 1999. Cimarron National Grassland lesser prairie-chicken lek survey report. Unpublished report on file at the Cimarron National Grasslands Ranger District Office, Elkhart, Kansas.

Smith, L., K. Johnson, and L. De Lay. 1998. Survey of the lesser prairie chicken on Bureau of Land Management lands, Carlsbad Resource Area, NM, 1998. New Mexico Natural Heritage Program, Department of Biology, University of New Mexico, 12 pp.

Snyder, W.A. 1967. Lesser prairie-chicken. Pages 121-128 in New Mexico Wildlife Management. New Mexico Dept. Game and Fish, Santa Fe.

Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A.

Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt. 2007: Technical Summary. Pages 19-90 In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the FourthAssessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Southwest Power Pool. 2006. SPP Transmission Expansion to Support Development of Texas Panhandle Competitive Renewable Energy Zones (CREZs). 15 pp.

Stabler, R.M. 1978. Plasmodium (Giovannolaia) pedioecetii from the lesser prairie chicken, *Tympanuchus pallidicinctus*. J. Parasitol. 64(6):1125-1126.

Stebbins, G.L. 1981. Coevolution of grasses and herbivores. Ann. Missouri Bot. Garden 68(1):75-86.

Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. *Range Management*. McGraw-Hill Book Co. New York. 532 pp.

Sullivan, R.M., J.P. Hughes, and J.E. Lionberger. 2000. Review of the historical and present status of the lesser prairie-chicken (Tympanuchus pallidicinctus) in Texas. The Prairie Naturalist 32:177-188.

Taylor, M.A. 1979. Lesser prairie chicken use of man-made leks. Southwestern Nat. 24(4): 706-707.

Taylor, M.A. and F.S. Guthery. 1980a. Fall-winter movements, ranges, and habitat use of lesser prairie-chickens. J. Wildl. Manage. 44(2): 512-524.

Taylor, M.A. and F.S. Guthery. 1980b. Status, ecology, and management of the lesser prairie-chicken. U. S. Dept. Agri. Forest Serv. Gen. Tech. Rep. RM-77. 15 pp.

Texas Railroad Commission, person communication citation with Stephanie Manes

Tilman, D. and A. El Haddi. 1992. Drought and biodiversity in grasslands. Oecologia 89(2):257-264.

U.S. Department of Energy, National Renewable Energy Laboratory. 2010a. Wind powering America – Installed wind capacity – yearly individual maps. Available online at: http://www.windpoweringamerica.gov/wind_installed_capacity. Accessed April 15, 2010.

U.S. Department of Energy, National Renewable Energy Laboratory. 2010b. New wind

resource maps and wind potential estimates for the United States--Individual maps. Available online at: http://www.windpoweringamerica.gov/wind_maps.aspx. Accessed April 16, 2010.

U.S. Forest Service. 2008. Cimarron and Comanche National Grasslands Land Management Plan. Pueblo, CO. 233 pp.

Vance, D.R. and R.L. Westemeier. 1979. Interactions of pheasants and prairie chickens in Illinois. Wildl. Soc. Bull. 7(4):221-225.

Verquer, T.L. 2007. Colorado lesser prairie-chicken breeding survey 2007. CO Div. of Wildl. 5 pp.

Verquer, T.L. 2008. Colorado lesser prairie-chicken breeding survey 2008. CO Div. of Wildl. 6 pp.

Verquer, T.L. 2009. Colorado lesser prairie-chicken breeding survey 2009. CO Div. of Wildl. 6 pp.

Waddell, B.H. and B. Hanzlick. 1978. The vanishing sandsage prairie. Kansas Fish and Game 35(2):17-23.

Westemeier, R.L., T.L. Esker, and S.A. Simpson. 1989. An unsuccessful clutch of northern bobwhites with hatched pheasant eggs. Wilson Bull. 101(4):640-642.

Westemeier, R.L., J.E. Buhnerkempe, W.R. Edwards, J.D. Brown, and S.A. Simpson. 1998. Parasitism of greater prairie-chicken nests by ring-necked pheasants. J. Wildl. Manage. 62(3): 854-863.

Whitlaw, H. 2007. Letter to US Fish and Wildlife Service, Oklahoma Ecological Services dated April 6, 2007 regarding 2007 lesser prairie-chicken candidate notice of review. 5 pp.

Wiedeman, V.E. 1960. Preliminary ecological study of the shinnery oak area of western Oklahoma. p 46. University of Oklahoma, Norman.

Wiedenfeld, D.A., D.H. Wolfe, J.E. Toepfer, L.M. Mechlin, R.D. Applegate, and S.K. Sherrod. 2002. Survey for reticuloendotheliosis viruses in wild populations of greater and lesser prairie-chickens. Wilson Bull. 114(1):142-144.

Wilcove, D.S., C.H. McLellan, and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. Pages 237-256 *in* M. E. Soule, ed. Conservation Biology. Sinauer Associates, Sunderland, Mass.

Wisdom, M J. 1980. Nesting habitat of lesser prairie chickens in eastern New Mexico. M. S. Thesis, New Mexico State Univ., Las Cruces.

Wisdom, M.J. and L.S. Mills. 1997. Sensitivity analysis to guide population recovery: prairie-chickens as an example. J. Wildl. Manage. 61(2):302-312.

Wolfe, D.H. 2008. Telephone interview with Don Wolfe, Research Biologist, G.M. Sutton Avian Research Center (October 8, 2008).

Wolfe, D.H. 2008. Telephone interview with Don Wolfe, Research Biologist, G.M. Sutton Avian Research Center.

Wolfe, D.H. 2010. Telephone interview with Don Wolfe, Research Biologist, G.M. Sutton Avian Research Center (March 10, 2010).

Wolfe, D.H., M.A. Patten, and S.K. Sherrod. 2009. Reducing grouse collision mortality by marking fences (Oklahoma). Ecol. Rest. 27(2):141-143.

Wolfe, D.H., M.A. Patten, E. Shochat, C.L. Pruet, and S.K. Sherrod. 2007. Causes and patterns of mortality in lesser prairie-chickens *Tympanuchus pallidicinctus* and implications for management. Wildl. Biol. 13(1):95-104.

Woodward, A. J.W., S.D. Fuhlendorf, D.M. Leslie, and J. Shackford. 2001. Influence of landscape composition and change on lesser prairie-chicken (*Tympanuchus pallidicinctus*) populations. Amer. Midl. Nat. 145(2):261-274.

Yost, J.A. 2005. Colorado lesser prairie-chicken breeding survey 2005. Colorado Division of Wildlife Annual Report, Denver. 4 pp.

Zetterberg, R. Electronic mail from Richard Zetterberg, Assistant State Conservationist – programs, NRCS, Stillwater, OK (March 27, 2007).

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: _____ May 21, 2010

Acting Regional Director, Fish and Wildlife Service Date

Concur: _____ Date: October 22, 2010

ACTING

Director, Fish and Wildlife Service

Do not concur: _____ _____

Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: April 2010
Conducted by: Ken Collins